



The 15th Annual Summer Conference on
Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery

DATE

2021. 6. 25 Fri ~ 26 Sat

VENUE

강릉 세인트존스호텔 그랜드볼룸

주최:  **대한뇌혈관내치료의학회**
Korean Neuroendovascular Society

주관:  **대한신경외과학연구재단**
THE KOREAN NEUROSURGICAL SOCIETY

인사말



존경하는 대한뇌혈관내치료의학회 회원 여러분!

회원 여러분을 동해안의 아름다운 도시 강릉으로 초대합니다.

코로나 바이러스 재확산과 백신접종의 어려움이 지속되고는 있으나 의료인은 대부분 백신접종을 시행하였기에 방역수칙을 준수하면서 ASCENT 2021을 개최하고자 합니다.

이번 학회의 테마는 “Exploring What is Next in Neuroendovascular Surgery”으로 정했습니다.

의학회에 가입한 다학제 학회로서 다양한 분야의 배경을 갖고 있는 회원들이 시행하고 있는 최신 연구에 대한 강의를 들을 수 있을 것이며, 최근 국내에 도입된 “WEB Intrasaccular Flow Disruptor”에 대한 해외의 경험과 기존 치료와의 차이를 조망해 보는 “Bifurcation Aneurysm Session”이 흥미로울 것입니다.

초청 강연은 “심미안” 책의 저자이신 윤광준 선생님을 모시고 “아름다움으로 채우는 일상”이라는 주제로 우리의 삶을 다른 각도에서 되짚어보는 시간을 마련하였습니다. ‘뇌혈관 시술의’로 환자의 건강을 지키기 위해 헌신적인 삶을 살아가는 우리들에게 삶의 목적이 무엇인지, 행복이란 무엇인지를 ‘아름다움’이란 화두를 통해서 생각해 보는 유익한 시간이 될 것입니다.

우리 학회의 저변을 확대하기 위해 혈관내 치료의 가장 기본인 대퇴동맥 천자에서부터 다양한 혈관내 접근 방법에 이르기까지 기본에 대한 미니 심포지엄을 준비하였습니다. 이와 함께 새로이 입문하는 초심자를 위한 “Basic Endovascular Training Course”에서는 경동맥 협착에 대한 스텐트 시술에 초점을 맞추어 강의와 워크숍을 준비하였으니 관심있는 회원 여러분께서는 여러 회사의 스텐트를 직접 설치해 볼 수 있을 것입니다.

마지막으로 코로나-19 재확산으로 인해 어려운 상황에서도 학술대회를 준비하느라 수고해 주신 임원 여러분께 감사드리며, 항상 우리 학회에 관심을 갖고 후원에 주시는 기업 관계자 여러분께도 감사의 인사를 드립니다.

모쪼록 건강에 유의하시고 건강한 모습으로 강릉에서 뵙기를 고대합니다.

감사합니다.

대한뇌혈관내치료의학회 회장 윤 석 만

2020~2021 대한뇌혈관내치료의학회 임원진

명예회장

직 위	성 명	소 속
명예회장	백민우	인봉의료재단 뉴고려병원
	권도훈	울산대학교 서울아산병원

회장

직 위	성 명	소 속
회장	윤석만	순천향대학교 천안병원

상임이사

직 위	성 명	소 속
총무	박석규	순천향대학교 서울병원
학술	권순찬	울산대학교병원
정책	신승훈	차의과학대학교 분당차병원
재무	김영우	가톨릭대학교 의정부성모병원
수련교육	유승훈	울산대학교 강릉아산병원
	김태곤	차의과학대학교 분당차병원
간행	하성곤	고려대학교 안산병원
보험	권현조	충남대학교병원
	정준호	연세대학교 세브란스병원
	박석규	순천향대학교 서울병원
대외협력	김성림	가톨릭대학교 부천성모병원
국제교류	정진영	연세에스병원
법제윤리	고준경	부산대학교병원
홍보	신희섭	강동경희대학교병원
전산정보	장경술	가톨릭대학교 인천성모병원
	신동성	순천향대학교 부천병원
회원관리	장인복	한림대학교 평촌성심병원
진료지침	남택균	중앙대학교병원
	최재형	동아대학교병원
연보·학회사편찬	임용철	아주대학교병원
진료심의	박중철	울산대학교 서울아산병원
전문병원	김문철	에스포항병원
	허준	명지성모병원
학술지편집	김대원	원광대학교병원
인증관리	이호국	한림대학교 강남성심병원
다기관임상	김범태	순천향대학교 부천병원
미래전략	권오기	분당서울대학교병원
국제학술대회	신용삼	가톨릭대학교 서울성모병원
의학회	장철훈	영남대학교병원
여의사위원회	심숙영	인제대학교 서울백병원
심뇌혈관질환정책	윤창환	분당서울대학교병원 순환기내과
뇌신경마취	전영태	분당서울대학교병원 마취통증의학과
의료기기연구	양수근	인하대학교 의과대학 의생명학과
뇌신경재활	김수아	순천향대학교 천안병원 재활의학과
다학제연구	이학승	원광대학교병원 신경과
다학제연구	정용안	가톨릭대학교 인천성모병원 핵의학과
다학제연구	이아름	순천향대학교 부천병원 영상의학과

2020~2021 대한뇌혈관내치료의학회 임원진

직 위	성 명	소 속
광주/전라지회	김대원	원광대학교병원
대구/경북지회	장철훈	영남대학교병원
대전/충청지회	권현조	충남대학교병원
부산/울산/경남지회	정진영	연세에스병원
인천지회	현동근	인하대학교병원
감사	고정호	단국대학교병원
	이종영	한림대학교 강동성심병원
간사	오재상	순천향대학교 천안병원

전임회장단

직 위	성 명	소 속
초대, 제2대	백민우	인보의료재단 뉴고려병원
제3대	김영준	오산한국병원
제4, 5대	권도훈	울산대학교 서울아산병원
제6대	안성기(작고)	(전) 한림대학교 성심병원
제7대	신용삼	가톨릭대학교 서울성모병원
제8대	권오기	분당서울대학교병원
제9대	김범태	순천향대학교 부천병원
제10대	성재훈	가톨릭대학교 성빈센트병원
제11대	고준석	강동경희대학교병원

초청연자

정 용 안

가톨릭대학교 방사선과학교실 핵의학과 교수
인천성모병원 뇌과학중개연구소장



학력	2004	가톨릭대학교 의과대학원 석박사
경력	2001-2002	가톨릭대학교 강남성모병원 핵의학과 임상강사
	2002-2004	가톨릭대학교 성모병원 핵의학과 전임강사
	2006-2007	Visiting Assistant Professor, Brain Imaging LAB, New York State Psychiatric Institute & Columbia University
	2004-2008	가톨릭대학교 의과대학 방사선과학교실 조교수
	2008-2013	가톨릭대학교 의과대학 방사선과학교실 부교수
	2013-현재	가톨릭대학교 의과대학 방사선과학교실 교수
연구비 수혜실적	2012-2019	교육과학기술부 글로벌프론티어사업 실감교류 인체감응솔루션연구단
	2009-2015	교육과학기술부 신기술융합형성장동력사업 첨단의료기기사업본부장, 미래기반기술 개발사업
	2002-2009	과학기술부 원자력기술개발과제 방사선뇌과학연구비

초청연자

이 종 하

계명대학교 의과대학 의용공학과



학력

2000	인하대학교 전자공학과 학사
2006	New York University, Tandon School of Engineering, Electrical Engineering 석사
2011	Temple University, Electrical Engineering 박사

경력

2000-2002	J.T. Corp (병역특례), 소프트웨어 엔지니어
2009. 5-9	삼성전자 종합기술원, Future IT Research Lab, 해외 우수 박사 유학생 인턴
2004-2005	The Center for Advanced Technology in Telecommunications and Distributed Information Systems, New York (뉴욕 CATT 연구소), 연구원
2006-2011	Control, Sensor, Network, and Perception (CSNAP) Lab, Temple University, 연구원
2011-2012	삼성전자 종합기술원, Future IT Research Lab, Data Analytics group, 전문연구원

초청연자

김 수 아

순천향대학교 천안병원 재활의학과



학력

1997	순천향대학교 의과대학 졸
2009	순천향대학교 대학원(박사)

경력

2018-현재	순천향대학교 부속 천안병원 교수
2006.06-2007.05	Schwab rehabilitation hospital at Chicago 연수
2014-현재	순천향대학교 부속 천안병원 재활의학과 과장
소아재활 2,3판 공동저술	

초청연자

윤 광 준

작가



글과 사진 영역을 넘나드는 작가로 열여섯 권의 책을 냈고 세 번의 사진전을 열었다. 대표작인 잘 찍은 사진 한 장, 생활명품, 심미안 수업, 내가 사랑한 공간들은 베스트 셀러다.

일상의 삶을 예술로 채우자는 지론으로 음악과 미술 건축 디자인에 관심 높다. 이들 분야의 연결과 협업을 이끄는 아트 워커로 활동한다. EBS를 비롯해 SBS, MBC TV에 출연했으며 중앙일보와 농민신문에 고정 컬럼을 연재 중이다.

Jacques Moret

Department of Interventional Neuroradiology,
Bicêtre University Hospital, France



Professional Situation

1975	Medical Doctor
1974-1977	Fellowship in Radiology
1975	Fellow, Department of Neuroradiology, Loma Linda University, USA
1977	Board of Radiology, René Descartes University, Paris, France
1993	Habilitation to Conduct Researches (HDR)
1989-1994	Full Professor of Radiology, Baylor College Of Medicine, Houston, Texas, USA
1994-2010	Former Chairman, Department of Interventional Neuroradiology, at The Foundation Rothschild Hospital, Paris, France
2011-2015	Former Chairman, Department of Interventional Neuroradiology, At Beaujon University Hospital Clichy, Paris, France
2015-Present	Honorary Chairman Department Of Interventional Neuroradiology At Bicêtre University Hospital Le Kremlin Bicêtre, Paris, France Professor of Neuroradiology, University Paris VII, Faculty Of Medicine "Bichat-Beaujon", Paris, France

Medical Societies

Member of The "Societe Francaise de Neuroradiologie"
Member (Former) of The "European Society of Neuroradiology"
Member (Former) of The "The American Society of Neuroradiology"
Member of the ESMINT "European Society of Minimally Invasive Neurological Therapy"
Founding Member of the "ABC-W.I.N." (Working Group In Interventional Neuroradiology)
Member (Former) of the "Cardiovascular and Interventional Radiological Society of Europe"
Member of the "Societe de Neurochirurgie de Langue Francaise"
Member (Former) of the "Societe de Chirurgie Vasculaire de Langue Francaise"
Member of "World Federation of Interventional and Therapeutic Neuroradiology"

프로그램

6 / 25 Fri

09:00-12:00	Workshop for review board of HIRA service / 장소: 바부다홀	좌장_ 권오기(서울대) / 박석규(순천향대)	
09:00-09:45	1. 심사체계 개편의 방향과 자율형 심사	박영희(건강보험심사평가원)	17
09:45-10:30	2. 뇌혈관내치료 심사의 기본	권오기(서울대)	18
10:30-11:15	3. 뇌혈관내치료 심사의 실제 및 제언 (I)	권현조(충남대)	19
11:15-12:00	4. 뇌혈관내치료 심사의 실제 및 제언 (II)	최재형(동아대)	20
11:00-12:00	Registration		
12:00-13:00	Mini-symposium for navigation to target vessels	좌장_ 임용철(아주대) / 이종영(한림대)	
	1. Trans-femoral approach	김명진(가천대)	27
	2. Trans-brachial approach	박상규(연세대)	29
	3. Direct carotid / vertebral approach	신동성(순천향대)	37
	4. Guiding technique for endovascular surgery	김성태(인제대)	43
13:20-13:30	Opening remark	윤석만(대한뇌혈관내치료의학회 회장)	
	Welcome remark	이일우(대한신경외과학회 회장)	
13:30-14:40	Free paper I : Ecstasy session (Troubleshooting for difficult cases)	좌장_ 이호국(한림대) / 고준석(경희대)	
13:30-13:40	Distinguishment the ruptured aneurysm at multiple aneurysm	배희진(명지병원)	53
13:40-13:50	SAH and dissecting aneurysm of ophthalmic artery	김소연(가톨릭관동대학교 국제성모병원)	54
13:50-14:00	Treatment of symptomatic partially thrombosed giant fusiform aneurysm of basilar artery	김재현(계명대학교 동산병원)	55
14:00-14:10	Successful rescue from desperate complication; retrieving damaged stent and migrated coil with another retrievable stent - A case report	박성찬(울산대학교병원)	56
14:10-14:20	Onyx embolization of dural AVF in the superior sagittal sinus region using external compression and direct open access: A case report	장동규(가톨릭대학교 인천성모병원)	57
14:20-14:30	Use of a rigid-tipped microwire for the endovascular treatment of cavernous sinus dural arteriovenous fistula with a membranous stricture	박중철(울산대학교 서울아산병원)	58
14:30-14:40	Treatment of symptomatic tandem BA & V4 severe stenosis	박현욱(부산부민병원)	59
14:40-15:40	Symposium I : Interdisciplinary session	좌장_ 김범태(순천향대) / 양수근(인하대 의생명학과)	
	1. Neurostimulation & clinical application	정용안(가톨릭대 핵의학과)	63
	2. The Computer Aided Diagnostics Algorithm and Intracranial Applicable Catheter of Intravascular OCT	이종하(계명대 의공학학과)	69
	3. Stroke rehabilitation at present, and in the future	김수아(순천향대 재활의학과)	76
15:40-16:00	Photo time & Coffee break		
16:00-16:40	인문학 특강	좌장_ 윤석만(순천향대)	
	아름다움으로 채우는 일상	윤광준 (작가)	83
16:40-16:50	Transfer		
16:50-18:00	Free paper II : Agony Session (Complication cases)	좌장_ 김태선(전남대) / 장철훈(영남대)	
16:50-17:00	Fatal complication of procedural rupture in unruptured cerebral aneurysm	진성철(인제대학교 해운대백병원)	87
17:00-17:10	A case of delayed rebleeding following ruptured anterior communicating artery aneurysm embolization	이성호(순천향대학교 천안병원)	88

17:10-17:20	Delayed rebleeding from ruptured broad-neck posterior communicating artery aneurysm after double-stent assisted coil embolization	정연구(성균관대학교 강북삼성병원)	89
17:20-17:30	A case of segment occlusion after treatment with a pipeline endovascular device in dissecting aneurysm on dominant VA	김창현(양산부산대학교병원)	90
17:30-17:40	Direct carotid cavernous fistula after pipeline implantation for a symptomatic large cavernous internal carotid artery aneurysm	반승필(분당서울대학교병원)	91
17:40-17:50	Superior sagittal sinus occlusion due to probable thrombocytopenic thrombosis after AstraZeneca COVID-19 Vaccination	최선웅(가톨릭대학교 부천성모병원)	92
17:50-18:00	Acute management of iatrogenic vertebral artery dissection during treatment of proximal vertebral artery stenosis	하상우(조선대학교병원)	93
16:50-17:50	Satellite symposium for nurses and technicians / 장소: 바부다홀 좌장_ 김태곤(차의과학대) / 심숙영(인제대)		
	1. Natural history and treatment guidelines of cerebral aneurysm	오세양(인하대)	97
	2. Endovascular treatment of cerebral aneurysm	김대원(원광대)	106
	3. Perioperative care of cerebral aneurysm	고정호(단국대)	114
18:00-18:20	<i>General Assembly of KoNES</i>	박석규(대한뇌혈관내치료의학회 총무이사)	
18:30-20:30	만찬	신희섭(대한뇌혈관내치료의학회 홍보이사)	

6/26 Sat

09:00-12:00	Basic endovascular training course	좌장_ 유승훈(울산대) / 장인복(한림대)	
	1. Imaging of carotid stenosis	이아름(순천향대 영상의학과)	127
	2. Review of devices	윤원기(고려대)	140
	3. Patent selection, technical tips and basic tactics	신병국(동의의료원)	157
	4. Escape from complicated situation	김영우(가톨릭대)	161
	5. Hands-on		
12:30-13:30	Luncheon seminar	좌장_ 이창영(계명대) / 김문철(에스포항병원)	
	1. Role of direct thrombin inhibitor for acute ischemic stroke	정진영(연세메스병원)	173
	2. Safety and feasibility of using Argatroban	이동훈(가톨릭대)	181
13:30-14:50	Free paper III : Early experiences by young gun in EVT	좌장_ 성재훈(가톨릭대) / 신승훈(차의과학대)	
13:30-13:40	Complications and solutions in treating cerebral arteriovenous malformation with liquid-embolic materials; Beginner's personal experience	조동영(이화여자대학교 서울병원)	185
13:40-13:50	Contrast neurotoxicity after coil embolization for cerebral unruptured aneurysm mimicking subarachnoid hemorrhage	김학성(중앙보훈병원)	186
13:50-14:00	Intractable seizure after endovascular coil embolization of unruptured paraclinoid aneurysm	윤별희(의정부유지대학교병원)	187
14:00-14:10	Framing coil total prolapse due to stretched coil stuck in a microcatheter	정동환(한림대학교 동탄성심병원)	188
14:10-14:20	First voyage as a neurosurgery vascular surgeon	박재원(천안충무병원)	189
14:20-14:30	The use of contralateral angioplasty to improve collateral flow in case of difficulty in initial EVT position	최연주(에스포항병원)	190
14:30-14:40	Early-visit patients with poor clinical outcomes after successful recanalization with multiple retrieval attempts	김승환(성균관대학교 삼성창원병원)	191
14:40-14:50	Safety and efficacy of mechanical thrombectomy using balloon-expandable stent deployment as a rescue therapy after failed stent retriever thrombectomy — young gun in EVT (Case report)	김상영(에스포항병원)	192

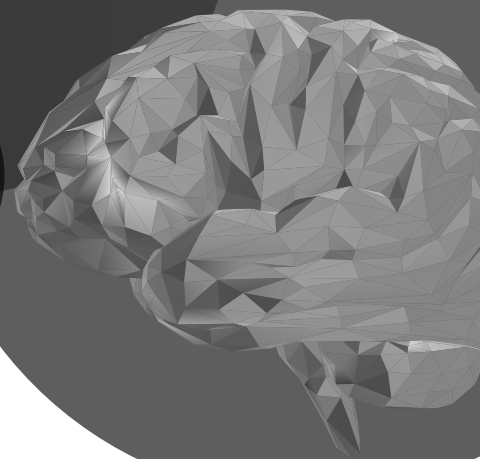
14:50-15:20	Introduction of new endovascular devices by company	좌장_ 정준호(대한뇌혈관내치료의학회 보험이사)
15:20-15:40	<i>Coffee break</i>	
15:40-17:20	Symposium II : Bifurcation aneurysm from clipping/coiling to flow modulation	좌장_ 신용삼(가톨릭대) / 권순찬(울산대)
15:40-16:00	1. Why clipping for bifurcation aneurysm	하성곤(고려대) 197
16:00-16:20	2. Why coiling for bifurcation aneurysm	박정현(한림대) 206
16:20-16:40	3. Benefit of flow disruptor on bifurcation aneurysm	신용삼(가톨릭대) 207
16:40-17:20	4. Update and review for flow disruptor on bifurcation aneurysm	Jacques Moret (NEURI center, Bicêtre University Hospital, France) 208
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P-02	Initial experiences of flow redirection endoluminal device (FRED) for complex cerebral aneurysms	강범모(순천향대학교 천안병원) 212
P-03	Clinical and angiographic outcomes of thrombectomy with novel stent-type clot-retrieval Embotrap II device in acute major arterial occlusion	김창현(계명대학교 동산병원) 213
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P-10	Y-stent-assisted-coil embolization of a wide-necked anterior communicating aneurysm involving a subcallosal artery: A case report	장동규(가톨릭대학교 인천성모병원) 220
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The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/25(Fri.)

Workshop for review board of HIRA service

좌장 : 권오기(서울대) / 박석규(순천향대)

1. 심사체계 개편의 방향과 자율형 심사
2. 뇌혈관내치료 심사의 기본
3. 뇌혈관내치료 심사의 실제 및 제언 (I)
4. 뇌혈관내치료 심사의 실제 및 제언 (II)

박영희(건강보험심사평가원)

권오기(서울대)

권현조(충남대)

최재형(동아대)

심사체계 개편의 방향과 자율형 심사

박 영 희

건강보험심사평가원

뇌혈관내치료 심사의 기본

권 오 기

분당서울대학교병원 신경외과

뇌혈관내치료 심사의 실제 및 제언 (I)

권 현 조

충남대학교병원 신경외과

뇌혈관내치료 심사의 실제 및 제언 (II)

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뇌혈관내 치료의 심사기준 (II)

동아대 병원 최재형, 부산대 병원 이재일

연번	제목
1	Detachable coil의 급여기준
2	뇌혈관의 중재적 시술 시 사용하는 Distal Access Intermediate Catheter(원위 접근용 중간도관) 급여기준
3	경피적 두개강내 동맥 스텐트 삽입술 시 스텐트의 급여기준
4	경피적 두개강외 동맥스텐트 삽입술 시 스텐트의 급여기준
5	뇌동맥류 코일이탈방지용 스텐트의 급여기준
6	액체형 색전물질(뇌혈관용)의 급여기준
7	기계적 혈전제거술용 치료재료 (회수성 Stent, 흡인성 Catheter)의 급여기준
8	뇌혈관내 흡인기구를 이용한 혈전제거술(penumbra system)Thrombectomy using aspiration device in intracranial vessel(penumbra system)
9	뇌동정맥기형적출술 시 사용하는 AVM (Arterio-Venous Malformation) Microclip의 급여기준
10	뇌동맥류수술시 클립(Clip) 종류별 산정기준
11	Flow-diverter를 이용한 뇌동맥류 색전술용 색전 기구(Embolization Device)의 급여기준
12	Flow-diverter를 이용한 뇌동맥류 색전술 Intracranial Aneurysms Embolization with Flow-diverter

Intra-cranial stenosis
→ balloon angioplasty & stenting

Carotid stenosis
→ Extra-cranial stenting (carotid stenting)

Acute ischemic stroke
→ Mechanical thrombectomy

AVM/CCF/Dural AVF
→ Embolization with Coil and Liquid material

경피적 풍선혈관 성형술 (Percutaneous Transluminal Angioplasty)

• 행위 정의

뇌혈관 협착 부위에 경피적으로 풍선을 확장시켜 혈관을 성형하는 수술

- 뇌혈관
- 경동맥 (추골동맥 포함)

적용증

- 1) 뇌혈관내 동맥, 경동맥, 추골동맥 협착에 의한 뇌관류 장애
- 2) 경동맥, 추골동맥 협착에 의한 뇌동맥 색전의 병력 또는 검사상의 증거
- 3) 경동맥 또는 추골동맥 박리에 의한 진행성 혈관협착 또는 파열
- 4) 혈전에 의한 경동맥 협착, 폐색

경피적 풍선혈관 성형술 (Percutaneous Transluminal Angioplasty)

고시 제2018-185호(행위), 2018.11.01 시행

• 세부인정 사항

- 가. 내경 70% 이상의 협착이 있는 경우
- 나. 협착부위 근위부와 원위부의 수축기 혈압의 차이
 - 1) 안정기에 혈압차 10mmHg 이상
 - 2) 혈관 확장제 투여 후 15mmHg(또는 15%) 이상 차이가 있는 경우

• 경피적풍선혈관 성형술(PTA) 시 실패한 경우의 수가 산정방법

경피적 풍선혈관 성형술 (PTA) 시 Guiding Catheter 와 Guide Wire 가 병소를 통과하지 못한 경우의 수가 산정 방법은 경피적 풍선혈관 성형술 (PTA) 소정점수 50%로 산정함 (주 수술인 경우 주 수술 소정점수의 50%, 부 수술인 경우 부 수술 소정점수의 50%)

경피적 혈관내 금속 스텐트 삽입술 (Percutaneous intravascular installation of metallic stent)

- 주: 1) 경피적 풍선혈관 성형술(PTA)과 동시에 시술한 경우에는 경피적 풍선혈관 성형술의 수기로는 산정하지 아니한다
- 2) 실패로 인하여 관혈적 수술을 행한 경우에는 방사선 진단에 소요된 비용과 동 시술 시 사용된 재료대만을 산정한다
 - 3) Stent, Balloon Catheter (Bare형 Stent 사용 시), Introducer, G-wire, 조영제 필름 재료대는 별도 산정한다

- 가. 뇌혈관
- 나. 경동맥 (추골동맥 포함): Carotid

Intracranial artery stenting 고시 제2019-131호(행위), 2019.08.01 시행

두개강내 동맥(intracranial artery)에 삽입하는 스텐트는 다음의 경우에 요양급여를 인정함

1. 유증상의 70% 이상 두개강내 대혈관 (내경동맥(internal carotid artery), 중대뇌동맥(middle cerebral artery), 척추동맥(vertebral artery), 기저동맥(basilar artery)) 협착 시
→ 6개월 이상 항혈소판제 및 항고지혈증 약물을 투여하였음에도 혈관 협착에 의해 증상성 뇌경색이 발생한 경우 (다만, 집중적인(intensive) 약물치료에도 증상이나 병변 재발이 있는 경우에는 6개월 이내시행에도 사례별로 인정함).
2. 혈관박리가 있는 경우
3. 두개내 혈관 폐색으로 인한 급성 허혈 뇌졸중 환자에서 기계적 혈전제거술을 시행한 이후에도 혈관협착이 70% 이상 남아 혈류 역학적으로 폐색의 가능성이 높다고 판단되는 경우

Extracranial artery stenting 고시 제2019-131호(행위), 2019.08.01 시행

• 세부인정 사항

- 가. 두개강외 경동맥 (NASCET 기준)
 - 1) 유증상의 50% 이상 경동맥 협착
 - 2) 무증상의 70% 이상 경동맥 협착
 - 단, 관류영상 검사 상 관류 저하가 확인된 경우(CTP,MRP,SPECT)
 - 3) 기타 (증상 또는 협착의 정도와 관계없이 시행 가능한 경우)
 - 가. 반대측 경동맥 폐색을 동반한 50% 이상의 경동맥 협착
 - 나. 가상동맥류(pseudoaneurysm)
 - 다. 동정맥루 치료를 위해 다른 방법이 가능하지 않은 경우
 - 라. 혈관박리로 인한 혈류 감소 또는 협착

나. 두개강외 척추동맥(extracranial vertebral artery)

- 1) 유증상의 70% 이상 척추동맥 협착
- 2) 척추동맥 박리로 혈류 감소 또는 출혈의 위험이 있는 경우 등

Extracranial artery stenting (II) 고시 제2019-131호(행위), 2019.08.01 시행

'유증상' 범위 : 최근 6개월 이내 협착 영역에 일과성 허혈발작이나 뇌경색이 있었던 두개강외 경동맥 또는 척추동맥 협착

일과성 허혈발작 : 일시적 편측마비, 편측 시야마비, 실어증 또는 이에 준하는 증상 등으로 단순한 어지럼증은 해당 안 됨.

2. 급여개수

스텐트는 한 병변 당 1개 사용을 원칙으로 함.

- 다만, - 스텐트의 길이를 초과하는 병변,
- 병변의 시술 전 후 혈관박리 시,
- 혈관내 치료가 필요한 다발병소(tandem lesion),
- 굴곡이 심한 혈관 등과 같이
인정개수 이외 추가사용이 불가피한 경우에는 병변 당 1개를 추가하여 최대 2개 까지 요양급여를 인정함

NASCET : North American Symptomatic Carotid Endarterectomy Trial



ASCENT 2021

Mechanical thrombectomy 고시 제2019-131호(치료재료), 2019.08.01 시행

1. 두개내 대형혈관의 기계적 혈전제거술용 치료재료(회수성 stent, 흡인성 catheter)는 다음의 경우에 요양급여를 인정함

가. 회수성 stent

1) 급여대상

- 가) 두개내 대형 혈관(두개강외 경부혈관 포함)의 폐색 질병으로 인한 급성 허혈 뇌졸중으로

(1) 증상발생 8시간 이내의 환자

- (2) 증상발생 3시간 이내의 환자는 정맥내 혈전용해술이 실패하거나 이에 대한 금기증에 해당하는 환자 (?)

회수성 stent의 혈관범위 : 내경동맥부터 후대뇌동맥까지 모두 해당됨

2. 상기 1항의 급여대상에도 불구하고 아래의 경우는 요양급여 대상에서 제외함

- 가. Non-contrast CT상 중대뇌동맥 영역 1/3이상을 침범한 뇌경색

- 나. 심한 뇌부종

- 다. 뇌출혈

Mechanical thrombectomy (Onset 8-24hr)

두개내 내경동맥 또는 중대뇌동맥의 폐색 질병으로 인한 급성 허혈 뇌졸중에서, 증상발생 8시간에서 24시간이내의 환자는 영상검사 결과 뇌경색이 크기가 한쪽 대뇌반구의 1/5 이하이면서 아래 조건 중 한 가지를 만족하는 경우

- (1) 초기 신경학적 결손이 NIHSS 점수 6점 이상~10점 미만이면서, 뇌관류영상에서 관류-뇌경색 불일치의 비율이 1.8이상 또는 불일치의 부피가 15ml 이상
- (2) 초기 신경학적 결손이 NIHSS 점수 10점 이상

- 증상발생 8시간에서 24시간이내의 환자

“영상검사 결과 뇌경색의 크기가 한쪽 뇌반구 1/5 이하”는 다음과 같음

1. 확산강조 MRI 에서 100ml 이하
2. 확산강조 MRI 에서 MR-ASPECTS 6점 이상
3. 비조영 뇌CT에서 CT-ASPECTS 6점 이상

Mechanical thrombectomy

2) 혈관 인정범위

- 가) 내경동맥 (internal carotid artery)

- 나) 중대뇌동맥(middle cerebral artery) 의 첫번째 (MCA M1 segment)와

두 번째 부위(MCA M2 segment)

- 다) 기저동맥(basilar artery)

- 라) 척추동맥(vertebral artery)

- 마) 전대뇌동맥(anterior cerebral artery)

- 바)후대뇌동맥(posterior cerebral artery)

나. 흡인성 catheter

1) 급여대상

- 가. 회수성 stent의 1)급여대상 가)와 동일

2) 혈관인정범위

- 가. 회수성 stent의 2)혈관인정범위 가)~라)와 동일

다. 급여개수 (stent and aspiration catheter)

재료 종류에 관계없이 1개 인정하는 것을 원칙으로 하되, 혈관폐색 부위의 개통 실패 사유가 영상자료에서 확인된 경우 1개를 추가 인정함

뇌혈관내 흡인기구를 이용한 혈전제거술 (Penumbra system)

Thrombectomy using aspiration device intracranial vessel (penumbra system)

고시 제2017-118호(기결정), 2017.1.1 시행

자633나 경피적혈전제거술-기계적혈전제거술(카테터법)의 소정점수를 산정함.

다만, 기계적 혈전제거술용 치료재료 급여기준에 적합한 경우만 산정함.



뇌혈관의 중재적 시술 시 사용하는 Distal Access Intermediate Catheter

(원위 접근용 중간도관)의 급여기준 고시 제2019-131호(치료재료), 2019.08.01 시행

Distal Access Intermediate Catheter 는 뇌혈관의 중재적 시술 시 뇌혈관 또는 대동맥의 꺾임과 굴곡이 심하거나, 혈관 근위부의 지지가 약하고 불안정하여 카테터의 진입이 어려운 경우 1개를 요양 급여로 인정함. (적응증 제한 없음)

Easy distal navigation of distal access guiding catheter

: Navien, Envoy DA, Sofia, Catalyst etc.

액체형 색전물질(뇌혈관용)의 급여기준 고시 제2018-254호(행위), 2019.01.01 시행

액체형 색전물질(뇌혈관용)은 혈관색전술 시 사용하는 치료재료로,
다음의 경우에 요양급여함.

가. 급여대상

- 1) 뇌동정맥기형(뇌경막동정맥루 포함)
- 2) 과혈관성 뇌종양(단순 meningioma 제외)
- 3) 다른 색전물질로 효과적으로 치료되지 않는 뇌혈관 파열에 사례별로 인정

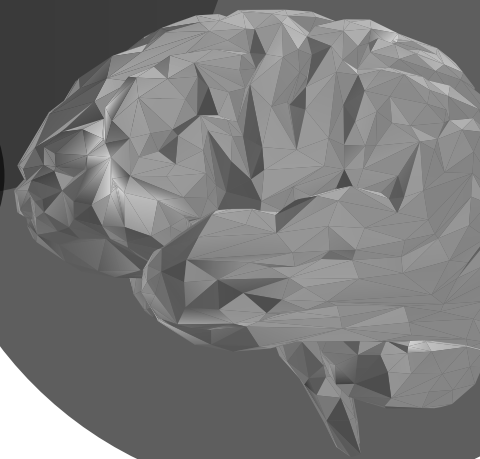
나. 급여개수: **6개**

단, 급여개수를 초과하여 사용한 경우에는 관련자료(영상자료 등)를 참조하여
사례별로 인정

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/25(Fri.)

Mini-symposium for navigation to target vessels

좌장 : 임용철(아주대), 이종영(한림대)

1. Trans-femoral approach
2. Trans-brachial approach
3. Direct carotid / vertebral approach
4. Guiding technique for endovascular surgery

김명진(가천대)

박상규(연세대)

신동성(순천향대)

김성태(인제대)

Trans-femoral approach

김 명 진

가천대학교 길병원 신경외과

At present the transfemoral approach (TFA) is the most commonly used approach for endovascular treatment in cerebrovascular diseases worldwide. In terms of treatment modality, the TFA provides many advantages described below*.

*The advantages of the TFA

1. almost possible introducing larger bore sheath and catheter than other access routes such as radial
2. immediately implementable endovascular procedure after the diagnostic angiography
3. more robust and straight proximal supporting
4. easier and more accustomed access than other sites such as radial, brachial, and carotid artery
5. more feasible manipulation of the closing device
6. simultaneously bilateral approach using right and left ilio-femoral arteries
7. simultaneously trans-arterial and trans-venous approaches

Although the TFA remains as the first option in most cases nowadays, some challengeable cases** might give us serious concerns about how overcome the pathway to target vessels in order.

**The challengeable pathways to the target vessels in the TFA

1. occlusion or severe stenosis of the femoral arteries
2. severe tortuous and atherosclerotic ilio-femoral arteries
3. aneurysmal dilatation or scoliotic tortuosity of thoraco-abdominal aorta
4. aberrant pathway of aortic arch and thoraco-abdominal aorta
5. calcified and acute angled aortic arch in elderly patients

In these cases, further procedure may take a longer time than expected or finally it may fail. First of all, the wire should be handled and advanced meticulously prior to be followed by the catheter involving guiding system. If needed, more stiff wire may be helpful in terms of supporting and advancing the catheter through severe tortuous or acute angled vessels.

When it comes to most dangerous and unthoughtful situation even though overcoming the crisis, whole

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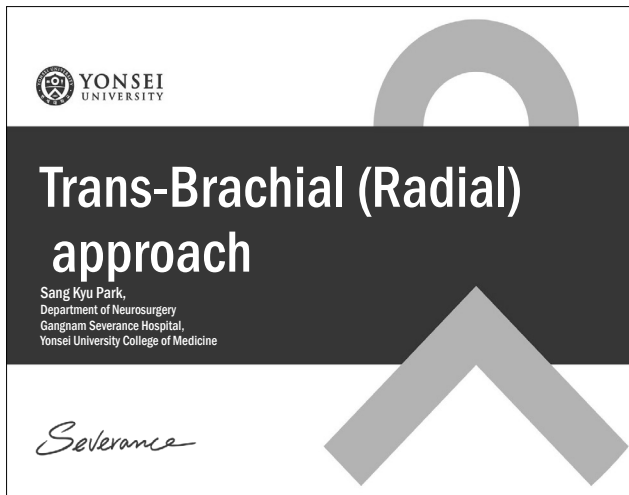
instruments system can be pulled back abruptly during the procedure, which might result in critical situation. That is because it is not enough proximal supporting. Therefore, it is very important to set more flexi-rigid guiding up such as multi-axial guiding method.

Alternative access routes such as transradial, transbrachial, and direct carotid approaches are of interest when the iliofemoral arteries are diseased, highly calcified or extremely tortuous.

Trans-brachial approach

박 상 규

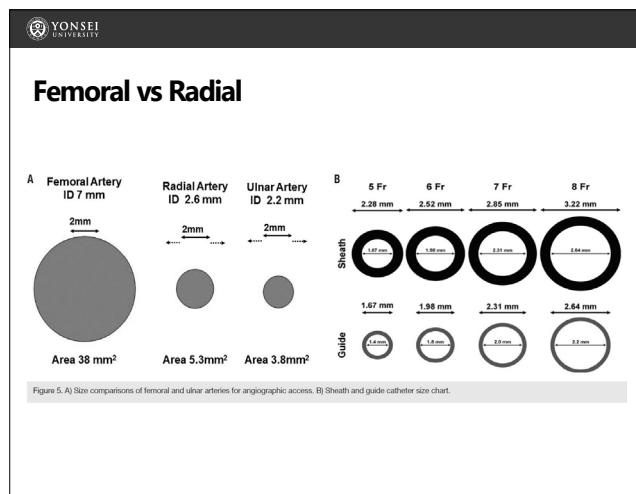
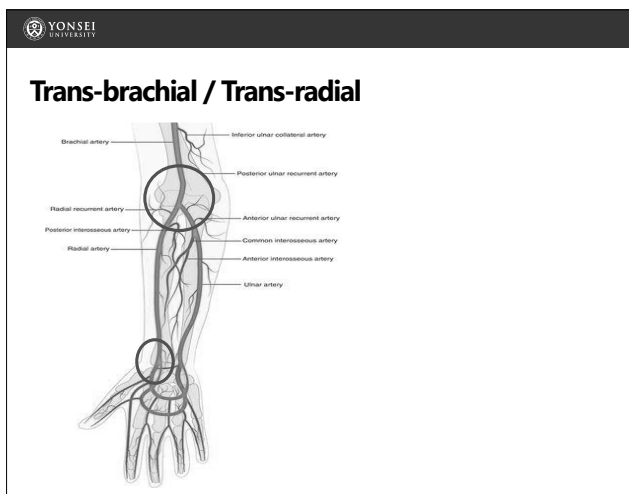
연세대학교 강남세브란스병원 신경외과



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Introduction

- Trans-brachial or Trans-radial (TR) : preferred in coronary intervention field
 1. difficulty in navigating the 4-vessels
- Trans-femoral (TF): preferred in neurointervention field
 1. familiarity
 2. easy accessible
- Interventional cardiology: shift from TF to TR
 1. low access site complication, less invasive
 2. improve pt's satisfaction
 3. 40% in US, 80% in EU -> 1st choice for cardiac procedure



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Radial vs Femoral

Radial artery friction and spasm

Radial artery (Lumen 1.8-2.5mm)	Femoral artery (Lumen 8.5-12mm)
6 F 5F : 1.65 mm 6F : 1.98 mm 7F : 2.31 mm	6F

www.drsvenkatesan.com

Patient position

Patient position

Patient position

Figure 1. The wrist in extension with the aid of a towel roll. The thumb is also taped in extension. The wrist and forearm have been widely prepared with 2% chlorhexidine solution.

Trans-radial access

- Allen test

Trans-radial access

- Allen test

Positive Modified Allen Test
Release the pressure on the ulnar artery. If the hand flushes within five to fifteen seconds, this shows that the hand has good blood flow.

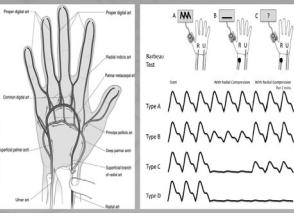
Negative Modified Allen Test
Release the pressure. If the hand doesn't flush within five to fifteen seconds, the circulation of the ulnar artery is not sufficient. If this is the case, the radial artery should not be punctured.

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Trans-radial access

Barbeau test

Evaluation of adequate collateral perfusion to the hand.
A pulse oximeter is placed on the patient's thumb, the radial pulse is identified, and the wave form is analyzed. The radial artery is then compressed, and the pulse oximeter wave-form is again analyzed for up to 2 minutes and graded.



Ulnar-palmar patency 4 types:
(A) no damping of the pulse tracing immediately after compression
(B) damping of pulse tracing,
(C) loss of pulse tracing followed by recovery within 2 minutes
(D) **loss of pulse tracing without recovery within 2 minutes**

1,5% D

Access site preparation

- 1-3 ml of 1% lidocaine, small gauge needle (22-25 gauge)
- local anesthesia both medial & lateral side of artery
- Injection may distort the anatomy & make difficult of palpation
- gentle massage of the area usually resolve this issue

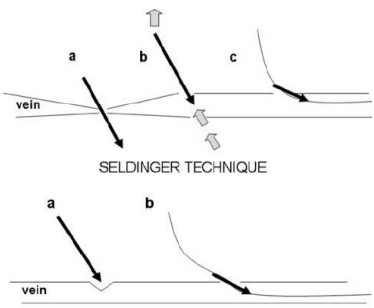


Prevent vasospasm - Nitroglycerin(NIG)

- NIG 1cc + saline 9cc = 10cc
- 5cc, after radial sheath apply
- 5cc, before radial sheath remove



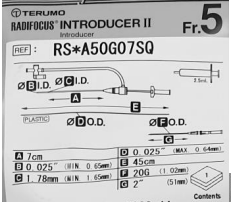
Arterial puncture – Seldinger method



- hematoma (?)
- dissection (?)

REAL TIME IMAGE-GUIDED TECHNIQUE

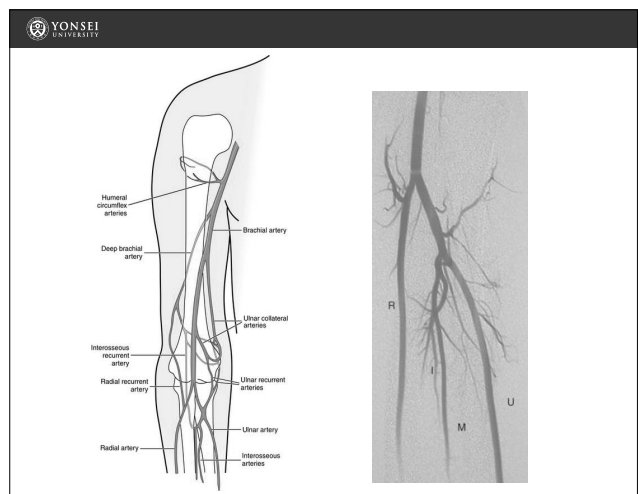
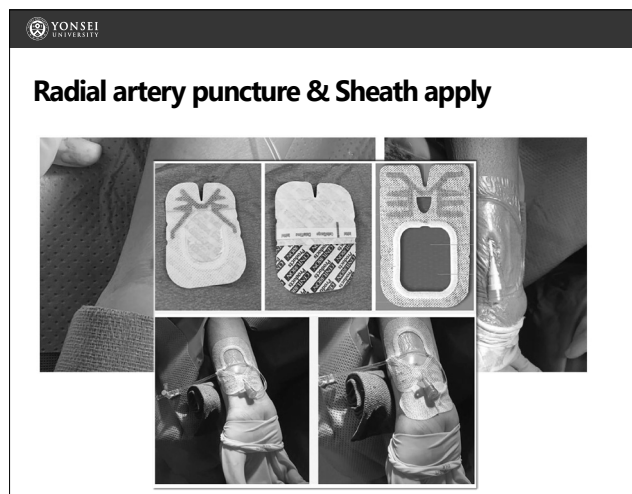
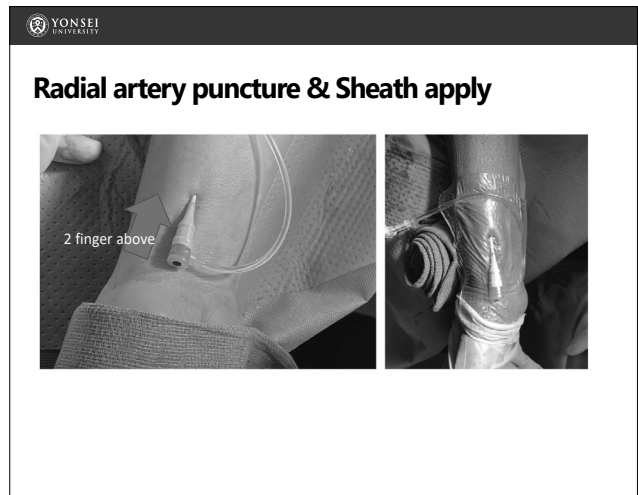
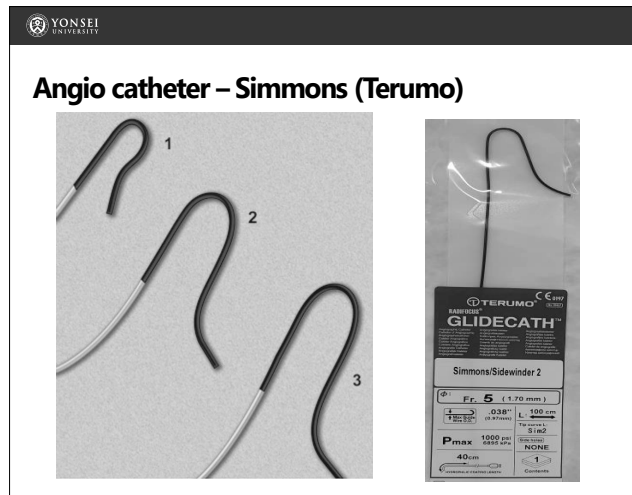
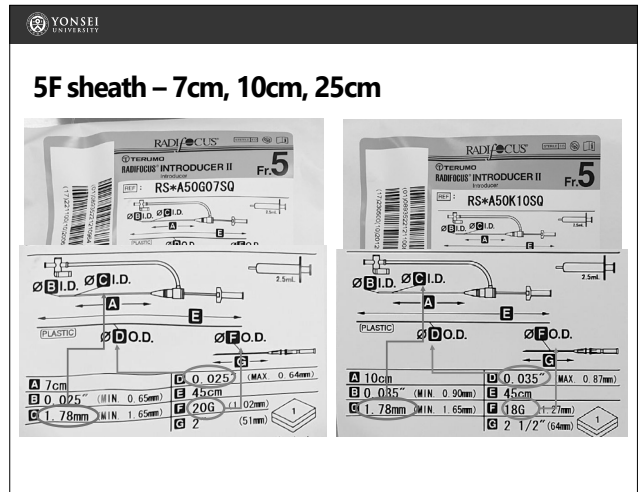
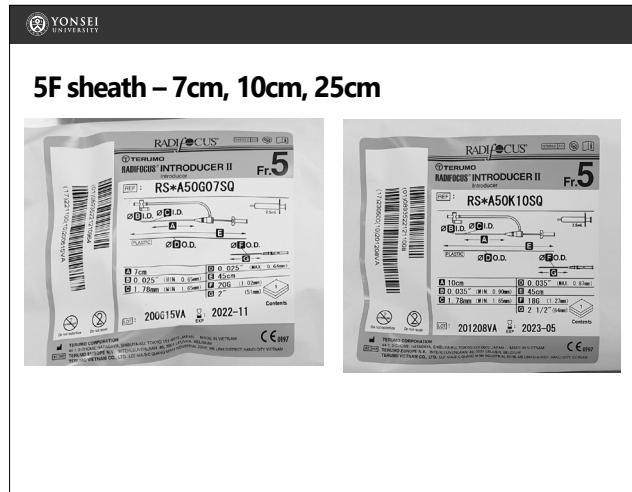
Radial sheath – 5F 7cm



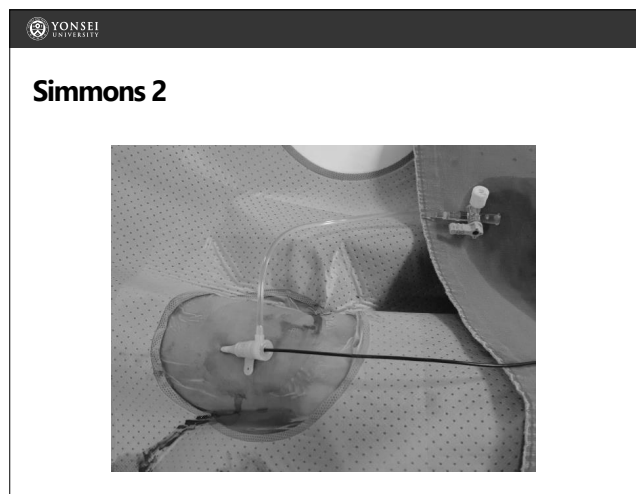
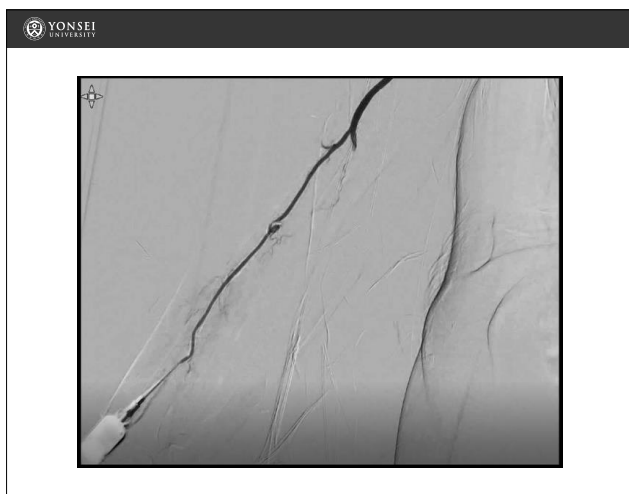
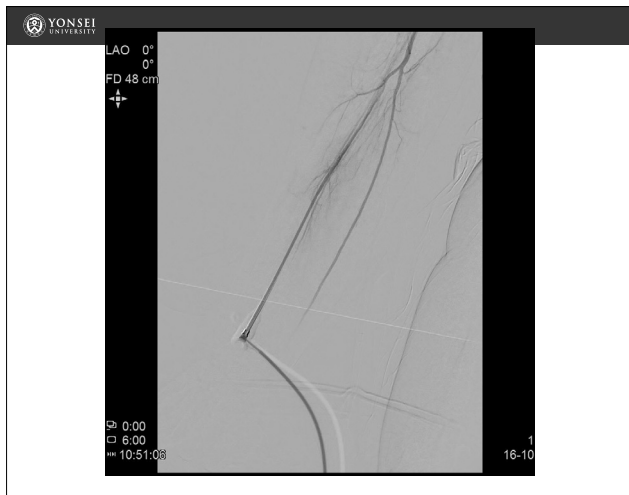
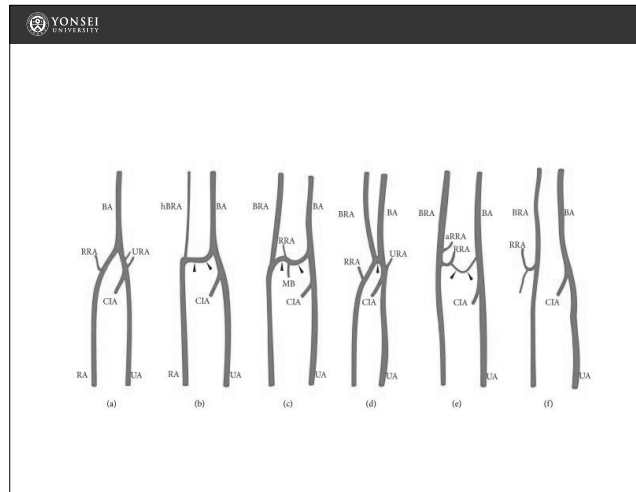
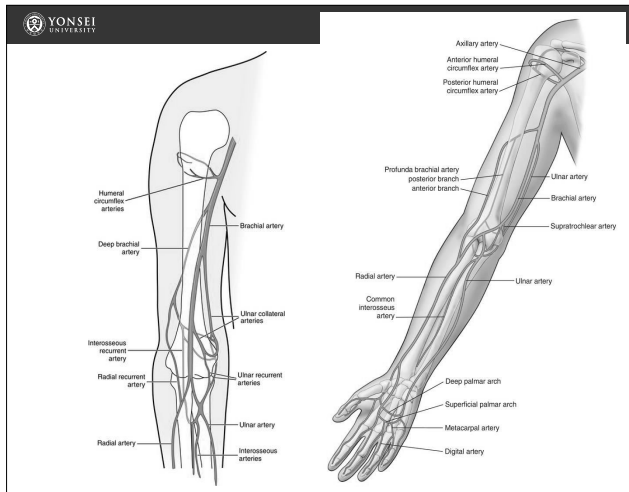

5F sheath – 7cm, 10cm, 25cm



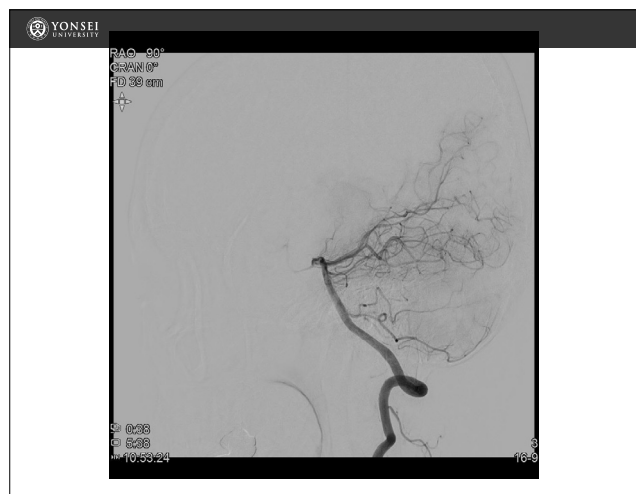
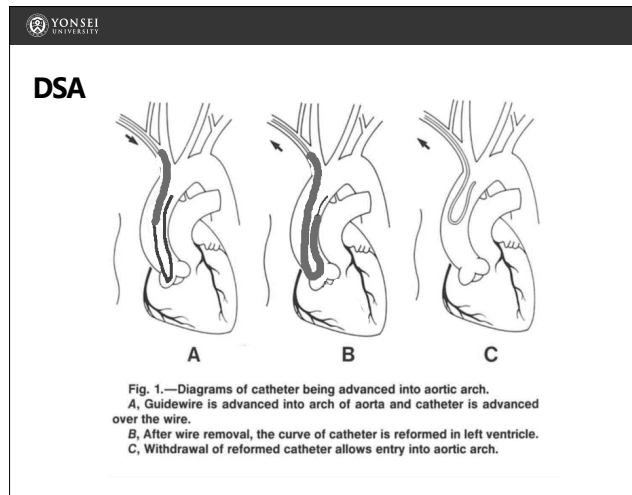
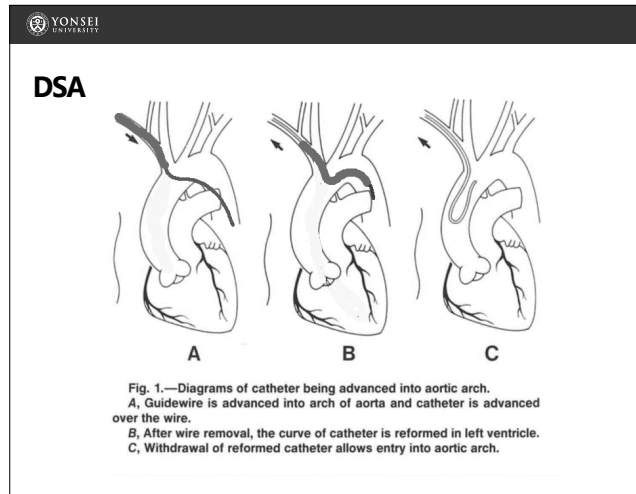
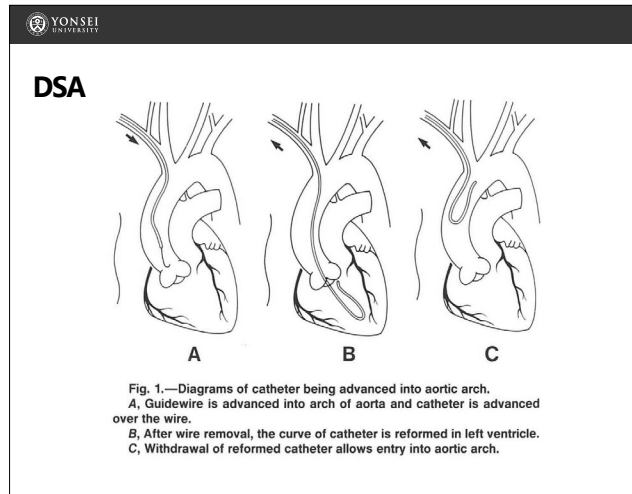
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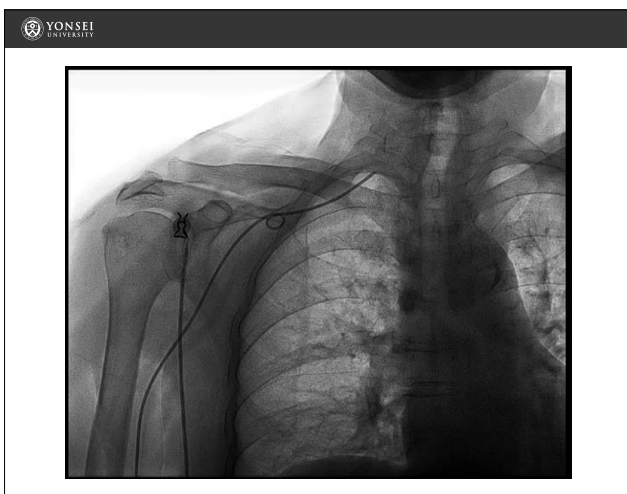
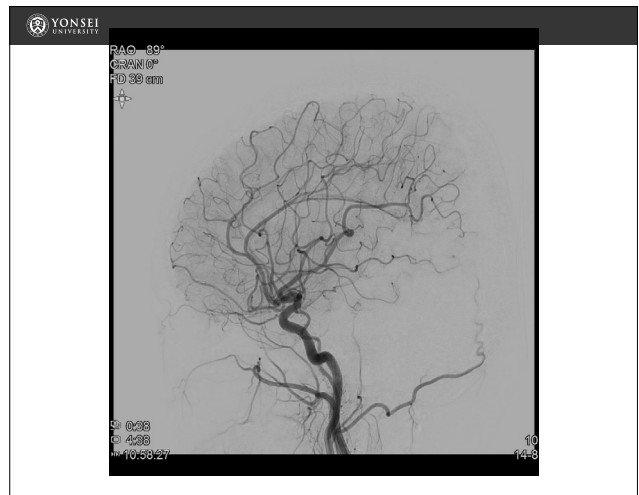
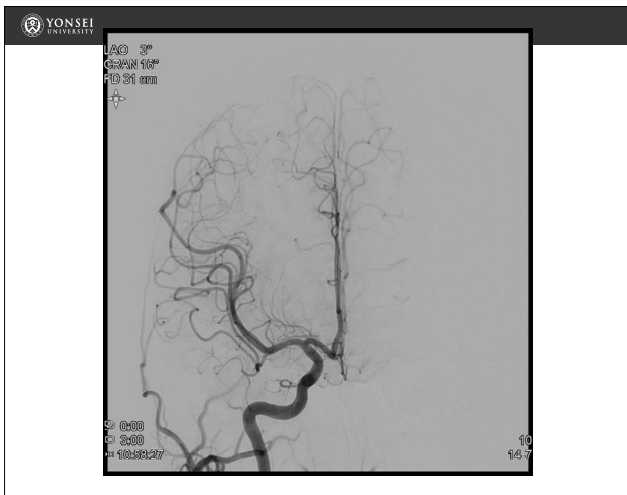
Mini-symposium for navigation to target vessels



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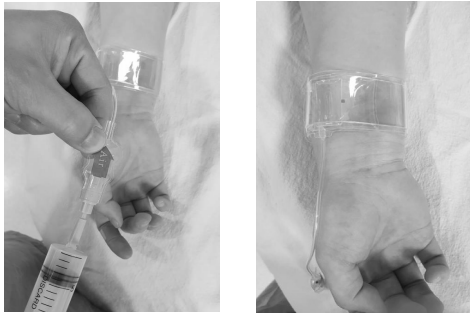
Mini-symposium for navigation to target vessels



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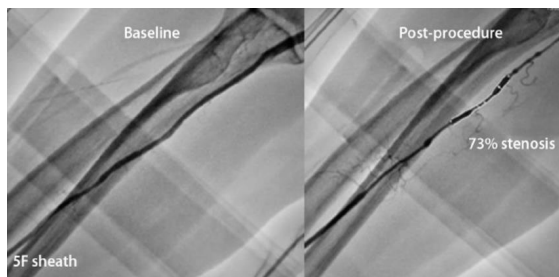
Hemostasis – radial tourniquet



Hemostasis – Q pad



Complications – radial artery vasospasm



Complications – compression site ulcer



Trans-radial (brachial) angiography

- Pros
 1. less invasive for Pt & Dr.
 2. early mobilization – no back pain
 3. less hematoma
 4. femoral saving for intervention
- Cons
 1. inaccessible to Lt VA selective angiography
 2. vasospasm of arm
 3. angio-site ulcer

Thank You



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Direct carotid / vertebral approach

신동성, 이호준, 김범태

순천향대학교 부천병원 신경외과

Navigation to Target vessels Neck Dissection and Carotid Access (NDCA)

신동성 이호준 김범태

Dept. Neurosurgery, Soonchunhyang University
Bucheon Hospital, South Korea,

SCH

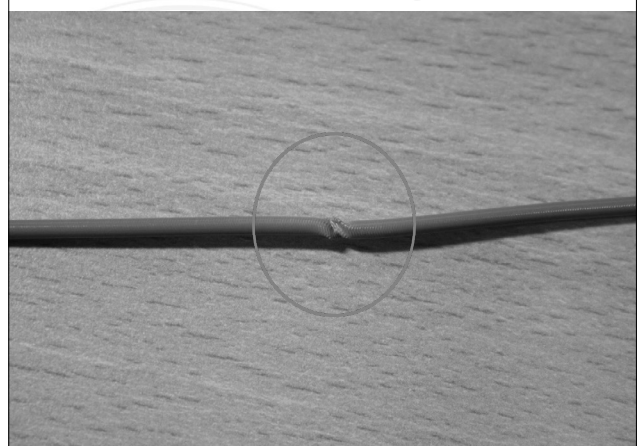
80/F with ruptured Lt. Pcom An.



Angiographic result after aneurysm coil
embolization (CE) with 3 GDCs



6Fr. Guide catheter after procedure



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Limitation of cranial access through another route

Femoral route

- Can't overcome aortic curve due to arteriosclerotic change

Brachial / Radial route

- Acute angle of vertebral-common carotid junction
- Pass through aortic arch for target vessel approach



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SCH

Closure of Carotid Artery Puncture Site With a Percutaneous Device

Bernardo Massière, Arno von Ristow, José Mussa Cury, Marcus Gress, Alberto Vescovi, Cleoni Pedron, Antônio Luiz Medina, Marcos Areas Masques, Paulo Roberto Silveira, and Salim Jeha



Patients with hostile anatomy is associated with challenge and associated clinical conditions. The use of a 7.5 Fr sheath, nonintentionally implanted carotid sheath was removed after introducing a wire, successfully introduced over the wire, successfully sealed the carotids, sealing of the puncture site. This maneuver allowed the safe seal to close the puncture site.

Ann Vasc Surg 2009; 23: 256.e5-256.e7

SCH

TECHNICAL NOTE

K. Nii
K. Kazekawa
M. Onizuka
H. Aikawa
M. Tsutsumi
M. Tomokiyo
M. Iko
T. Kodama
S. Matsubara
Y. Go
A. Tanaka

Direct Carotid Puncture for the Endovascular Treatment of Anterior Circulation Aneurysms

SUMMARY: We report the usefulness of Guglielmi detachable coil (GDC) embolization by direct carotid puncture for anterior circulation aneurysms. For all 27 patients, GDC embolization by direct carotid puncture was safely performed by using a 5F sheath introducer 5 cm long and a Tracker-38 catheter. Neurologic deficits and hemorrhage were not found in any patient during the follow-up period. If the transfemoral approach cannot be applied, GDC embolization should be considered as an alternative method.



AJNR 27;Aug 2006; 1502-1504

NDCA

Save Set up time for coil embolization

- Selection, exchange time ↓

Reduce vessel manipulation during catheter work

- Thromboembolic event ↓
- Anesthesia ↓
- Heparin infusion ↓

More straight work corridor

- Easy handling

More secure puncture site due to surgical suture

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Original Article 505

Direct Carotid Exposure for Neuroendovascular Approaches

Dong Seong Shin¹ Ali Yilmaz² Ayca Ozkul³ Dong Kyu Yeo⁴ Sun-Chul Hwang¹ Bum-Tae Kim¹

¹Department of Neurosurgery, Soonchunhyang University Bucheon Hospital, Bucheon, Republic of Korea
²Department of Neurosurgery, Adnan Menderes University, Aydın, Turkey
³Department of Neurology, Adnan Menderes University, Aydın, Turkey
⁴Department of Neurosurgery, Soonchunhyang University, Gumi Hospital, Gumi, Republic of Korea

J Neurol Surg A 2016;77:505-510.

Abstract

Objective: The transfemoral approach is a common route for catheterization of the supra-aortic vessels in neuroendovascular therapy. However, in some cases, the patient's anatomy prevents transfemoral catheterization or distal access to the carotid. In such cases, direct carotid exposure (DCE) for neuroendovascular approaches may be used to treat cerebrovascular diseases.

Methods: We present 11 cases in which we were unable to perform the distal approach and DCE was the preferred neuroendovascular treatment procedure.

Results: DCE was performed on 11 patients with cerebral aneurysm (n = 8), carotid cavernous fistula (CCF) (n = 1), malignant brain tumor (n = 1), and carotid angioplasty and stenting (n = 1). Ten patients were female; one was male. Ages ranged from 63 to 87 years (mean: 71.36 years). Coil embolization was performed on patients with cerebral aneurysm and CCF. The patient with a malignant brain tumor underwent polyvinyl alcohol particle embolization. The only complication was a carotid artery dissection that occurred in one patient during stenting.

Conclusion: DCE for neuroendovascular approaches can be used as an alternative for patients with tortuous vasculature access in the femoral route. In such patients, a combination of neuroendovascular treatment and surgery in a hybrid operating room with angiography is preferred.

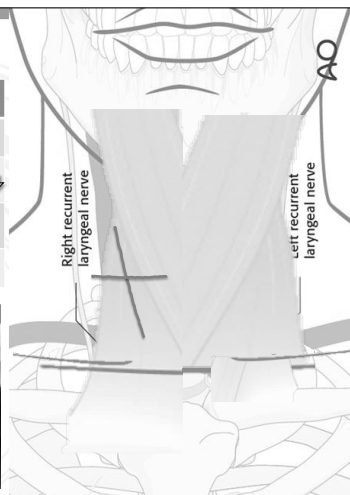
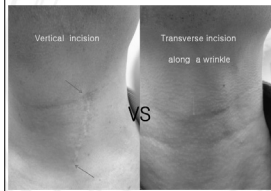
Keywords:
- direct carotid exposure
- neuroendovascular therapy
- cerebral angiography

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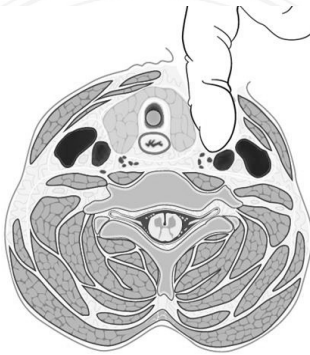
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Neck incision

Vertical	Transverse
Working space ↑	space ↓
Working space for vessel suture ↑	Working space ↓
Working space extension ↑	extension ↓
Scar ↑	Scar ↓



Muscle and carotid dissection

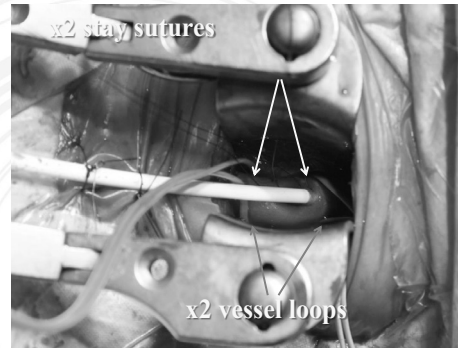


- **Carotid artery**
 - Pulsatile structure
 - Easy identification
- **Jugular vein/Vagus N**
 - Lateral location
 - Contact Jugular V. first,
 - Dissect and retract to lateral location

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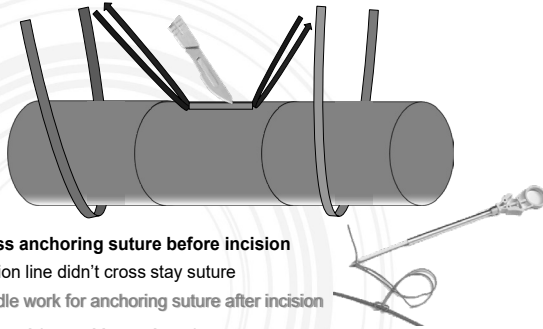
Past work up



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SCH

Muscle and carotid dissection

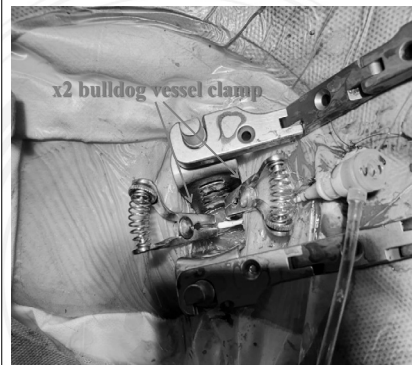


- **Useless anchoring suture before incision**
 - Incision line didn't cross stay suture
 - needle work for anchoring suture after incision
- **Bulky tool (vessel loop clamp)**
 - More narrowing working space during vessel repair

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SCH

Present work up



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preparation



curved bulldog vessel clamp



CASPER Cervical retractor (CCR)

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Practice (Transverse incision)

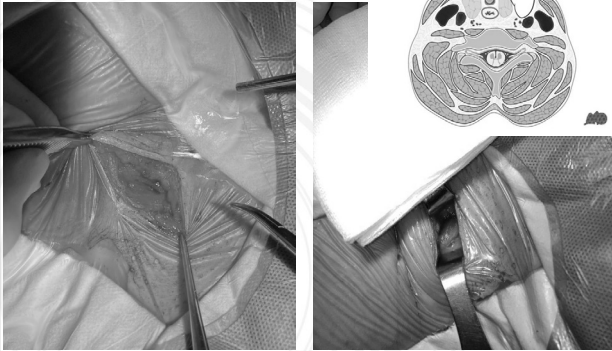


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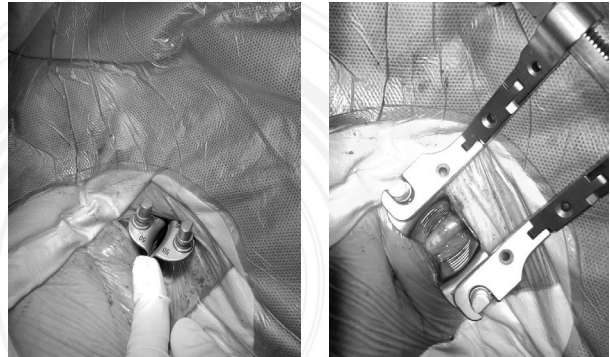
Practice(dissection)



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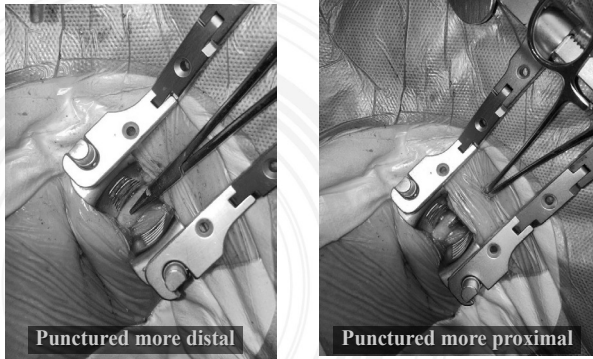
Practice (retractor)



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Practice (puncture corridor)



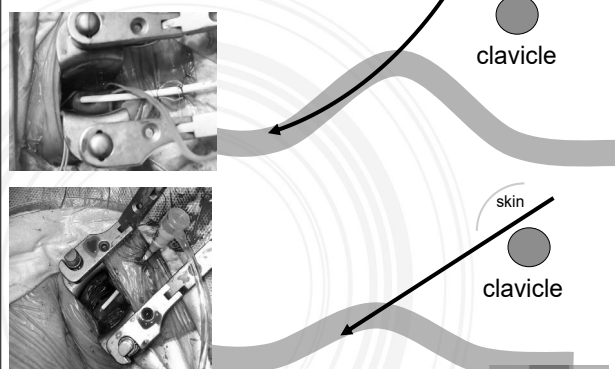
Punctured more distal

Punctured more proximal

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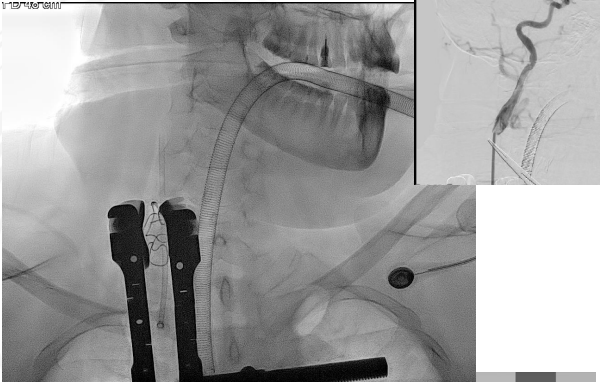
Practice(corridor)



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SCH

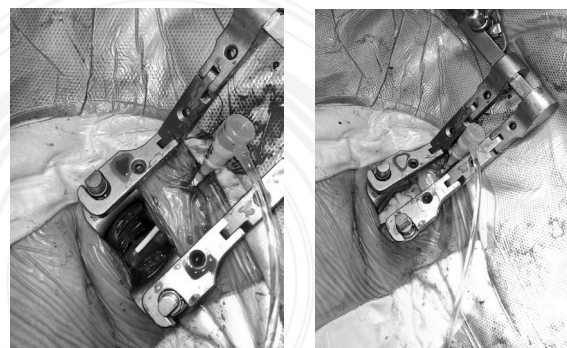
Practice(sheath advance)



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Practice (sheath anchoring and retractor release)

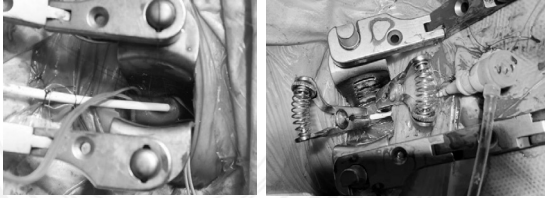


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Carotid Incision

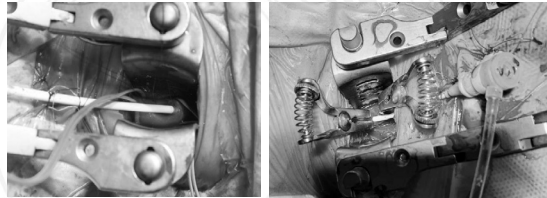
- Carotid direct incision (No. 11 blade)
 - Carotid artery dissection ↓
- **Subcutaneous route**: vessel clamp(obstacle), difficult to puncture
- **Open space route**: more convenient puncture
- Bleeding during incision : use vessel clamp
- Anchoring suture place on incision site
- Clamp release for Wire and Sheath advance: bleeding ↑



SCH

Carotid puncture without incision

- Angio puncture needle
 - inappropriate puncture: Carotid artery dissection ↑
- **Subcutaneous route**: more ideal angle puncture
- **Open space route**: more acute angle puncture
- Minimal Bleeding : may not use vessel clamp(experienced)
- More rigid sheath advance: keep gentle and smooth handling



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SCH

Carotid repair

- No. 6 Nylon
 - 3 - 4 stitch
 - Previous anchoring suture
 - About 5-minute vessel clamping
 - Useful knot pusher



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SCH

Case presentation

- RMCA UIA
 - 65/F

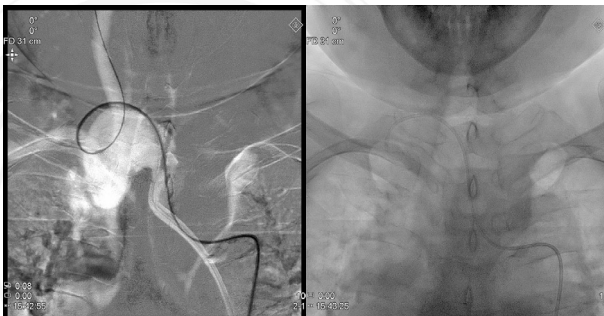


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SCH

Case presentation

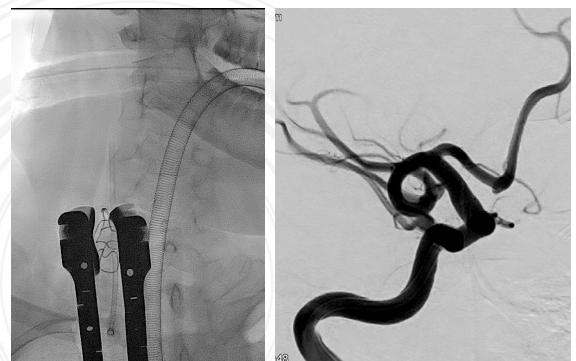
- TFCA (Rt. Innominate artery selection)



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Case presentation



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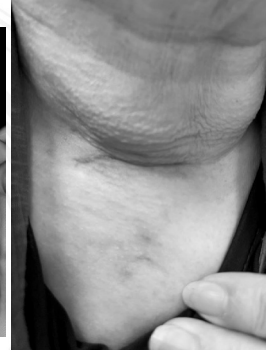
Case presentation



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Case presentation



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**Thank you
for
your attention**

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SCH

Guiding technique for endovascular surgery

김 성 태

인제대학교 부산백병원 신경외과

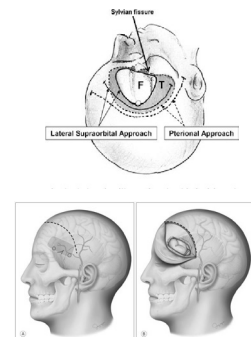
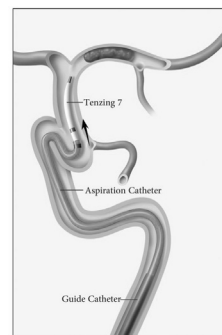


Guiding technique for endovascular surgery

인제대학교 부산백병원

김 성 태

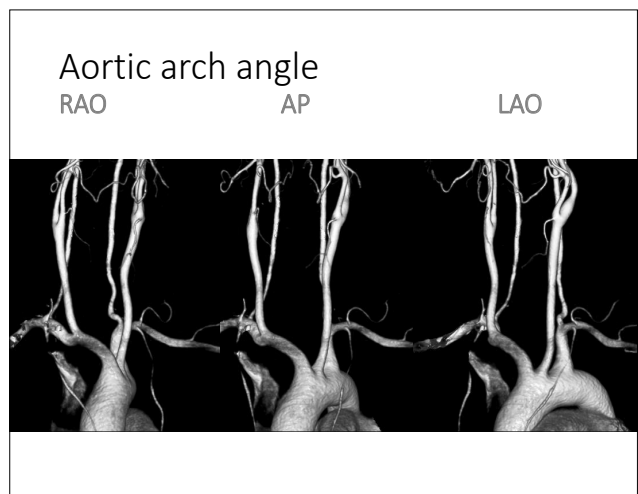
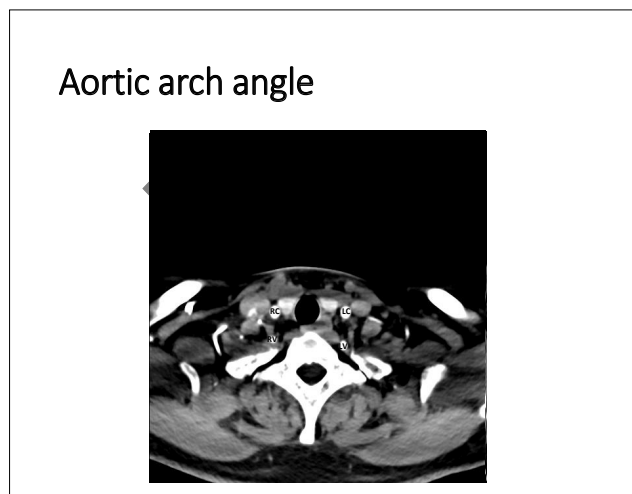
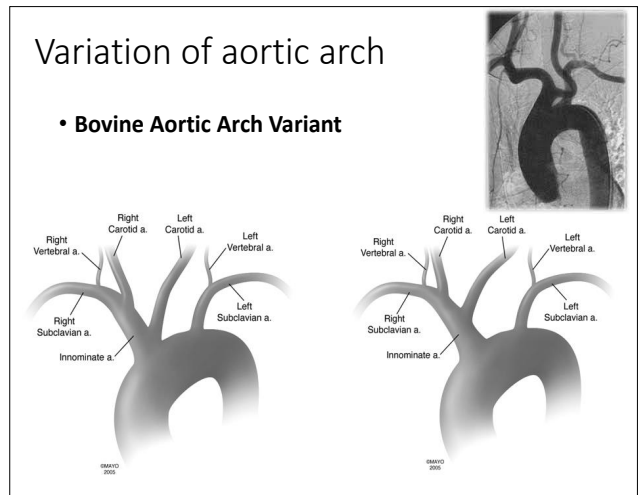
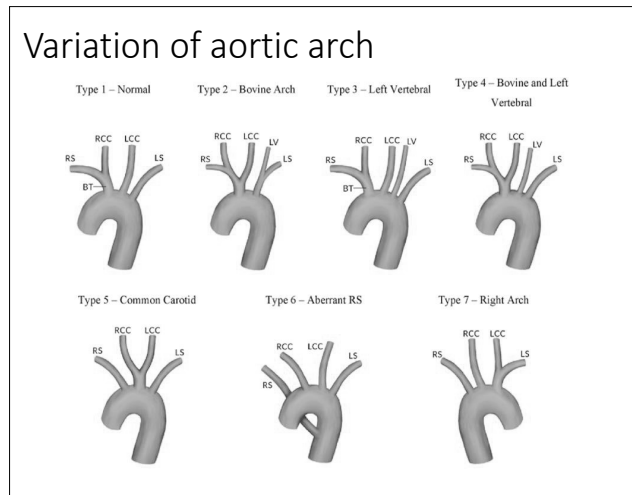
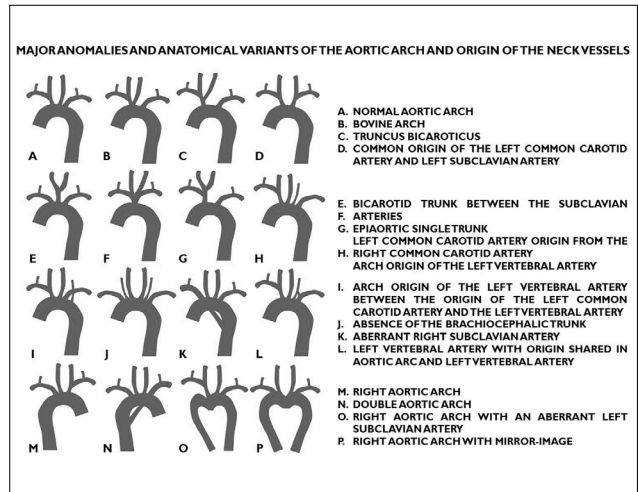
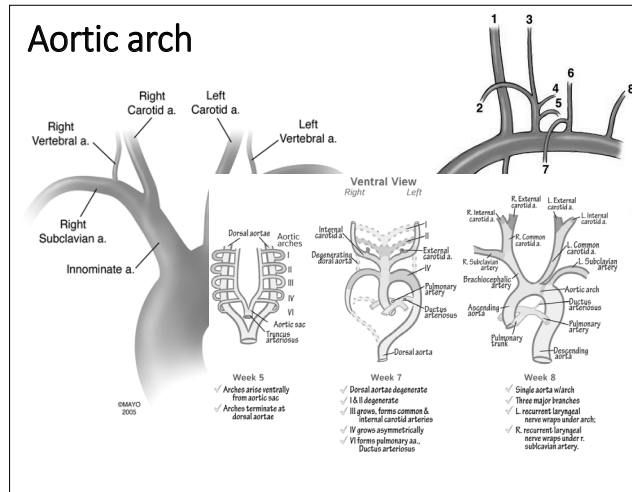
Guiding technique ≡ Craniotomy



Contents

1. **Anatomy** of the Aortic arch
2. Concept of **great vessel selection**
3. **Cases**

1. Anatomy of the Aortic arch



Aging change

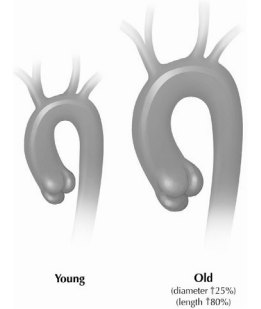


Figure 1. Typical Change With Age in the Ascending Aorta
Typical change in the ascending aorta is noted between a 20-year-old (left) compared with an 80-year-old man (right). The length increases for an approximate 12% size.

EDITORIAL COMMENT

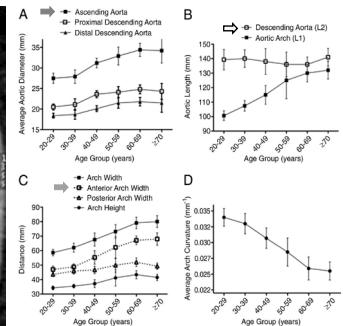
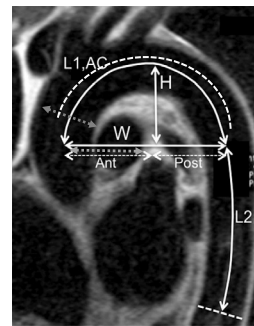
Aortic Dimensions and Stiffness in Normal Adults*

Michael O'Rourke, MD, DSc, FACC, Alan Farnsworth, FRACS, MD, John O'Rourke, MD
Sydney, Australia

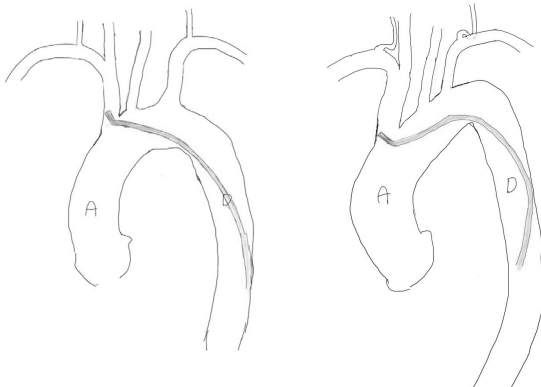
Age-Related Changes in Aortic Arch Geometry

Relationship With Proximal Aortic Function and Left Ventricular Mass and Remodeling

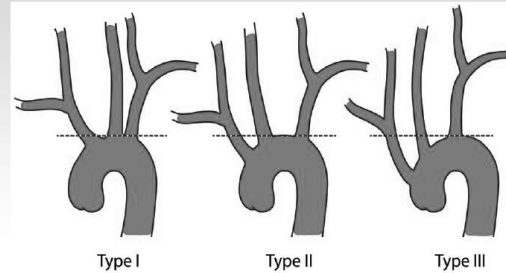
Alban Redheuil, MD, PhD, Wen-Chung Yu, MD, Elie Mousseaux, MD, PhD, Ahmed A. Harouni, PhD, Nadja Kachour, PhD, Colin O. Wu, PhD, David Blomberg, MD, PhD, Joon A. C. Lima, MD
Baltimore and Bethesda, Maryland; Paris, France; and Taipei, Taiwan



Normal VS Aging



Acquired aortic arch variants



• Simple angled
H1, Davis...

Reverse angled
Simmons, VTK...

2. Concept of great vessel selection

Wire, angiocatheter, and technique

Wires and Catheters for Cerebral Angiography

Hydrophilic Wires

1. The 0.035 in. angled Glidewire® (Terumo Medical, Somerset, NJ) is soft, flexible, and steerable.
2. The 0.038 in. angled Glidewire® (Terumo Medical, Somerset, NJ) is slightly stiffer than the 0.035 in., making it helpful when added wire support is needed.
3. Extra-stiff versions of these wires are available for even more support, but they should be used with extreme caution because of the tendency of the tip to dissect vessels.

Catheters (100cm, 125cm)

Many catheters are suitable for cerebral angiography (Fig. 2.1). As a general rule, use 100 cm long catheters that have a curve that allows selection of the vessels from the arch. Simpler curves (e.g., Berenstein curve) are adaptable to many anatomic situations and are most appropriate for young patients with straighter vessels. More complicated curves (e.g., Simmons curve) help deal with more difficult aortic arch anatomy.

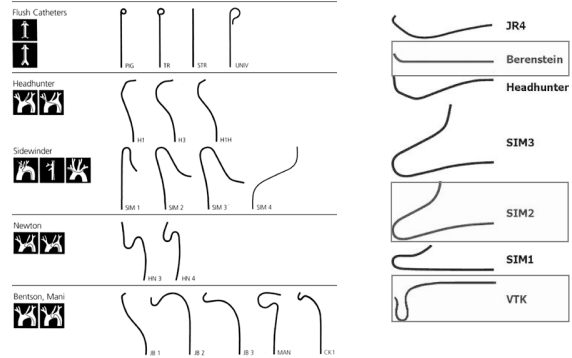


ASCENT 2021

Guidewires



Angiocatheters, 5F



Guiding catheters

제134 표 유도도관 5 Fr	Stryker	Codman	Codman	Penumbra	Terumo	Cook
이름	GUIDER SOFT TIP	ENVOL	NEUROPATH	NEURON	CHAPERON	SHUTTLE
크기	5 Fr	5 Fr	5 Fr	5 Fr	5 Fr	5 Fr
길이	90 cm, 100 cm	90 cm, 100 cm	90 cm, 100 cm	120 cm, 130 cm	95 cm	90, 110 cm
외경	5 Fr	5 Fr	5 Fr	5 Fr	5 Fr	0.090"
내경	0.053"	0.056"	0.057"	0.040	0.059"	0.074
Tip 모양	Straight, MP, KD	Straight, MPC	Straight, MPC	H1, SM, Ber	Straight, MP1	JR1, JR2, VTX, H1, CM2

제135 표 유도도관 6 Fr	Stryker	Codman	Codman	Penumbra	Terumo	Cook
이름	GUIDER SOFT TIP	ENVOL	NEUROPATH	NEURON	CHAPERON	SHUTTLE
크기	6 Fr	6 Fr	6 Fr	6 Fr	6 Fr	6 Fr
길이	90 cm, 100 cm	90 cm, 100 cm	90 cm, 100 cm	120 cm, 130 cm	95 cm	90, 110 cm
외경	6 Fr	6 Fr	6 Fr	6 Fr	6 Fr	0.108"
내경	0.064"	0.067"	0.068"	0.045	0.069"	0.084
Tip 모양	Straight, MP, KD	Straight, MPC	Straight, MPC	H1, SM, Ber	Straight, MP1	JR1, JR2, VTX, H1, CM2

Guiding catheter size and length

- Envoy 6F (100cm) + Terumo 035
- Envoy 6F DA (105cm) + Terumo 035
- Envoy 6F DA (105cm) + VTK 125cm + Terumo 035 (stiff)
- Shuttle 80cm + 6F Sofia (115cm) + VTK 125cm + Terumo 035 (stiff)
- Flowgate (8F, 95cm) + Catalyst 6 (6F, 132cm)

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Original Article

Advantages and disadvantages of the ENVOL 6F distal access guiding catheter in endovascular coiling for anterior circulation aneurysms

Jin Wook Baek¹, Sung Chul Jin¹, Sung Tae Kim¹, Young Jin Heo¹, Ji Yeon Han¹, Jung Hwa Seo¹, Sung Hwa Paeng¹, Jung Sook Kim¹, Hae Woong Jeong¹, Young Gyun Jeong¹
¹Department of Diagnostic Radiology, Neurosurgery, Neurology, Yonsei University Severance Park Hospital, Yonsei University Severance Park Hospital, Yonsei University Severance Park Hospital

These authors contributed equally to this paper.

Objective: Selecting an appropriate guiding catheter to provide both sufficient supportability for working devices and sufficient distal navigability is essential for ensuring the success of a procedure. This study aimed to evaluate the advantages and disadvantages of using the ENVOL 6F distal access (DA) guiding catheter in coil embolization of anterior circulation cerebral aneurysms.

Methods: We included 96 patients (72 (73.1%) women, median age: 63 (range: 25-84) years) who underwent endovascular coiling with the ENVOL 6F DA guiding catheter from May to November 2016. We analyzed data on patient demographics and the number of coiling techniques to position the guiding catheter, initial and final location of the catheter, and complications related to the catheter.

Results: The coiled technique was used to position the ENVOL 6F DA guiding catheter in the internal carotid artery (ICA) in 20 cases (20.41%). The initial position of the ENVOL 6F DA guiding catheter involved the internal ICA (75.6%), horizontal petrous ICA (12.3%), and vertical petrous ICA (12.1%). Final control angiograms after endovascular coiling showed proximal change in the final compared to the initial position of the ENVOL 6F DA guiding catheter in 25 cases (25.51%). Procedure-related complications were observed in nine patients (9.18%), involving vasospasm in all cases; however, there was no symptomatic case.

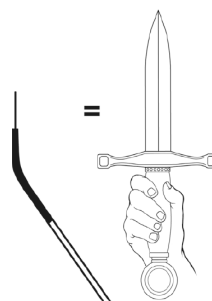
Conclusion: The ENVOL 6F DA guiding catheter had relatively sufficient distal navigability without symptomatic procedural complications. However, the change in the catheter position after endovascular coiling directed to sufficient supportability.

Keywords: Cerebral Artery, Internal Catheterization, Intracranial Aneurysm, Endovascular Coiling

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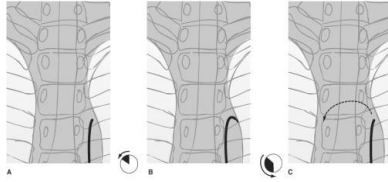
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Gladius

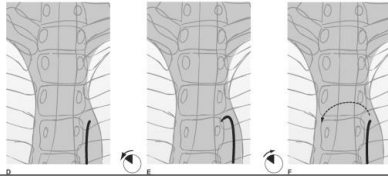


Turning the catheter anteriorly in the aorta - steer the catheter

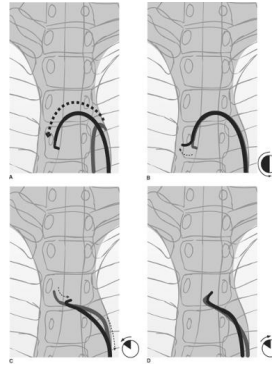
1. Tip is pointing posteriorly. Movement is discordant.



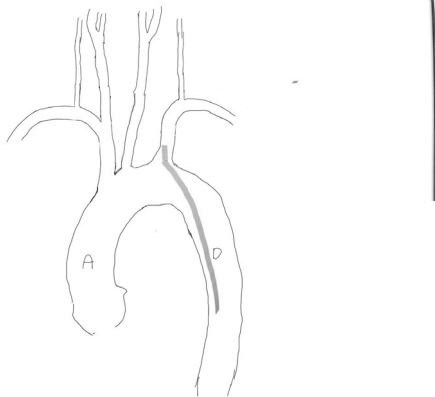
2. Tip is pointing anteriorly. Movement is concordant.



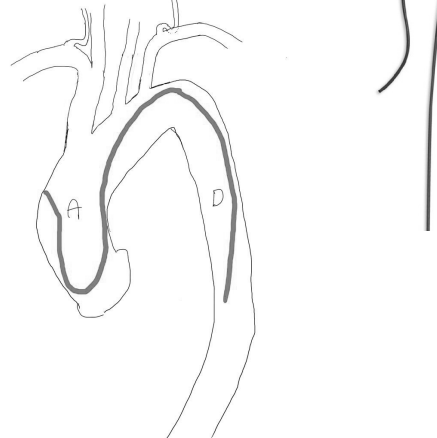
Selecting the great vessels: Establishing a stable catheter address in the left common carotid artery.



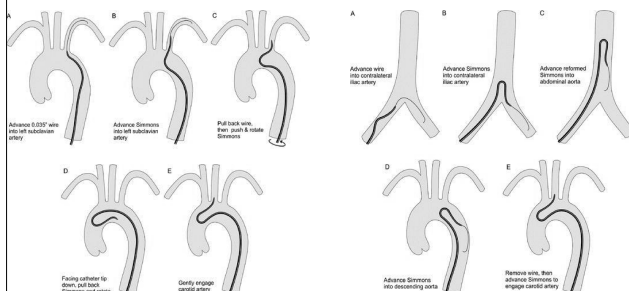
Basic guiding step



Simmons 2 action



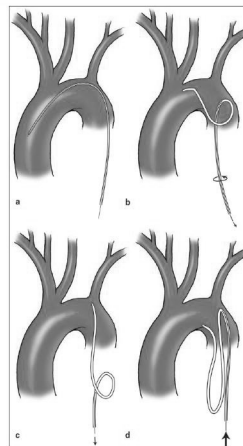
Reconstituting Simon -2

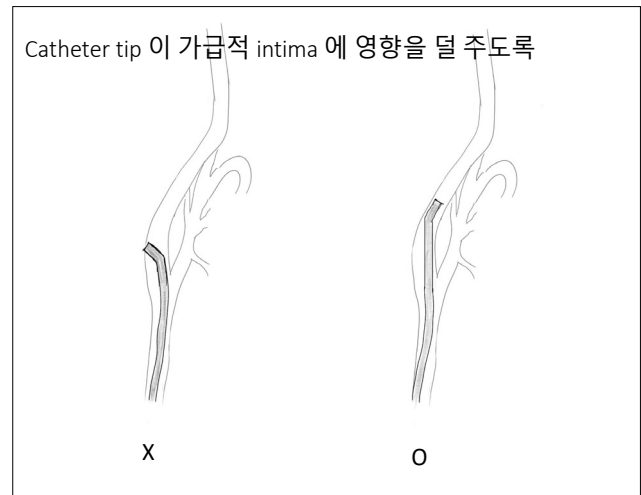
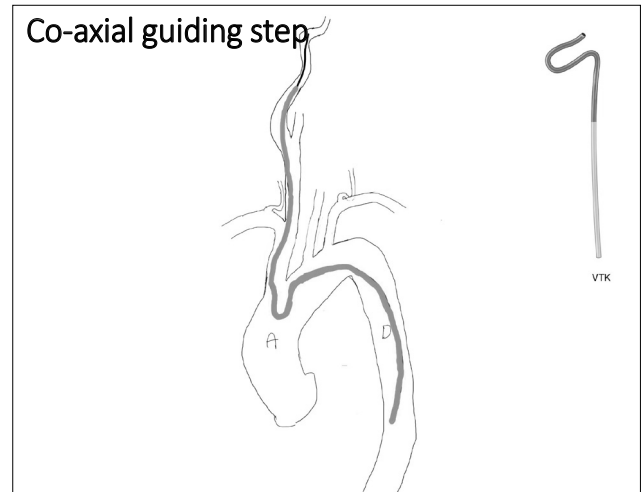


2.5 Procedures

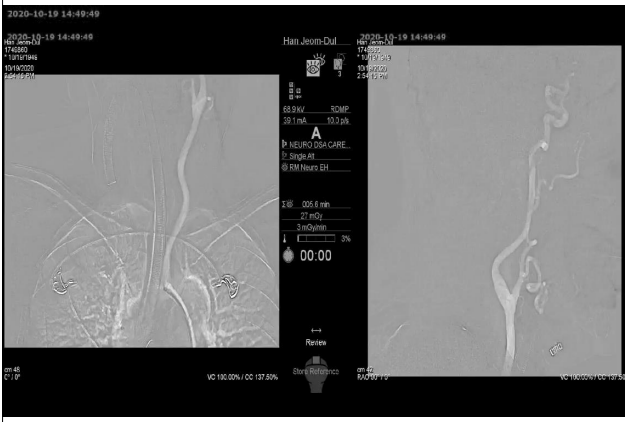
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Fig. 2.8 Alternative method for reconstituting a Simmons 2 catheter. The catheter is advanced over a hydrophilic wire as the tip of the catheter is in the ascending aorta (a). The wire is then withdrawn until the wire tip is proximal to the elbow, and the catheter is rotated clockwise as it is simultaneously withdrawn so that the loop is in the descending aorta (b, c). The wire is then advanced until (d) to reconstitute the catheter.

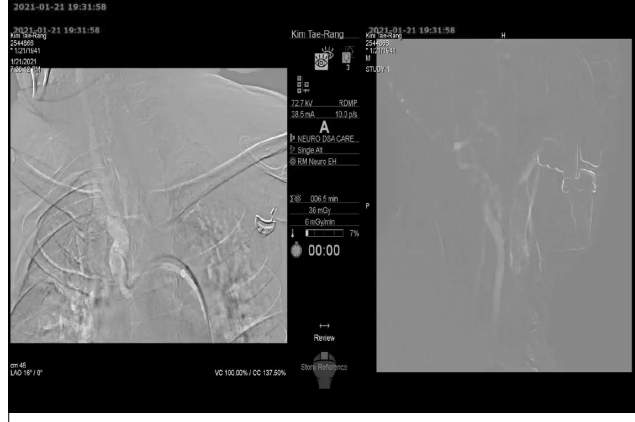




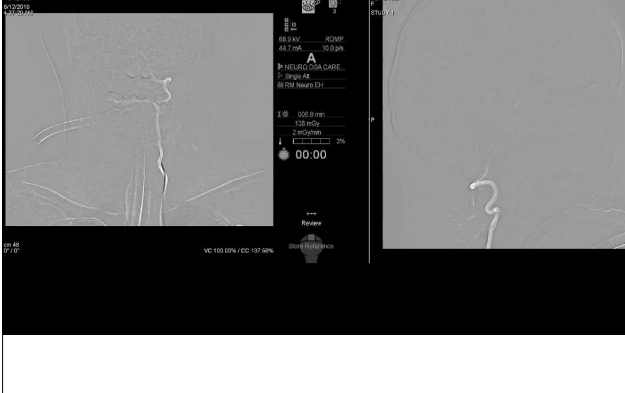
F/71 coiling(Lt.ICA) 6F shuttle + VTK



M/80, IAT(Rt. ICA), VTK → Simmons



F/64 SAH, Exchangewire



SCA selection, 5F Davis, F/79 SAH



Buddy wire



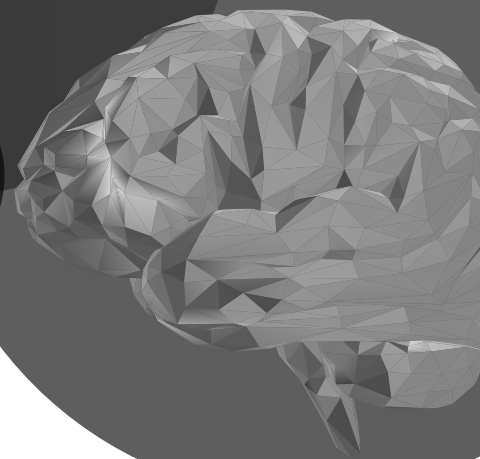
Recommendations

- Roadmap 를 항상 사용, angiocatheter 만 전진(X)
- Wire navigation 시 꼭 wire tip을 눈으로 확인하면서 하기
- Wire 를 길게 넣을수록 guiding 이 쉽고 안전하다
- 천천히 하기
- 무리하지 않는다

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/25(Fri.)

Free paper I : Ecstasy session (Troubleshooting for difficult cases)

좌장 : 이호국(한림대) / 고준석(경희대)

- | | | |
|-------|---|--------------------------|
| FP1-1 | Distinguishment the ruptured aneurysm at multiple aneurysm | 배희진
(명지병원) |
| FP1-2 | SAH and dissecting aneurysm of ophthalmic artery | 김소연
(가톨릭관동대학교 국제성모병원) |
| FP1-3 | Treatment of symptomatic partially thrombosed giant fusiform aneurysm of basilar artery | 김재현
(계명대학교 동산병원) |
| FP1-4 | Successful rescue from desperate complication; retrieving damaged stent and migrated coil with another retrievable stent - A case report | 박성찬
(울산대학교병원) |
| FP1-5 | Onyx embolization of dural AVF in the superior sagittal sinus region using external compression and direct open access: A case report | 장동규
(가톨릭대학교 인천성모병원) |
| FP1-6 | Use of a rigid-tipped microwire for the endovascular treatment of cavernous sinus dural arteriovenous fistula with a membranous stricture | 박중철
(울산대학교 서울아산병원) |
| FP1-7 | Treatment of symptomatic tandem BA & V4 severe stenosis | 박현욱(부산부민병원) |

Distinguishment the ruptured aneurysm at multiple aneurysm

Heejin Bae

Department of Neurosurgery, Myongji Hospital

Objective: Distinguishment ruptured aneurysm from unruptured one is paramount at subarachnoid hemorrhage patient. There are several factors to distinguish such as morphology, size, location, and imaging finding. Nevertheless, we should remember there could be atypical case.

Result: 63-year-old woman visited emergency room complaining dizziness. Subarachnoid hemorrhage was diagnosed with brain computed tomography (CT), and 2 aneurysms were found at right middle cerebral artery bifurcation (MCAB) and posterior cerebral artery (P1). The aneurysm at right MCAB was thought ruptured due to its characteristics (larger size and having bleb). The aneurysm neck clipping surgery for right MCAB aneurysm was done, revealed the aneurysm had not rupture. Stent-assisted coil embolization for P1 aneurysm was followed surgery. Patient recovered well, and discharged.

Conclusion: Even there were some parameters to distinguish ruptured aneurysm from unruptured one, none of them are definite. Thus, we should focus to find ruptured aneurysm out as possible as accurately, and prepare when the aneurysm suspected to be ruptured is not ruptured.

SAH and dissecting aneurysm of ophthalmic artery

So Yeon Kim

Department of Neurosurgery, Catholic Kwandong University International St. Mary's Hospital

Objective: A 40-year-old male patient visited ER presenting a sudden severe headache during sexual intercourse. Noncontrast CT showed Fisher Gr 3 SAH along the Lt sylvian fissure, suggesting aneurysm rupture. However, emergent cerebral angiography revealed no rupture aneurysm but mild bulging at Lt ophthalmic artery.

Methods: The patient was suffering from a moderate headache but follow-up CT angiography and MR angiography showed no suspected aneurysm. However, cerebral angiography underwent at rupture day #8, mild bulging at Lt ophthalmic artery became bigger and evolved to a 2mm sized aneurysm, suggesting ruptured ophthalmic aneurysm. Coil embolization was planned for the obliteration of the ruptured aneurysm.

Result: The selection of an ophthalmic artery orifice was quite easy, but the advancement of the microcatheter distal to the aneurysm was very difficult. After several trials, microcatheter selection to the aneurysm sac was finally achieved by inflating a hyper-compliant balloon supporting the microcatheter. Coil embolization was successful with effort, and the patient's condition was good even after the delayed procedure. Nevertheless, follow-up angiography underwent a week after revealed further aggravation of dissecting segment. After balloon occlusion test for ECA to ophthalmic artery collaterals, ophthalmic artery occlusion with coils and ICA stenting was performed.

Conclusion: This is a rare case of an ophthalmic artery dissecting aneurysm presenting with SAH. In serial follow-up angiography, it showed a consistent change of morphology. After evaluating ECA collaterals, parent artery occlusion was performed at last without complications.

Treatment of symptomatic partially thrombosed giant fusiform aneurysm of basilar artery

Jae-Hyun Kim, Chang-Hyun Kim, Chang-Young Lee

Department of Neurosurgery, Dongsan Medical Center Keimyung University School of Medicine

Objective: The natural course of symptomatic Partial thrombosed giant fusiform aneurysm of basilar artery is devastating. Therefore, various treatment methods have been introduced, but a definitive treatment has not been established yet. We report a case applying parallel and telescopic stents first with interval period in one patient and then implanting flow diverter.

Methods: A 42-year-old female patient showed old pons infarction and Partial thrombosed giant fusiform aneurysm of the basilar trunk, parallel and telescopic stent deployment was performed as the first treatment. An progressive enlarged basilar aneurysm was observed on the 12 months followed cerebral angiogram. Unintentionally, additional flow diverter was implanted through the preexisted conventional stents as a second treatment.

Result: The patient had recurrent pons infarction, 3 months after the first treatment. However, the symptoms resolved with mRS 0. The flow diverter deployment as a second treatment was technically successful. 1 year later the procedure, complete occlusion with minor residual filling was observed on the angiography. However, there was no change in the size of aneurysm with mass effect on brainstem in MRI. The patient was observed no other neurological symptoms or recurrent ischemic events at 24 months f/u.

Conclusion: For the treatment of Partial thrombosed giant fusiform basilar aneurysm, an established optimal treatment has not yet been introduced. In this case, fortunately, effective occlusion result on the angiogram was obtained through chronological parallel and telescopic stents deployment and then flow diversion stent insertion. However, it cannot sure that the aneurysm was cured, because the size of aneurysm was not reduced and histological changes within the aneurysm were unknown. Therefore, remained issue of treatment for symptomatic Partial thrombosed giant fusiform aneurysm of basilar artery should be continuously elucidated.

Successful rescue from desperate complication; retrieving damaged stent and migrated coil with another retrievable stent - A case report

Sung Chan Park, Soon Chan Kwon

Department of Neurosurgery, Ulsan University Hospital, University of Ulsan, College of Medicine

Coil migration is relatively well-known complication and there are many reports for removal of migrated coil. However, dislocation of stent with migration of coil may be an extremely rare case. A 52-year-old woman underwent a coiling for Lt. distal ICA An. During procedures, stent was mal-positioned to proximal and damaged, and detached coil was migrated to distal M1. The coil and stent were retrieved by Solitaire Platinum stent. We want to report extremely rare our case and technical tips.

Onyx embolization of dural AVF in the superior sagittal sinus region using external compression and direct open access: A case report

Seonjun Jeong, Dong-Kyu Jang, Byung-Rae Cho

Department of Neurosurgery, Incheon St. Mary's Hospital and College of Medicine, The Catholic University of Korea

Objective: Dural arteriovenous fistula (DAVF) in the superior sagittal sinus (SSS) region is difficult to treat. A very tortuous anatomical course sometimes hampers the access of fistula point through MMA or scalp artery. We here report a DAVF case in the vicinity of mid-SSS treated with IA onyx embolization through external manual compression and direct open access.

Methods: A 69-year-old man presented with post-traumatic intractable seizure at 5 months later after multiple cerebral contusions due to falling was diagnosed with DAVF in the region of mid-SSS. Brain MRI showed high signal change on both frontal lobes and left parietal lobe. EEG displayed occasional spikes in the left fronto-temporal region. Diagnostic angiography showed Cognard type IIB with feeding arteries of both superficial temporal arteries and occipital arteries, left middle meningeal artery (MMA) and cortical venous reflux and normal SSS function. Intraarterial (IA) embolization was planned.

Result: As left MMA was very thin and not a main feeder, but scalp arteries were main feeders, IA onyx embolization through left STA anterior, middle, and posterior branches super-selection using external compression technique for microcatheter navigation and prevention of onyx reflux and too extensive spreading into normal scalp arteries achieved subtotal occlusion with remnant small shunt from right OA and STA branches without cortical reflux. The following day after first IA embolization, seizure attack persisted. Therefore, remaining fistula was treated with onyx embolization through direct open access of right STA parietal branch under the C-arm angiography because right external carotid artery had a severe tortuous course. Complete occlusion was achieved without any complications.

Conclusion: In a specific case of DAVF in the SSS region with difficult access but dominant scalp feeding arteries, external compression technique and direct open access may enable successful IA embolization.

Use of a rigid-tipped microwire for the endovascular treatment of cavernous sinus dural arteriovenous fistula with a membranous stricture

Jung Cheol Park

Department of Neurosurgery, University of Ulsan College of Medicine, Asan Medical Center

Objective: Transvenous embolization (TVE) via an occluded inferior petrosal sinus (IPS) in a cavernous sinus dural arteriovenous fistula (CSDAVF) is challenging, often requiring navigation of a microcatheter through resistive strictures between the occluded IPS and dilated cavernous sinus (CS) sac. We report a cases of successful target access by puncturing the stricture with a rigid-tipped microguidewire (Conquest pro 12 [Asahi Intecc Co., Ltd]), initially designed for the cannulation of chronic total occlusion (CTO) during coronary artery revascularization.

Methods: 52-year female patient was underwent procedure using the CTO wire during TVE.

Result: Despite successful access through the occluded IPS, further entry into the target region was not possible due to the strictures within the venous sac. However, puncturing the strictures using the rigid-tipped microguidewire was successful. We advanced the microcatheter over the rigid wire for additional navigation to the fistular hole, and achieved complete occlusion of the shunt without complications.

Conclusion: We overcame tight strictures, which seemed otherwise impossible to pass through with standard guidewires and microcatheters, using a rigid-tipped microguidewire in the cannulation of the occluded IPS for the TVE of a CSDAVF.

Treatment of symptomatic tandem BA & V4 severe stenosis

Hyun Wook Park

Department of Neurosurgery, Busan Bumin Hospital

Objective: Several reports have demonstrated the feasibility of basilar artery(BA) stent in symptomatic BA stenosis. But, concerns about stent of BA have included the risk of occluding the ostia of the pontine perforators by compression of the plaque. We report our experience with stenting of V4 stenosis in symptomatic tandem BA and Lt. V4 severe stenosis.

Methods: A 78-year-old male presented with intermittent dysarthria and quadriparesis that had occurred 5 days before admission. Brain CTA and Diffusion MRI was done which demonstrated tandem BA and Left V4 severe stenosis, and no acute infarction. TIA was diagnosed and aspirin and clopidogrel were prescribed. 8 days later, he revisited with severe dysarthria and quadriparesis Gr IV. Diffusion MRI showed acute pontine infarction. TFCA showed 89% stenosis in Lt. V4 stenosis, 85% stenosis in the BA, and Rt. V4 had no stenosis. We should decide on stent treatment of BA severe stenosis. But, the risk of infarction in symptomatic BA stenting is high. So we decided to treat only Lt. V4 stenosis with a stent. Procedures were performed using Gateway balloon and Wingspan stent and there were no procedure related complication. He was discharged 7 days later with recovery from dysarthria and quadriparesis. Currently, he visits the outpatient clinic alone without neurological symptoms for 1 year.

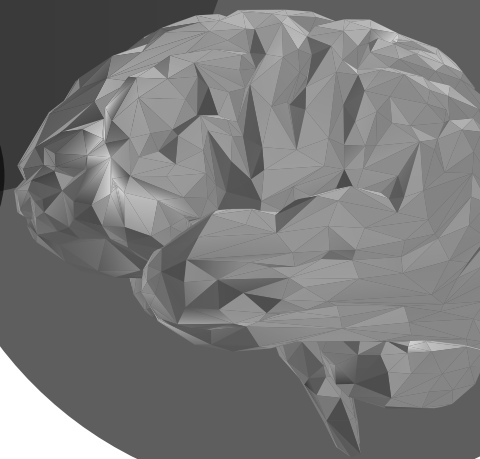
Result: BA blood flow is supplied by both V4 blood flow. Therefore, we thought that BA blood flow would increase if the blood flow of the left V4 was improved by stenting. For this patient's symptomatic BA stenosis, we thought that BA stent treatment would increase the risk of exacerbation of pontine infarction. Therefore, the progression of pontine infarction could be prevented by improving left V4 blood flow by stenting.

Conclusion: When both BA and unilateral V4 have symptomatic severe stenosis, the risk of pontine infarction can be prevented even if unilateral V4 blood flow is improved by using stent.

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/25(Fri.)

Symposium I: Interdisciplinary session

좌장 : 김범태(순천향대) / 양수근(인하대 의생명학과)

1. Neurostimulation & clinical application
2. The Computer Aided Diagnostics Algorithm and Intracranial Applicable Catheter of Intravascular OCT
3. Stroke rehabilitation at present, and in the future

정용안(가톨릭대 핵의학과)

이종하(계명대 의용공학과)

김수아(순천향대 재활의학과)

Neurostimulation & clinical application

정 용 안

가톨릭대학교 방사선과학교실 핵의학과

Neurostimulation & Clinical Application

2021. 06. 25.
Yong-An Chung, MD, PhD

뇌 기능 조절을 통한 새로운 접근

수술 기반 → 최소 수술 → 비수술

Deep Brain Stimulation



Tremor, FDA 1997
Parkinson's Disease, FDA 2002



Vagus Nerve Stimulation



Epilepsy, FDA 1997
Depression, FDA 2005



Transcranial Magnetic Stimulation

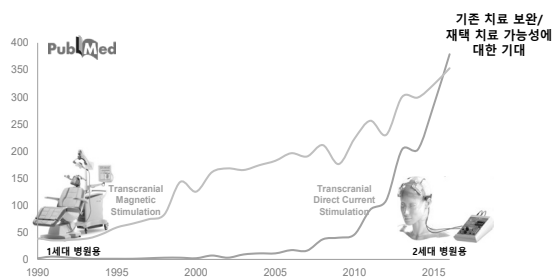


Depression, FDA 2008

NEURONETICS

2

최근 비침습적 뇌 기능 조절 기술 임상 급증



3

TMS tDCS 국내외 인허가 현황

	미국	유럽	한국 식약처
TMS	Depression Pain	Depression Mood Disorder Schizophrenia PTSD Parkinson's Disease Pain	Depression
tDCS	None	Depression Anxiety Addiction Stroke Pain Migraine	Depression Stroke

4

ASCENT 2021

Neuromodulation

- 전기/자기 등의 에너지, 화학물질 등의 외부 자극을 이용하여 뇌신경계 기능을 조절하는 기술 (cf. brain stimulation, neurostimulation)
- 침습적(invasive) 또는 비침습적(non-invasive) 기술로 구분
 - 침습적: 뇌심부자극 등
 - 비침습적: 전기경련요법, 경두개자극자극, 경두개자극자극, 경두개자극자극 등
- 뇌 기능의 향상 및 억제를 모두 포괄
- 뇌과학/의학 연구에서 빠르게 중요성이 커지는 분야로서, 최근 뇌신경회로망의 기능을 선택적으로 조절함으로써 인지 및 정서 기능을 조절하는 기술이 미래유망기술로 선정

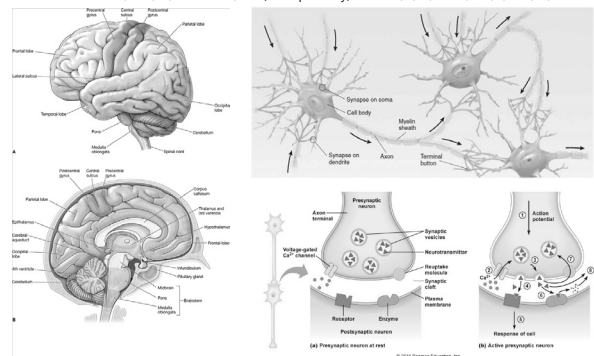


Neuromodulation 기술의 중요성

- 다양한 뇌질환에 대한 치료 기술로서의 가능성
 - 현재 임상에서 약물치료, 인지행동치료 등에 비해 널리 사용되지는 못함
 - 기존 치료에 반응을 보이지 않는 환자에게는 유력한 대안 또는 병행치료 전략이 될 수 있음
 - 뇌 특정 영역만을 타겟팅 가능하여 기존 중추신경계 약물들에 비해 전신 부작용이 덜하고 환자의 거부감이 적음
- 뇌과학 기초 연구에서의 활용 가능성
 - 기존에는 뇌 기능 연구를 위해 뇌출중/외상 등으로 인해 뇌의 특정 영역이 손상된 환자의 인지, 정서, 행동 등의 변화를 관찰
 - Neuroimaging 기술과 함께 neuromodulation으로 특정 뇌영역/회로의 기능을 조절하면서 인지, 정서, 행동 등의 변화를 관찰함으로써 뇌-마음-행동 사이의 인과관계 규명 및 brain mapping에 중요한 도구로 활용 가능 (예: functional knockout 또는 인지기능 향상 연구)

뇌의 신경신호 전달

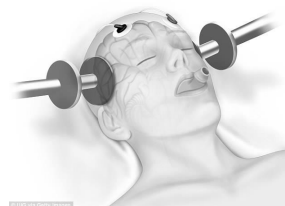
- Dendrite -> cell body -> axon의 방향으로 neuron내 전기적 신호 전달
- Synapse에서는 신경전달물질(neurotransmitter)을 이용하여 이웃 neuron으로 화학적 신호 전달
- Neuromodulation의 반복 적용은 신경가소성(neuroplasticity)를 향상시켜 뇌신경회로의 구조와 기능을 변화



Carson, Foundations of Behavioral Neuroscience, 9th ed; <http://droualb.faculty.mjc.edu/>

전기경련요법 (Electroconvulsive Therapy, ECT)

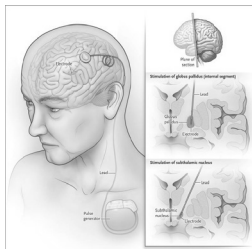
- 1930년대 개발된 가장 오래된 비침습적 신경조절 기술로 특정 영역이 아닌 뇌 전반의 기능 조절
- 뇌에 강한 전기 자극을 가하여 경련을 유발함으로써 심한 정신질환의 증상을 호전
- 약물치료, 정신치료로는 치료 반응을 보이지 않거나 응급상황/빠른 치료 효과가 필요한 경우에 한하여 주로 사용 (예: 약물저항성/자살 위험이 높은 우울장애 등)
- 치료 반응에 보통 수 주가 걸리는 약물들에 비해 빠른 경우 1주일 이내로 효과가 빠르고, 약물 사용이 조심스러운 노인 환자들에 유용
- 일부 일시적 두통, 복통, 근육통, 기억손실 등의 부작용 (수 일~수 주내 대부분 회복)



<https://www.dailymail.co.uk/>

뇌심부자극술 (Deep Brain Stimulation, DBS)

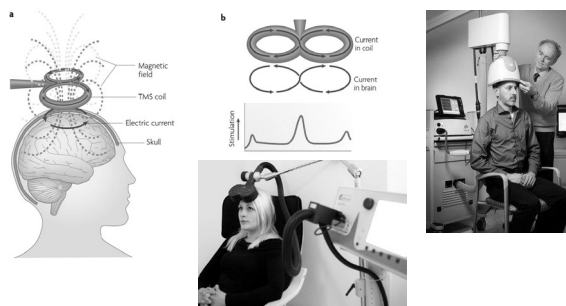
- 뇌심부에 전극을 삽입하여 전기적으로 자극하는 침습적 신경조절 기술
 - 뇌 MRI 영상을 확인하며 수술을 통해 전극을 타겟 뇌심부에 삽입
 - 전류를 조절하는 전류발생장치를 세골 아래 피부 밑에 이식
 - 전기자극이 지속적으로 유지되며 세기와 빈도는 환자에 맞게 조절 가능
- 파킨슨병과 같은 떨림, 경직, 보행 문제 등 신경학적 운동 장애 호전을 위해 고안되었으며, 난치성 우울장애와 강박장애 치료에도 연구되고 있음
- 전극 삽입을 위한 수술에 따른 위험
 - 출혈 및 감염의 가능성은 매우 드물지만, 일시적이고 경미한 어지러움, 기분 변화, 불면 등 보고
 - 전극의 타겟팅 정확도에 따라 치료 효과 및 부작용이 달라질 수 있음



Okun, 2012

경두개자극자극 (Transcranial Magnetic Stimulation, TMS)

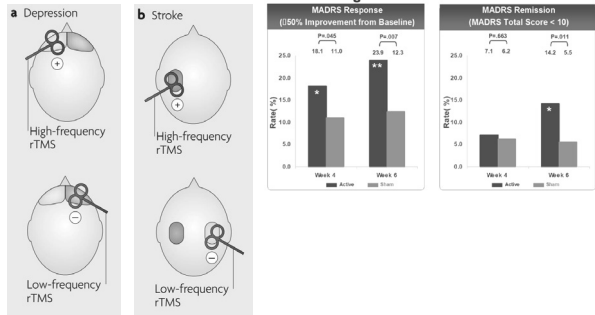
- 두피 가까이 위치한 전자기코일로 만든 자기장이 두개골을 통과하여 뇌신경에 닿으면 미세한 전류를 유도하여 타겟 뇌영역의 활동을 조절하는 비침습적 기술
- 코일 내의 전기에너지 -> 코일 주변의 자기에너지 -> 뉴런 내의 전기에너지
- 고주파 자극은 기능 향상, 저주파 자극은 기능 억제
- 두피와의 직접 접촉이 없다는 장점 / 일부 경미하고 일시적인 두통, 두피 불편감 등



Ridding et al, 2007; O'reardon et al, 2007

경두개자기자극 (Transcranial Magnetic Stimulation, TMS)

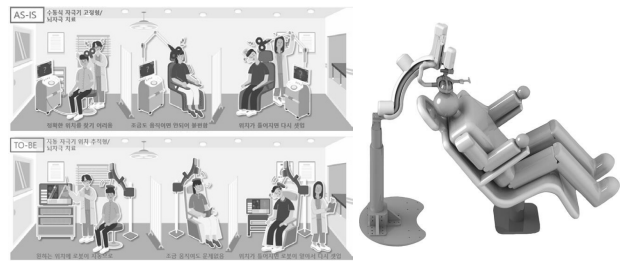
- 우울, 불안, 조현병 등 다양한 뇌질환 치료기술로 연구되어 왔으며, 2008년 항우울제에 치료 반응을 보이지 않는 주요우울장애 환자에 대한 치료법으로 미국 FDA 승인
- 메타분석에서 30~50% 주요우울장애 환자에서 치료 반응 및 20~30%에서 관해 (Berlim, 2014)
- 주요우울장애 치료 12개월 후에도 초기 반응 환자 중 62%가 치료 효과 유지 (Dunner, 2013)



Ridding et al, 2007; Oerendon et al, 2007

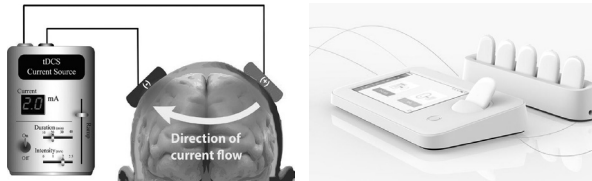
경두개자기자극 (Transcranial Magnetic Stimulation, TMS)

- 자동화를 위한 neuro-navigation 및 robot-arm 시스템 개발



경두개직류자극 (Transcranial Direct Current Stimulation, tDCS)

- 두피에 부착한 두개의 전극 사이로 약 1~2mA의 미세 직류전류를 가하여 뇌기능을 조절하는 비침습적 기술
- 일반적으로 양극은 뇌신경 활성화, 음극은 억제
- 보통 1세션 당 15~30분 정도 적용하며 1회~수회 적용 가능
- TMS에 비해 가볍고 작으며 저렴한 portable 기기로 제작 가능
- 우울증, 뇌졸중 등에 대한 치료 및 정상인의 인지기능 향상 연구 등
- 일부 경미하고 일시적인 따끔거림, 가려움, 두통 등 보고



<https://www.brainlatam.com/>; <https://www.ybrain.com/>

경두개직류자극 (Transcranial Direct Current Stimulation, tDCS)

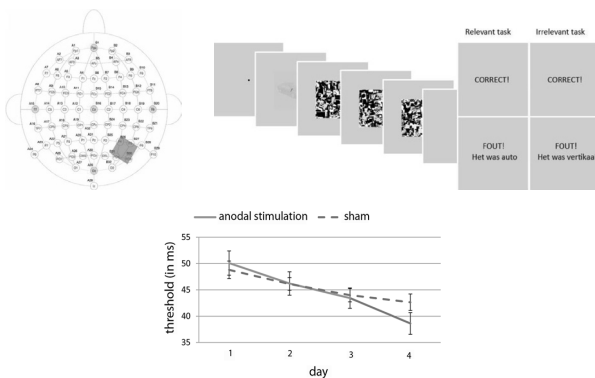
- tDCS 사용 방법의 예시



<https://www.ybrain.com/>

경두개직류자극 (Transcranial Direct Current Stimulation, tDCS)

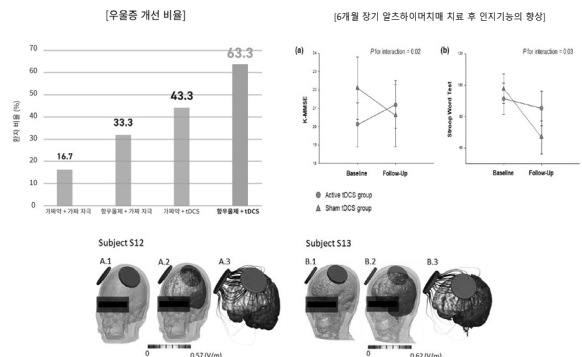
- 정상인의 인지기능에 미치는 영향에 대한 연구 (Van Meel, 2016)



Van Meel et al, 2016

경두개직류자극 (Transcranial Direct Current Stimulation, tDCS)

- 우울증, 경도인지장애, 알츠하이머치매, 뇌졸중 등 뇌기능 이상 환자들을 위한 임상연구가 활발함
- 개인별 뇌의 해부학적 차이를 고려하기 위한 전기 에너지 전달 simulation 및 modelling 연구

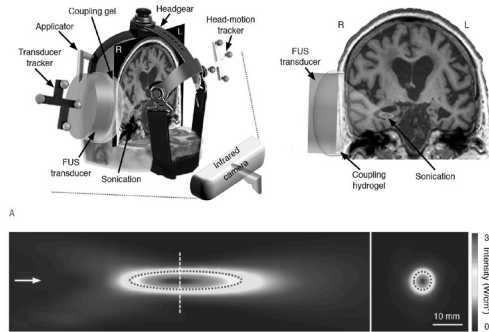


Brunoni et al, 2013; Im et al, 2019

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경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

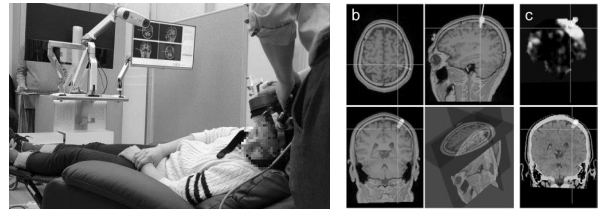
- 열을 발생시키지 않는 인체에 안전한 저강도의 초음파 에너지를 뇌심부(약 8 cm의 깊이)의 타겟 지점까지 정밀하게 (5 mm 미만의 공간해상도) 전달하는 새로운 비침습적 뇌조절 기술
- 파라미터에 따라 뇌회로의 자극과 억제가 모두 가능하고, 뇌혈관장벽의 개방 및 약물전달에도 응용이 가능



Jeong et al, 2021

경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

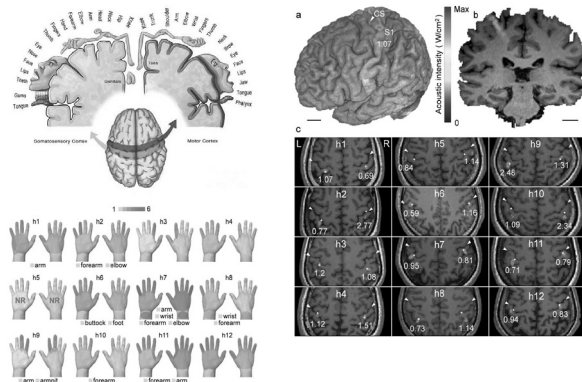
- MRI/CT 기반의 영상유도 내비게이션 기술과 결합하여 개인 맞춤형 정밀 타겟팅 가능



Lee et al, 2015

경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

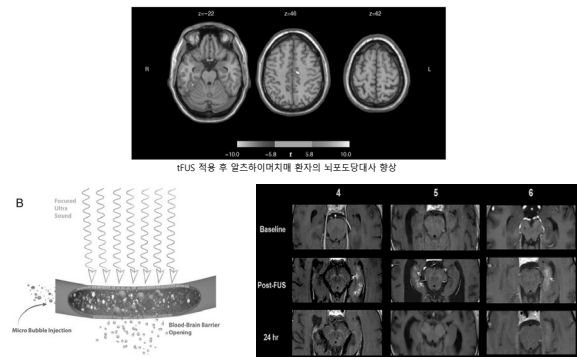
- 인체 감각피질 자극을 통한 말초의 촉각 유도 연구



Lee et al, 2015

경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

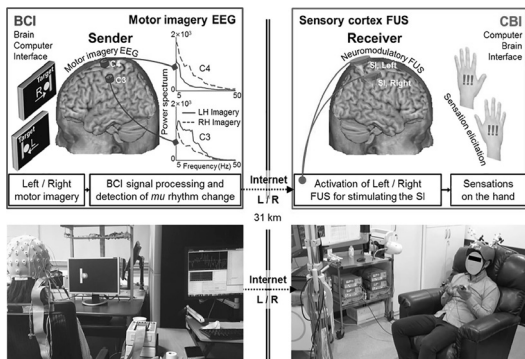
- 세계적으로 인체 적용 연구는 초기 단계로, 알츠하이머치매, 우울증, 불면증, 외상성뇌손상으로 인한 의식장애, 신경병증성 통증 환자군 등 다양한 뇌질환 치료를 위한 임상연구가 시도 중임



Jeong et al, 2021; Rezai et al, 2020

경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

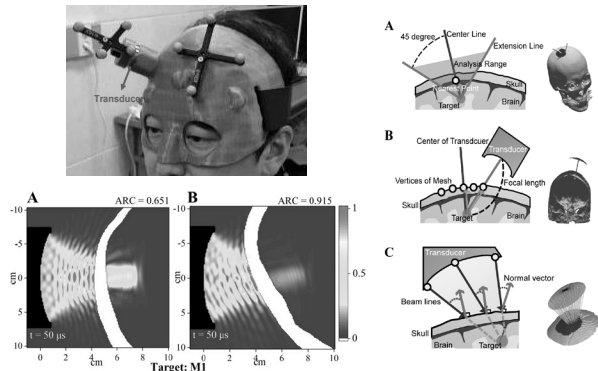
- 뇌파와 tFUS를 이용한 brain-to-brain interface 실험교류 연구



Lee et al, 2017

경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

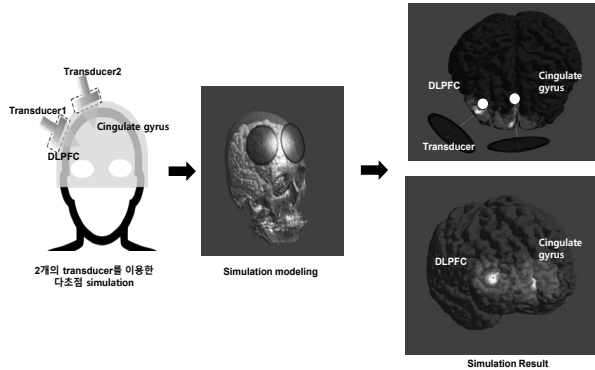
- 3D 프린팅 기술을 활용한 개인 맞춤형 뇌조절 기술 개발을 통한 타겟팅 정확도/일관성 향상
- 개인의 두개골 형상을 고려한 최적의 초음파 경로 시뮬레이션 기술 개발



Pahk et al, 2017

경두개집속초음파 (Transcranial Focused-ultrasound, tFUS)

- 개인의 두개골 형상을 고려한 최적의 초음파 경로 시뮬레이션 기술 개발



Neuromodulation 기술의 발전 방향

- 다양한 파라미터 조합에 대한 탐색, 최적화, 표준화
 - 타겟 뇌영역의 위치, 자극의 세기/지속시간/횟수/빈도 등
 - 파라미터의 차이로 인해 연구 결과간 직접적인 비교가 어려움
 - 개인별 증상 및 뇌신경회로 특성을 반영한 맞춤형 치료 기술 개발
 - 개인별 다양한 교란변인의 영향에 대한 분석
- Neuromodulation과 동시에 fMRI/뇌파 등의 뇌신호를 측정하여 개인별 뇌기능적 특성 및 뇌반응을 실시간으로 분석하고 신경조절 파라미터를 최적화하는 기술 개발

TABLE 1 | Table of variables which can alter current flow and action.

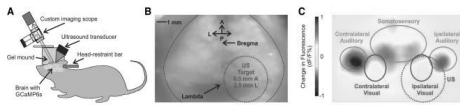
Source of variability	Variable	Citations
Biological	Head thickness	Honrich et al., 2014
	Amount of sweat produced on the skin surface below the electrode pad	Bikson et al., 2002
	Head size	Datta et al., 2012
	Tissue thickness	Cole et al., 2010
	Subcutaneous fat levels	Cole et al., 2010
	CSF depth	Cole et al., 2010
	Cortical fold density	Cole et al., 2010
	Cortical surface morphology	Cole et al., 2010
	Individual morphologies of cortical gyri and sulci	Cole et al., 2010
	Initial state of the cortex before stimulation	Forman et al., 2014; Kuo and Cohen, 2014; Kuo and Cohen, 2014
Neurotransmitter levels (especially GABA)		Kuo and Cohen, 2014
Stages of the menstrual cycle		Hughes et al., 2014
Age		2014; Li et al., 2015
Genetics (e.g., relative of those with schizophrenia)		Nason et al., 2015
Lifestyle	History of neurosurgical interventions (e.g., resection)	Chen et al., 2012
	Education level	Samuel and Jones, 2012
	Personality	Reich et al., 2011



Thair et al. 2017; https://sotiermedical.com/

Neuromodulation 기술의 발전 방향

- 뇌신경학적 기전에 대한 연구
 - 뇌질환의 뇌신경회로 이상 기전 및 neuromodulation의 보다 구체적인 작용 기전에 대한 연구 필요
 - 뇌신경 네트워크의 변화를 특정 뇌영역의 활성화/비활성화로 단순화할 수 없음
 - 일본 연구에서 특정 인지기능이 향상된 반면, 다른 인지기능의 저하가 함께 나타남이 보고됨
 - 동물모델 및 다양한 뇌영상을 이용한 뇌기능 변화 및 치료 반응 예측 연구가 활발함
- 효과와 안전성에 대한 검증
 - 수개월 이상 장기 적용 시의 효과와 안전성에 대한 검증
 - 발달기의 소아/청소년 및 노인에 대한 검증
 - 스마트폰/웨어러블 디바이스 등과 연동된 재택 자가 적용에 대한 안전성 검증 및 제도적 장치 마련
 - 비임상적 기능성 의료기기의 활용 가능성 탐색 (일반인의 인지기능 향상, 스트레스 조절 등)



Walsh, 2000

Alzheimer's Research & Therapy

Open Access

RESEARCH

Changes in cerebral glucose metabolism after 3 weeks of noninvasive electrical stimulation of mild cognitive impairment patients

Kyunguk Kim^{1,2}, In-Kwon Song^{1,2} and Yong-An Chung^{1,2}

Abstract

Background Mild cognitive impairment (MCI) is a syndrome that disrupts an individual's cognitive function but prevents them from developing into dementia. Although numerous clinical trials have attempted to slow the progression of MCI, no treatment has been shown to be effective. Noninvasive electrical stimulation (NIES) is a noninvasive method of stimulating the brain. We hypothesized that NIES could improve cognitive function in MCI patients. We conducted a randomized, controlled, double-blind study to evaluate the effects of NIES on cognitive function in MCI patients. The results showed that NIES significantly improved cognitive function in MCI patients. These findings suggest that NIES could be a potential treatment for MCI.

Results: We showed that regular and relatively long-term use of tDCS significantly increased regional cerebral metabolism in MCI patients. Furthermore, subjective memory satisfaction and improvement of the memory strategies of participants were observed only in the real tDCS group after 3 weeks of stimulation.

Conclusion: Our findings suggest that neurophysiological intervention of MCI could improve glucose metabolism and transient memory function in MCI patients.

Keywords: Alzheimer's disease, mild cognitive impairment, noninvasive electrical stimulation, glucose metabolism, memory function.

Brain Stimulation

Effects of 6-month at-home transcranial direct current stimulation on cognition and cerebral glucose metabolism in Alzheimer's disease

Joyoung Jang^{1,2}, Hyeonseo Jeong^{1,2}, Marom Biskin^{1,2}, Adam J. Woods^{1,2}, Gohee Lim^{1,2}, Jin Kyung Oh^{1,2}, Seunghee Na^{1,2}, Jong-Sik Park^{1,2}, Helena Knikou^{1,2}, In-Se Song^{1,2}, and Yong-An Chung^{1,2}

Abstract

Background Alzheimer's disease (AD) is the most prevalent type of dementia, affecting 5.5 million individuals over age 65 in the US alone [1]. Although AD is primarily characterized by progressive loss of memory, other cognitive domains such as language, visuospatial skills, and executive functions are also frequently impaired [2]. Despite the increasing prevalence and devastating impact of AD, current treatment strategies demonstrate limited efficacy in preventing, slowing, or reversing the progression of the disease. Therefore, the exploration and development of novel treatments for AD are of highest importance.

Introduction

Alzheimer's disease (AD) is the most prevalent type of dementia, affecting 5.5 million individuals over age 65 in the US alone [1]. Although AD is primarily characterized by progressive loss of memory, other cognitive domains such as language, visuospatial skills, and executive functions are also frequently impaired [2]. Despite the increasing prevalence and devastating impact of AD, current treatment strategies demonstrate limited efficacy in preventing, slowing, or reversing the progression of the disease. Therefore, the exploration and development of novel treatments for AD are of highest importance.

Results: Compared to sham tDCS, active tDCS improved global cognition measured with Mini-Mental State Examination (p for interaction = 0.02) and language function assessed by Boston Naming Test (p for interaction = 0.04), but not delayed recall performance. In addition, active tDCS prevented decreases in executive function at a marginal level (p for interaction < 0.10). rCMRglc in the left middle/inferior temporal gyrus was preserved in the active group, but decreased in the sham group (p for interaction < 0.001).

Conclusions: Daily tDCS over the DLPFC for 6 months may improve or stabilize cognition and rCMRglc in AD patients, suggesting the therapeutic potential of repeated at-home tDCS.

Transcranial direct current stimulation for online gamers: A prospective single-arm feasibility study

SANG HUN LEE¹, HYEONSEO JEONG¹, IN-KWON SONG¹, YOUNG-AN CHUNG¹, SEUNGHEE NA¹, JONG-SIK PARK¹, HELENA KNIKOU¹, IN-SE SONG¹, and YOUNG-AN CHUNG¹

Abstract

Background Online gaming is a popular leisure activity, and excessive gaming can lead to gaming disorder. Transcranial direct current stimulation (tDCS) is a noninvasive method of stimulating the brain. We hypothesized that tDCS could improve cognitive function in online gamers. We conducted a prospective, single-arm, feasibility study to evaluate the effects of tDCS on cognitive function in online gamers. The results showed that tDCS significantly improved cognitive function in online gamers. These findings suggest that tDCS could be a potential treatment for gaming disorder.

Results: After tDCS sessions, weekly hours spent on games (p = .02) and scores of IAT (p < .001) and BDI-II (p = .01) were decreased, whereas BSCS score was increased (p = .01). Increases in self-control were associated with decreases in both addiction severity (p = .002) and time spent on games (p = .02). Moreover, abnormal right-greater-than-left asymmetry of regional cerebral glucose metabolism in the DLPFC was partially alleviated (p = .04). **Conclusions:** Our preliminary results suggest that tDCS may be useful for reducing online game use by improving interhemispheric balance of glucose metabolism in the DLPFC and enhancing self-control. Larger sham-controlled studies with longer follow-up period are warranted to validate the efficacy of tDCS in gamers.

Keywords: Alzheimer's disease, mild cognitive impairment, noninvasive electrical stimulation, glucose metabolism, memory function.

ASCENT 2021

Effects of transcranial direct current stimulation on addictive behavior and brain glucose metabolism in problematic online gamers

HYUNSEOK JEONG^{1,2}, JIN KYOUNG OH¹, EUN KYOUNG CHOI¹, JOYOUN JAMIE IM¹, SUJUNG YOON¹, HELENA KNOTOVA³, MAROM BIKSON¹, IN-UK SONG¹, SANG HOON LEE^{1,2} and YOUNG-AN CHUNG^{1,2}*

¹Department of Nuclear Medicine, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, South Korea
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Abstract

Transcranial direct current stimulation (tDCS) is a non-invasive brain stimulation technique that has been shown to be effective in treating various neurological and psychiatric disorders. In this study, we investigated the effects of tDCS on addictive behavior and brain glucose metabolism in problematic online gamers. The study included 20 participants who were divided into two groups: tDCS and sham. The tDCS group received a 20-minute tDCS session over the left prefrontal cortex. The sham group received a sham tDCS session. The study was conducted over a 4-week period. The primary outcome was the change in brain glucose metabolism, measured using PET-CT. The secondary outcome was the change in addictive behavior, measured using the Addiction Severity Index (ASI). The results showed that the tDCS group had a significant decrease in brain glucose metabolism compared to the sham group. Additionally, the tDCS group had a significant decrease in ASI scores compared to the sham group. These findings suggest that tDCS may be a promising treatment for addictive behavior and brain glucose metabolism in problematic online gamers.

Keywords: tDCS, brain glucose metabolism, addictive behavior, problematic online gamers.

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Results

Significant decreases in time spent on gaming ($P = 0.005$), BIS ($P = 0.03$), BAS-fun seeking ($P = 0.04$), and BAS-reward responsiveness ($P = 0.01$), and increases in BSCS ($P = 0.03$) were found in the active tDCS group, while decreases in IAT were shown in both groups ($P < 0.001$). Group-by-time interaction effects were not significant for these measures. Increases in BSCS scores were correlated with decreases in IAT scores in the active group ($\beta = -0.85$, $P < 0.001$). rCMRglu in the left putamen, pallidum, and insula was increased in the active group compared to the sham group (P for interaction < 0.001). **Discussion and conclusions:** tDCS may be beneficial for problematic online gaming potentially through changes in self-control, motivation, and striatal/insular metabolism. Further larger studies with longer follow-up period are warranted to confirm our findings.

Keywords: tDCS, brain glucose metabolism, addictive behavior, problematic online gamers.

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A pilot clinical study of low-intensity transcranial focused ultrasound in Alzheimer's disease

ULTRA SONOGRAPHY

ORIGINAL ARTICLE

Hyunseok Jeong^{1,2*}, Jooyoun Jamie Im¹, Jong-Sik Park¹, Seung-Hee Na¹, Wanhye Lee¹, Seung-Suk Yoo¹, In-UK Song¹, Yong-An Chung^{1,2}

¹Department of Nuclear Medicine, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea; ²Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Abstract

Transcranial focused ultrasound (tFUS) is a non-invasive brain stimulation technique that has been shown to be effective in treating various neurological and psychiatric disorders. In this study, we investigated the effects of tFUS on Alzheimer's disease. The study included 20 participants who were divided into two groups: tFUS and sham. The tFUS group received a 20-minute tFUS session over the left prefrontal cortex. The sham group received a sham tFUS session. The study was conducted over a 4-week period. The primary outcome was the change in brain glucose metabolism, measured using PET-CT. The secondary outcome was the change in cognitive function, measured using the Mini-Mental State Exam (MMSE). The results showed that the tFUS group had a significant increase in brain glucose metabolism compared to the sham group. Additionally, the tFUS group had a significant increase in MMSE scores compared to the sham group. These findings suggest that tFUS may be a promising treatment for Alzheimer's disease.

Keywords: tFUS, brain glucose metabolism, Alzheimer's disease, cognitive function.

Introduction

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Results

The sonication, as anticipated, did not show evidence of active blood-brain barrier opening on T1 dynamic contrast-enhanced magnetic resonance imaging. rCMRglu in the superior frontal gyrus ($P < 0.001$), middle cingulate gyrus ($P < 0.001$), and fusiform gyrus increased after tFUS ($P = 0.001$). Patients demonstrated mild improvement in measures of memory, executive, and global cognitive function following tFUS. No adverse events were reported. **Conclusion:** These results suggest that hippocampal sonication with low-intensity tFUS may have beneficial effects on cerebral glucose metabolism and cognitive function in patients with AD. Further larger studies are needed to confirm the therapeutic efficacy of tFUS in AD.

Keywords: Low-intensity transcranial focused ultrasound, Alzheimer's disease, Regional cerebral metabolic rate of glucose, Cognitive function.

건강위험요소에 따른 기대 수명의 상실

하루 20 개비의 흡연 – 6년
15%의 과체중 – 2년
평균적인 음주 – 1년
진료에 의한 방사선 피폭 – 7일
직업적인 방사선 피폭
- 0.3 rem (3 mSv)/년 (18-65세): 15일
- 1.0 rem (10 mSv)/년 (18-65세): 51일

The Administration of Radioactive Substances Advisory Committee (ARSAC)

Institute for Bio-Medical Convergence
Basic Neuroscience and Brain Disorders Research
using Functional Neuroimaging and Neuromodulation

REMED (Neuromodulation TMS)
ILSM (Neuromodulation Ultrasonography)
ybrain (Neuromodulation DCS)

KAIST (Unit of Bio and Brain Engineering)
HYU (Neuromodulation Device Development (Sungun Lee))
Basic Science (Jelwon Cho)
BRAIN INSTITUTE (In Kyoon Lyoo, Sujun Yoon)
Neural Engineering Group (Marom Bikson)
The City College of New York

THE CATHOLIC UNIVERSITY OF KOREA
INCHEON ST. MARY'S HOSPITAL
PET, SPECT, fMRI, MRS, DTI, SWI (Radiology)

Harvard Medical School
Brain MRI Neuromodulation (SS Yoo, Harry Lee)
Device & SW Development (Hyung Min Kim)
Addictive Disorders (Younghoon Chon)
Mental Health Training Center (Hsin-An Chang)
NEUROGEAR (Venture Company)
POCUS (Venture Company)
SNUH (SNU-SNU BUDANG MEDICAL CENTER)
SNUH (SNU NATIONAL UNIVERSITY BUDANG HOSPITAL)

Thanks for your attention!!

The Computer Aided Diagnostics Algorithm and Intracranial Applicable Catheter of Intravascular OCT

이 중 하

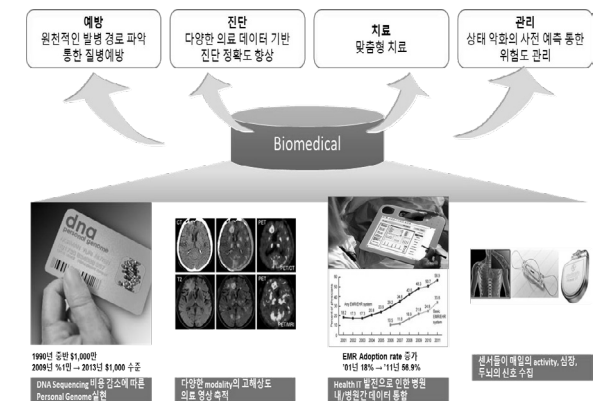
계명대학교 의과대학 의용공학과

The Computer Aided Diagnostics Algorithm and Intracranial Applicable Catheter of Intravascular OCT

계명대학교 의과대학 의용공학과

이 중 하

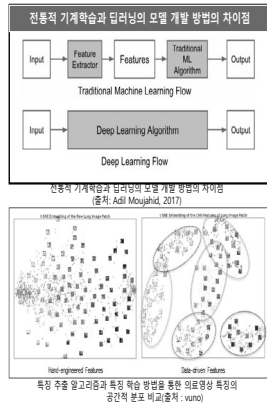
진단/치료/예방/관리 등 의료 전 분야에 걸친 IT 혁신으로 인한 Data Size 증가



인공지능/의료

인공 지능 기반의 의료 영상 분석 기술

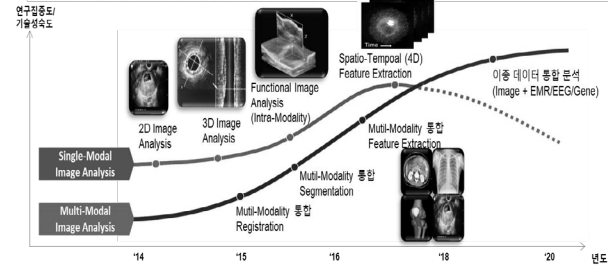
- 의료영상 분석
 - 특징 추출(Feature Extraction) 알고리즘에 따라 모델의 정확도가 결정
 - 문제는 특징 추출 알고리즘이 설계자의 직관이나 경험에 근거하기 때문에 다양한 상황과 데이터의 형태 및 변화들을 모두 고려하기 힘들고, 설계자의 지식을 넘어서는 복잡하고 추상적인 변환들을 모델링할 수 없다는 점
- 인공지능
 - 분별력 확보데이터에 기반한 특징을 학습으로 대체
 - 설계자에 의존적인 것이 아닌 데이터에 의존적인 패러다임으로의 변화
 - 학습된 특징들은 설계된 특징에 비해 보다 데이터에 근거한 객관적이며 일관적인 성격을 가지고 있고, 데이터 분석의 목적에 부합함
- 알고리즘 설계에 의해 추출된 특징
 - 정의가 모호하거나 주관적 판단이 개입하는 경우 서로 다른 병변 간의 특징이 중첩되거나 동일 병변에 대한 특징이 분산되는 특징을 보임
 - 학습 기반의 특징은 영상적으로 유사한 병변이 공간적으로 가까운 곳으로 변환되어 최종적인 분류 성능을 높임
 - 복잡하고 추상적인 의료 영상의 특징을 대량의 데이터에 기반한 학습을 통해 표현하고자 하는 시도가 빠르게 확산



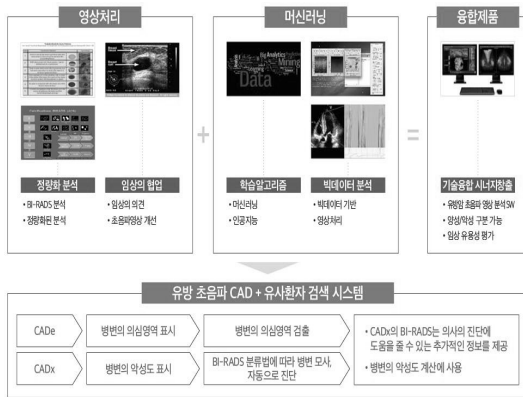
의료영상분석

Medical Image Analysis

- 다수의 multi-modality 영상들을 functional imaging과 시간 등 다양한 축을 고려하여 통합 분석함으로써 고정확한 병변을 검출하고 진단하는 기술



인공지능 및 빅데이터기반의 바이오메디컬 처리기술

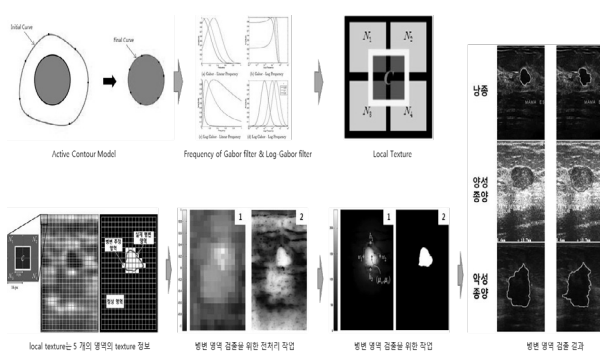


진단 기준에 따른 이상 세포 분류

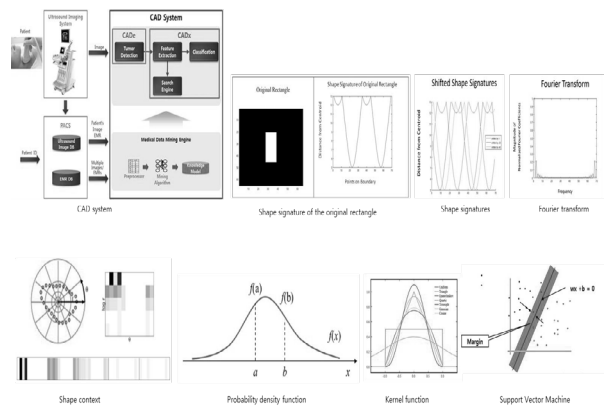
- 머신러닝을 통한 인공지능 기반의 자궁경부암 세포 분석을 위한 학습모델



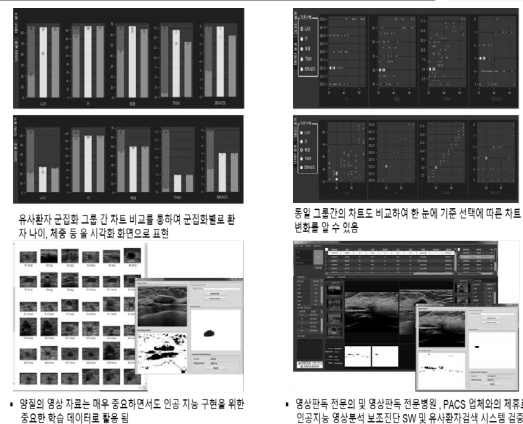
유방암 진단을 위한 보조진단프로그램 개발을 위한 프로세스



초음파 영상의 양성/악성 판독 기술

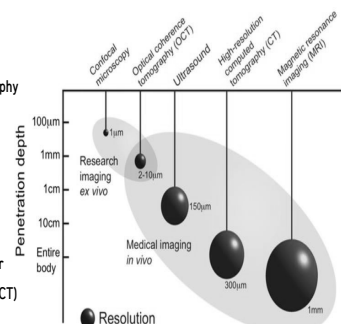


인공지능 환자 분류 및 진단

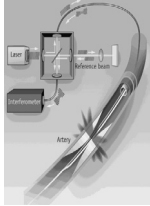


진단 검사

- X-ray 혈관조영술(angiography)
- 컴퓨터 단층촬영(computed tomography angiography, CTA)
- 자기공명영상(magnetic resonance imaging, MRI)
- 혈관 내 초음파검사(intravascular ultrasound, IVUS)
- 혈관 내 광간섭단층촬영(intravascular optical coherence tomography, IVOCT)

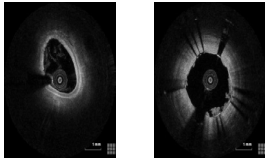


Intravascular Optical Coherence Tomography (IVOCT)



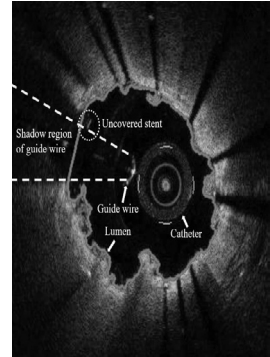
What are the advantages?

- 1) 침습적 방법으로 혈관 단면 영상 촬영하는 기기
- 2) IVUS 보다 해상도가 10배 높고, 영상화 속도가 빠름
- 3) 심혈관 증례를 평가 및 혈전 검출 가능
- 4) 상대적으로 높은 해상도로 빠르게 영상화가 가능하므로 의료현장에서 임상 활용 가치가 매우 높음

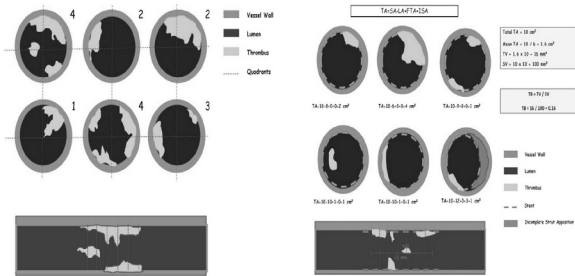


IVOCT 영상 처리 알고리즘 연구 고려사항

- 영상 내 혈액 덩어리(blood clot) 혈관 내강 영역에서 관찰
 - 광신호를 흡수하여 혈관 내벽을 덜 밝게 됨
 - 혈관 내강의 경계 추출시 노이즈로써 경계 검출을 방해
- 혈관 내강의 표면이 종종 불규칙한 형태
 - 혈전은 혈관 내강의 표면에서 불규칙한 돌출부로 관찰
 - 전자동 혈관 내강 분할시 혈관 내강 형태학적 특징 고려
- 가이드 와이어, 스텐트 스트럿 그림자로 내강 형태 왜곡
 - 가이드 와이어는 카테터를 가이드하는 용도로 사용
 - 영상 중앙 위치, 그림자를 포함한 원의 형태로 관찰
 - 그림자가 존재하는 혈관 내강의 일부는 검정색 왜곡

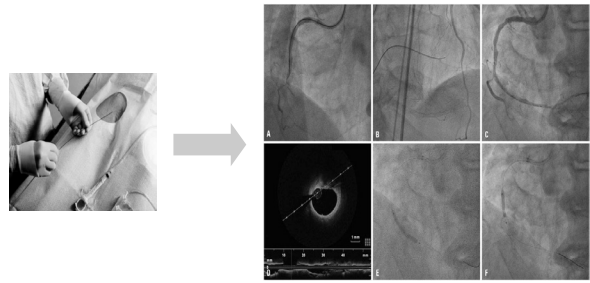


Assessment and Quantification of Intracoronary Thrombus

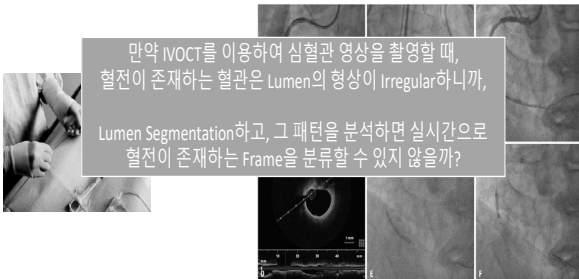


*Optical coherence tomography assessment and quantification of intracoronary thrombus: Status and perspectives (Ito P, et al, 2015)

Research Hypothesis



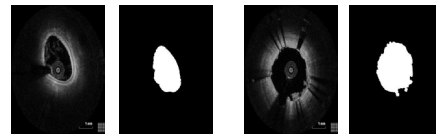
Research Hypothesis



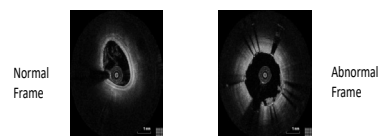
Key Words: Thrombus, Lumen Segmentation, Lumen Classification, Machine Learning

Research Objective

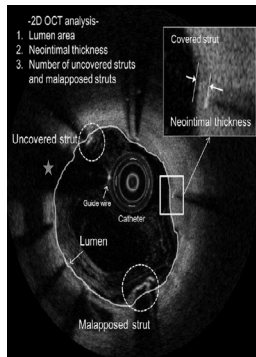
A Fully Automated Lumen Segmentation Algorithm



Normal/Abnormal Lumen Classification



Characteristics of IVOCT Images

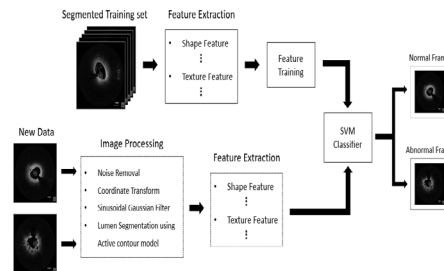


What are the difficulties of IVOCT image processing?

- 1) IVOCT는 적혈구에 의해 노이즈가 많이 발생
- 2) Guide wire의 Shadow를 고려 (Red star)
- 3) Catheter Object 고려
- 4) Stent strut 고려 (Uncovered struts, Malapposed struts)
- 5) Side Branch 고려
- 6) Thrombus가 존재하면 Lumen의 형상이 Irregular

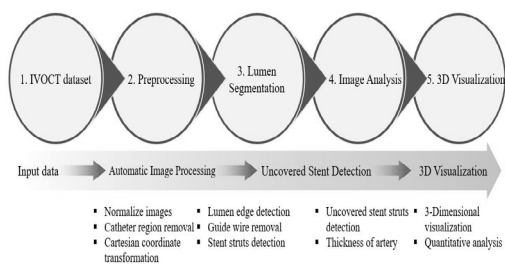
컴퓨터 보조 진단 연구

- 컴퓨터 보조 진단(computer aided diagnosis, CAD)은 의사가 의료 영상을 판독하는데 보조할 수 있는 시스템
- X-ray, CT, MRI, 초음파, 양전자단층촬영(positron emission tomography, PET) 등 다양한 의료영상화
- 영상판독 시간 단축, 작업의 일관성을 높이고 정량적 분석 결과를 통해 의사의 최종 진단을 보조



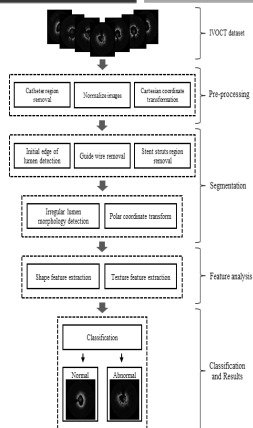
3-D Visualization Algorithm for IVOCT Images

- 약물 방출 스텐트를 시술한 환자의 경우 단기간 또는 장기간 동안 재협착의 우려가 있어, 환자의 약물 방출 스텐트의 배치와 상태를 정기적으로 재진단하는 것이 중요
- 약물 방출 스텐트와 동맥의 구조적 관계를 이해하기 위해 혈관 내강과 스텐트 스트럿을 전자동으로 검출한 후 혈관과 스텐트 스트럿을 2차원 및 3차원으로 시각화하고, uncovered stent의 위치를 분석하는 알고리즘을 제안



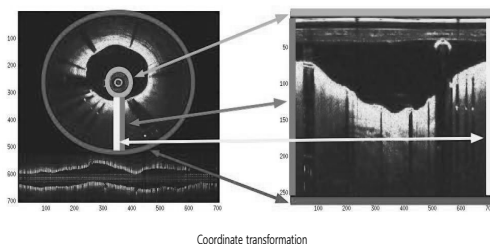
전자동 혈관 내강 분할 및 분류 알고리즘

- IVOCT 영상에서 관찰되는 혈관 내강을 분할한 후, 형상 특징과 질감 특징을 추출하여 정상 또는 비정상 혈관 내강으로 분류하는 알고리즘을 제안
- 가이드 와이어의 그림자 영역 및 스텐트 스트럿은 혈관 내강의 초기 경계의 패턴을 분석하여 검출
- 혈관 내강에서 38 개의 형상 특징과 54 개의 질감 특징 추출
- Partition-Membership Filter 사용 최적의 특징 벡터를 선택
- 벡터를 지도학습 기반의 기계 학습 알고리즘을 사용하여 정상 또는 비정상 혈관 내강으로 분류



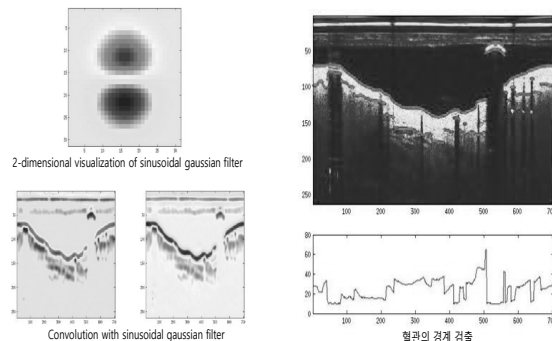
IVOCT 영상의 3차원 시각화 알고리즘

- IVOCT 영상은 극좌표계로 표현
- 효율적인 영상처리를 위해 극좌표계인 IVOCT 영상을 직각좌표계로 변환
- 극좌표계인 IVOCT 영상의 중심점을 기준으로 보라색 선에서 노란색 선까지 직각좌표계로 변환



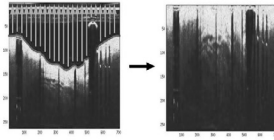
혈관 내강과 외막의 경계 추출

- 혈관 내강의 경계를 검출하기 위해 수직 정렬된 sinusoidal gaussian filter(SGF)로 IVOCT 영상을 컨볼루션

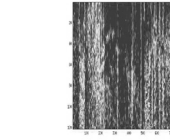


스텐트 스트럿 검출

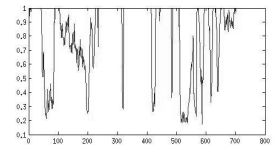
- 영상 내 스텐트 스트럿(Stent Strut)을 검출, 픽셀 사이의 차를 통해 스텐트 스트럿의 그림자 영역의 후보군 추출



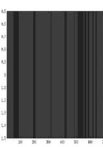
혈관 내강 경계 영상 상단부로 정렬



임계값에 따른 혈관 벽, 스텐트 스트럿의 그림자 영역 정의



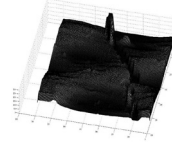
스텐트 스트럿 그림자 영역 후보군 추출



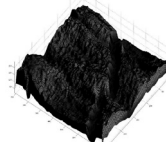
스텐트 스트럿 그림자 영역

Uncovered Stent Struts 검출 및 3차원 시각화

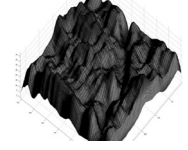
- 연속적인 IVOCT 영상에서 혈관의 경계와 스텐트 스트럿을 추출



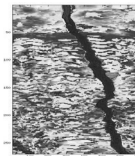
혈관 내강 경계 3차원 시각화



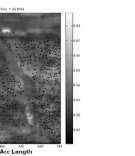
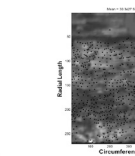
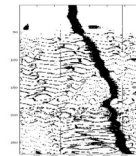
혈관 외막 경계 3차원 시각화



혈관 내강 및 외막 경계 영상 3차원 시각화

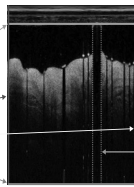
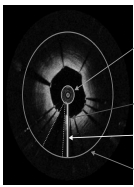


스텐트 스트럿의 위치와 혈관 내강의 두께 3차원 시각화



스텐트 스트럿과 uncovered stent struts 위치, 상태를 3차원 시각화

Coordinate Transformation and Removal of Catheter region



Catheter line region

Lumen area

Vessel wall layer

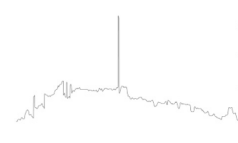
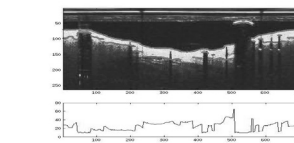
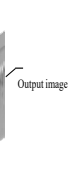
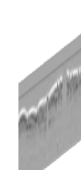
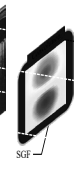
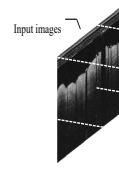
Shadow region of the guide wire

$$A_x = r \cos \theta, \quad A_y = r \sin \theta$$

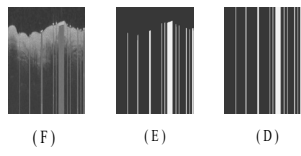
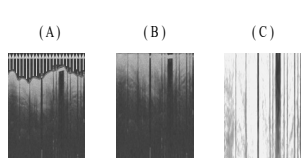
$$r = \sqrt{A_x^2 + A_y^2}, \quad \theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

$$I(r, \theta) = 0 \quad \text{for } r < D/2 + c(5)$$

Initial lumen edge detection and Removal of guide wire's shadow



Stent struts detection and Fill the shadow region



A. 검출된 Initial Lumen Edge를 Image의 첫 번째 행으로 정렬

B. 첫 번째 행으로 정렬된 결과

C. Stent Struts가 포함된 행 제거

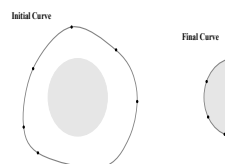
D. 각 열의 평균 중 가장 큰 값을 이용하여 Normalization 후, 0.4 보다 작은 값을 추출 (Shadow of Stent Struts)

E. 추출된 Shadow of Stent Struts에 해당하는 열에서 최댓값을 가지는 픽셀의 위치를 추출한 후, 그 위치보다 아래의 행은 혈관 벽과 비슷한 픽셀 값으로 채움

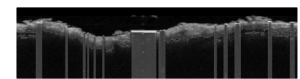
F. Stent struts detection and Fill the shadow region 결과

Irregular Lumen Segmentation using Active contour model

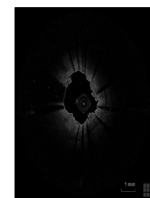
Active Contour Model Principle



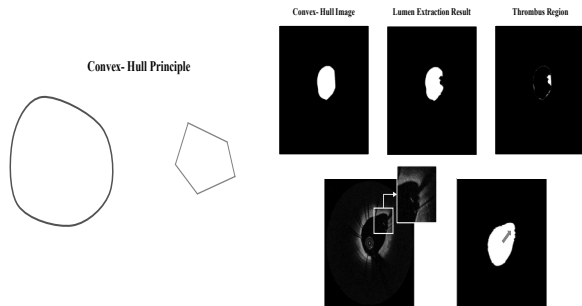
Result of lumen segmentation using Active contour model



Polar transformation and comparison with the original IVOCT image



Thrombus Extraction and Uncovered Stent Removal using Convex-Hull

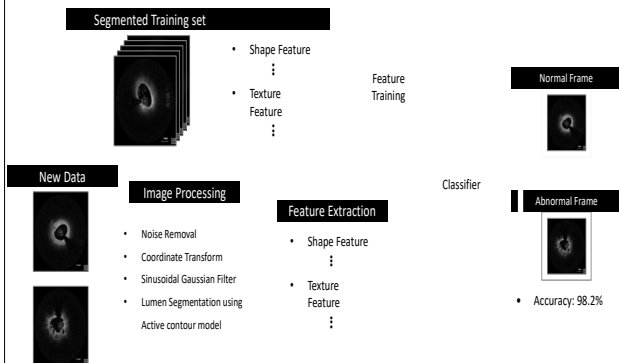


Shape Feature and Texture Feature Extractions

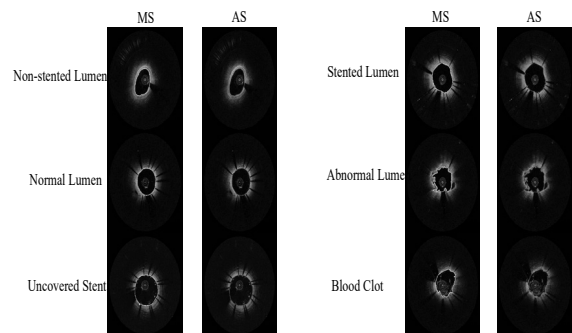
Feature No.	Feature Name
1-32	Fourier Descriptors
33-81	Gray-Level Co-occurrence Matrix
82	GLCM-Homogeneity
83	GLCM-Energy
84	GLCM-Correlation
85	GLCM-Contrast
86	GLCM-Entropy
87	Circularity
88	Mean Curvature
89	Gaussian Curvature
90	Compactness
91	Solidity
92	Absolute Mean Curvature
93	Bending Energy

- 39개의 형상 특징과 54개의 질감 특징
- PartitionMembership Filter를 사용해 최적의 Feature Vector 정의
- The WEKA 3.8.1 has the Partition-Membership Filter that can apply any PartitionGenerator to a given feature vector to get these filtered vectors for all instances. The Partition-Membership Filter that uses a PartitionGenerator to generate partition membership values; filtered instances are composed of these values plus class attribute and make as sparse instances.
- 총 8가지의 Machine Learning model 사용.
 - Support vector machine (SVM), AdaBoost (AB), J48, Random Forest (RF), Naive Bayes (NB), Bagging.

Flow chart of entire process



Manual Segmentation (MS) vs Automated Segmentation (AS)



Performance of our Segmentation Algorithm

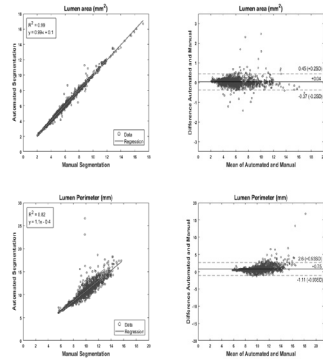
Methods	Equations
JSC	$\frac{ A \cap B }{ A \cup B }$
DSC	$\frac{2 A \cap B }{ A + B }$
MANA	$\frac{\sum_{i=1}^N A_i - B_i }{N}$
ASSD	$\frac{1}{ A + B } \sum_{i \in A \cup B} d(i, A \cap B)$
RMSSSD	$\sqrt{\frac{1}{ A + B } \sum_{i \in A \cup B} d^2(i, A \cap B)}$
HD	$\max_{i \in A} \min_{j \in B} d(i, j)$
ACC	$\frac{TP + TN}{TP + FP + FN + TN}$

- Jaccard similarity coefficient (JSC)
- Dice similarity coefficient (DSC)
- Mean absolute difference of area (MANA)
- Average symmetric surface distance (ASSD)
- Root mean square symmetric surface distance (RMSSSD)
- Hausdorff distance (HD)
- Accuracy (ACC)

Performance of our Segmentation Algorithm

Case (Numbers)	JSC	DSC	MADA	ASSD	Hausdorff	RMSSSD	ACC
Total (1541)	95.4(2.2)	97.6(1.2)	0.27(0.19)	0.033(0.007)	0.061(0.013)	0.036(0.008)	98.9(1.2)
Non-stented (627)	95.7(1.5)	97.8(0.8)	0.18(0.06)	0.030(0.004)	0.054(0.005)	0.032(0.005)	99.4(0.5)
Stented (914)	95.2(2.6)	97.6(1.4)	0.32(0.23)	0.035(0.008)	0.066(0.013)	0.038(0.008)	98.6(0.9)
Normal (1227)	95.5(2.2)	97.6(1.2)	0.26(0.20)	0.033(0.007)	0.060(0.013)	0.035(0.008)	99.0(0.8)
Abnormal (314)	94.9(5.5)	97.2(5.1)	0.51(0.32)	0.035(0.009)	0.064(0.014)	0.038(0.010)	98.7(1.5)
Uncovered Stent (135)	95.0(3.4)	97.4(1.9)	0.41(0.37)	0.037(0.011)	0.068(0.014)	0.040(0.011)	98.5(0.9)
Blood Clot (66)	92.7(5.2)	96.1(3.0)	0.45(0.45)	0.041(0.012)	0.071(0.021)	0.044(0.014)	97.9(2.0)

Relationship between MS and AS

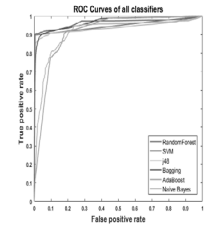


Performance of Artificial Intelligence Models

Total 14027 frames containing 1857 irregular frames

Classifiers	ACCURACY	Specificity	Sensitivity	PPV	NPV	ROC area	PRC area
RF	98.2	98.5	95.9	90.0	99.4	96.3	97.8
SVM	98.1	98.4	95.9	89.8	99.4	95.7	97.5
J48	97.3	97.8	93.7	85.6	99.1	93.6	96.5
Bagging	96.6	97.2	91.6	81.6	98.9	96.7	98.1
NB	88.8	96.8	54.9	80.3	92.0	91.4	93.2
AB	88.7	94.7	55.6	66.2	90.1	91.0	92.9

Performance of support vector machines (SVM), random forests (RF), Bagging, Decision tree (J48), Naïve Bayes (NB), and AdaBoost (AB) score on classification. PPV, positive predictive value; NPV, negative predictive value; ROC area, Receiver operating characteristic curve area; PRC area, Precision recall curve area.



Compare with related works

Case (Numbers)	JSC	DSC	MADA	ASSD	Hausdorff	RMSSD	ACC
Wang (2010)	x	97.0	x	x	0.07(0.05)	x	x
Unal (2010)	x	x	0.11	x	x	x	x
Tung (2011)	x	97.0	x	x	x	x	x
Tsantis (2012)	93.8	x	x	x	x	x	x
Ughi (2015)	x	97.0	x	x	x	x	x
Macedo (2016)	94.7	97.3	0.19	x	0.15(0.09)	0.040	99.0
Our Algorithm	95.4	97.6	0.27	0.033(0.007)	0.06(0.01)	0.036	98.9(1.2)

IVOCT 영상을 위한 3차원 시각화 알고리즘

- 혈관 내강과 스텐트 스트럿을 전자동으로 검출한 후 혈관과 스텐트 스트럿을 2차원 및 3차원으로 시각화
- Uncovered stent의 위치를 분석하는 알고리즘을 고안
- 삼차원 시각화의 결과는 임상 의사 동맥 내에서 스텐트의 상태를 더 잘 이해할 수 있도록 도움
- 빠른 시간 내 예방 영역에서 우려 영역을 정의하는데 사용
- 스텐트 상태와 부작용에 대한 조기 판독을 보조

전자동 혈관 내강 분할 및 정상/비정상 분류 알고리즘

- 알고리즘은 다양한 혈관 내강 케이스를 효과적이고 정확하게 분할
- 높은 정확도로 정상/비정상 혈관 내강을 분류
- 형상 특징과 질감 특징을 RF 방법으로 학습시켰을 때 높은 정확도의 정상/비정상 혈관 분류 성능 확보
- 정확한 양적 정보와 짧은 시간 내에 비정상 혈관 내강에 대한 경고 신호를 제공
- 과도한 업무 부담 감소 및 판독 결과를 보조하여 조기 진단 및 향후 발생할 수 있는 부작용 감소 기대

Conclusion

- IVOCT 영상 내에서 혈관 내 스텐트 스트럿의 배치 여부를 분석하는 것은 매우 중요
- Uncovered stent struts 자동 검출, 혈관의 두께와 스텐트의 배치 여부를 3차원으로 시각화하는 알고리즘 개발
- IVOCT 영상의 영상처리 과정은 uncovered stent, 가이드 와이어의 그림자, 혈전 등 고려해야 할 부분이 많음
- 이러한 문제를 해결하기 위해 본 연구에서는 다양한 케이스의 혈관 내강을 분할할 수 있는 강력한 전자동 혈관 내강 분할 알고리즘을 제안
- IVOCT를 위한 컴퓨터 보조 진단 알고리즘 개발을 위해 전자동으로 분할한 혈관 내강의 형상 특징과 질감 특징을 분석하여 정상 또는 비정상 영상으로 분류 방법을 제안



Stroke rehabilitation at present, and in the future

김 수 아

순천향대학교 천안병원 재활의학과

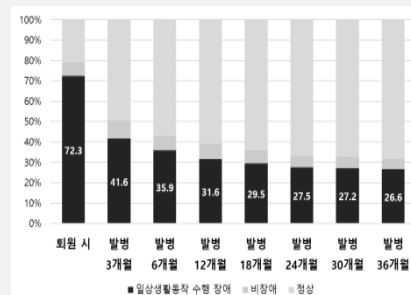
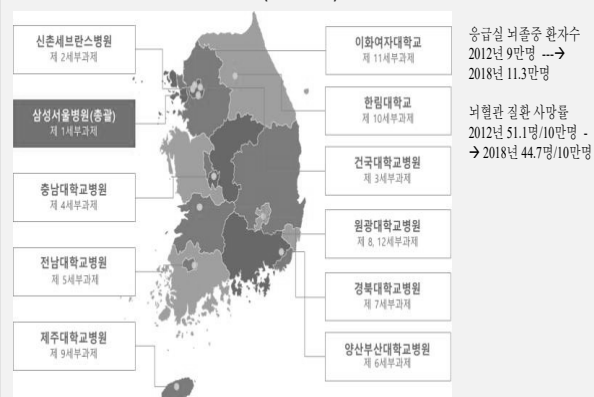
STROKE REHABILITATION AT PRESENT, AND IN THE FUTURE

Soonchunhyang University
Cheonan
Physical medicine and Rehabilitation
Soo A Kim, MD, Ph D

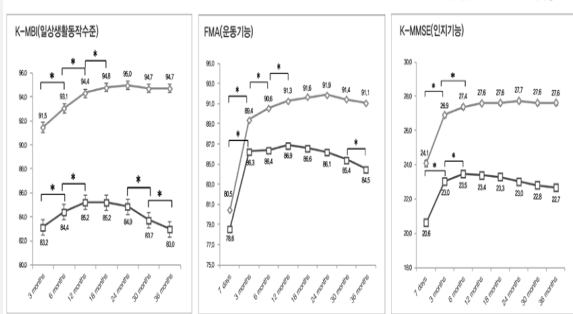
질병관리청 보도참고자료 2020.10.29

- ◆ 뇌졸중 재활 장기추적조사 연구를 통하여 뇌졸중 환자의 일상생활 회복에 영향을 미치는 요인 발표
- ◆ 뇌졸중 초기의 집중재활치료 여부가 일상생활 동작 수행에 유의한 영향을 미치며, 뇌졸중 이후 사회생활은 직업재활 및 재훈련 교육으로 가능
- ◆ 뇌졸중 환자의 일상생활 회복을 높이기 위해서 초기 집중재활치료 강조

뇌졸중 환자의 재활분야 장기적 기능수준 관련요인에 대한 10년 추적조사연구(KOSCO)



뇌졸중 발병 후 뇌병변 장애 판정 기준 해당 환자 비율 회원시점 72.3%에서 발병 3년 시점 26.6%로 감소



운동 및 인지기능은 발병 후 18개월까지 지속적으로 호전되나 65세 이상의 경우 발병 2년 이후 기능저하 보임

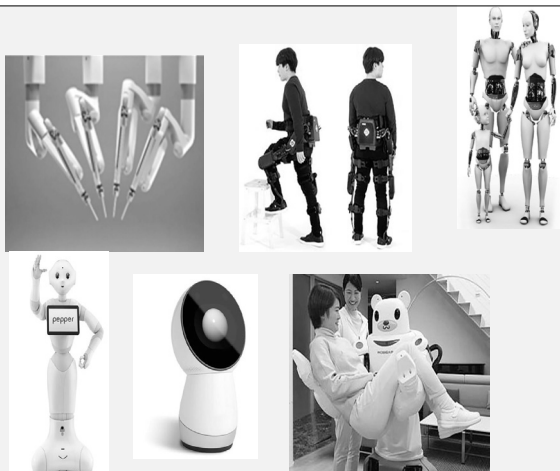
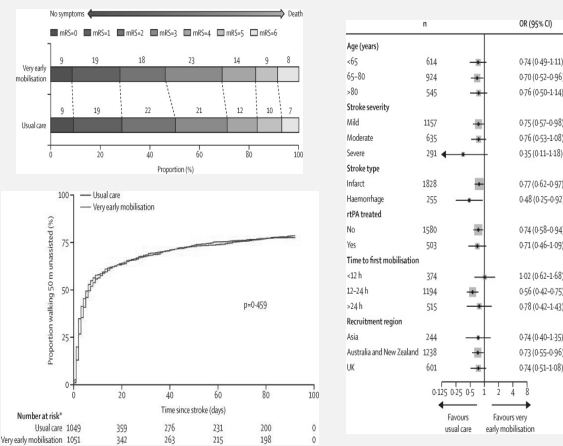
뇌졸중, 초기 집중재활치료를 일상생활 회복을 높인다!



EFFICACY AND SAFETY OF VERY EARLY MOBILISATION WITHIN 24 H OF STROKE ONSET (AVERT): A RANDOMISED CONTROLLED TRIAL

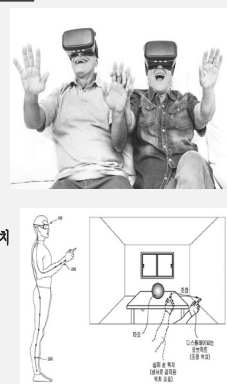
- Total 2104 pts recruited 2006 to 2014
- large multicenter/intercontinental patient population
- 5 countries in 3 continents (Australia/New Zealand, Europe, and Asia), 56 acute stroke units
- very early mobilization (VEM) within 24 hours after symptom onset with usual care in patients with ischemic or hemorrhagic stroke without significant coexisting comorbidity or pre-morbid disability
- Measure: mRS score 3 months after stroke, 50m walking.
- >18 yr, admit to stroke unit within 24h of stroke onset
- (1) begin within 24 h of stroke onset; (2) focus on sitting, standing, and walking (ie, out-of-bed) activity; and (3) result in at least three additional out-of-bed sessions to usual care
- At 3 months, fewer pts in VEM group had favourable outcome
- Poorer outcomes c VEM in pts c severe stroke and ICH but not statistical significance ($p > 0.05$)

The Lancet 2015



미래의 재활치료 전망

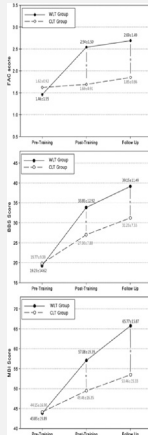
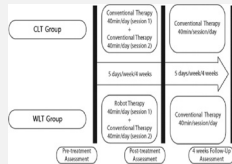
- VR, 재활기구에 결합되면 최적치료 제공
가상현실이 재활치료에 적용되면 공간-시간 제약 극복
AI-빅데이터 로봇 융합되면 재활치료시스템 혁신 기대
- 가상현실기술이 재활훈련기구에 결합, 특히 보행치료와 상지운동치료에 게임이 적용된 기기가 있다.
- 3-D 프린팅-보조기, 의지, 맞춤형 의료가기, 재활보조기기 개발
- 가상증강현실 지능형 로봇-로봇재활치료, 웨어러블 재활로봇, 스마트와치 운동 모니터링
- 인공지능 결합 치료를 위해 3차원 가상 현실을 이용하는 정보 제공 방법 및 시스템 도전.



ASCENT 2021

EFFECTS OF INNOVATIVE WALKBOT ROBOTIC-ASSISTED LOCOMOTOR TRAINING ON BALANCE AND GAIT RECOVERY IN HEMIPARETIC STROKE: A PROSPECTIVE, RANDOMIZED, EXPERIMENTER BLINDED CASE CONTROL STUDY WITH A FOUR-WEEK FOLLOW-UP

- WALKBOT-assisted locomotor training(40min) + conventional training (40min)
- Conventional locomotor training(80min)
- 5 days/week *4 weeks
- Measure; functional ambulation category(FAC),
- berg balance scale(BBS),
- K-MBI, MAS, EuroQol-5 dimension



- Effects of Walkbot gait training on kinematics, kinetics, and clinical gait function in paraplegia and quadriplegia, Neurorehabilitation 2018
- Effects of Innovative WALKBOT Robotic-Assisted Locomotor Training on Balance and Gait Recovery in Hemiparetic Stroke: A Prospective, Randomized, Experimenter Blinded Case Control Study With a Four-Week Follow-Up, IEEE Trans Neural Syst Rehabil Eng. 2015
- Comparative effects of robotic-assisted gait training combined with conventional physical therapy on paretic hip joint stiffness and kinematics between subacute and chronic hemiparetic stroke, Neurorehabilitation 2018
- Comparisons between Locomat and Walkbot robotic gait training regarding balance and lower extremity function among non-ambulatory chronic acquired brain injury survivors, Medicine (Baltimore), 2021
- Effects of trunk stabilization training robot on postural control and gait in patients with chronic stroke: a randomized controlled trial, Int J Rehabil Res 2020

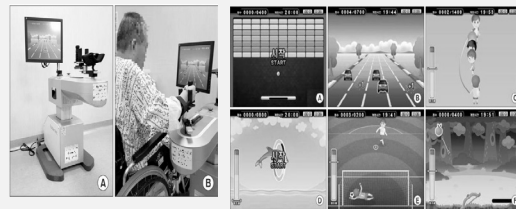
재활로봇의 역할



- 대체재-마비환자
- 복원력-기능회복
- 반복
- 목적을 가진 정확한 행동
- 치료강도
- 단순하게 적용

메디칼잡지바(<http://www.monews.co.kr>)

EFFECT OF ROBOT-ASSISTED GAME TRAINING ON UPPER EXTREMITY FUNCTION IN STROKE PATIENTS



	RCT (n=25)			OCT (n=25)		
	Pre	Post	p-value	Pre	Post	p-value
MMT						
Shoulder abduction	2.52±1.71	2.80±1.79	0.000*	2.36±1.57	2.84±1.55	0.001*
Shoulder extension	2.48±1.75	2.88±1.79	0.000*	2.48±1.50	2.92±1.57	0.000*
Elbow flexion	2.04±1.84	2.80±1.87	0.001*	2.16±1.55	2.72±1.62	0.000*
Elbow extension	2.52±1.73	2.84±1.81	0.000*	2.08±1.57	2.36±1.71	0.000*
Wrist flexion	1.32±1.56	1.72±1.61	0.000*	1.24±1.44	1.72±1.67	0.000*
Wrist extension	1.28±1.50	1.72±1.61	0.000*	1.16±1.37	1.48±1.56	0.000*
Group	1.52±1.33	1.58±1.58	0.000*	1.08±1.38	1.56±1.51	0.001*
MMT	4.86±1.35	11.72±1.53	0.000*	6.72±1.35	11.48±1.64	0.000*
K-MBI	47.34±1.63	52.84±1.97	0.000*	46.34±1.82	51.38±1.54	0.000*

Ann Rehabil Med 2017

EFFECT OF COMBINED THERAPY OF ROBOT AND LOW-FREQUENCY REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION ON HEMISPATIAL NEGLECT IN STROKE PATIENTS



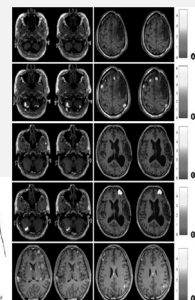
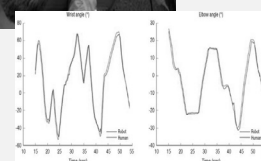
	RG (n=20)	CG (n=18)	p-value
ΔMVPT-3	8.20±4.85	6.58±4.87	0.411
ΔLine bisection	-11.10±9.40	-7.46±10.11	0.306
ΔStar cancellation	7.90±5.46	5.94±4.96	0.325
ΔAlbert's test	3.85±2.08	4.44±2.66	0.477
ΔCBS	-3.70±2.25	-4.28±1.53	0.415
ΔMMSE	1.45±2.06	1.22±2.13	0.696
ΔK-MBI	12.55±4.12	12.72±4.00	0.735

Ann Rehabil Med 2016

RECOVERY OF PROPRIOCEPTION IN THE UPPER EXTREMITY BY ROBOTIC MIRROR THERAPY: A CLINICAL PILOT STUDY FOR PROOF OF CONCEPT

- 56 YRS RT MCA Infarction 11 months ago
- Robotic mirror therapy for ten 30 minute session during 2 weeks

J Korean Med Sci 2017



EFFECT OF CAREGIVER DRIVEN ROBOT-ASSISTED IN-WARD TRAINING IN SUBACUTE STROKE PATIENTS: A CASE SERIES



Four Robin-T (TES Co., Osan, Korea) units

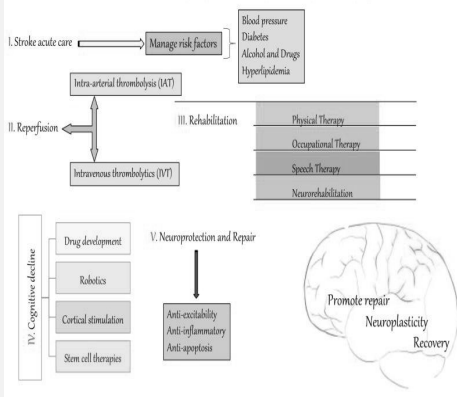
Ann Rehabil Med 2018

THE EFFECTS OF VIRTUAL REALITY TRAINING ON FUNCTION IN CHRONIC STROKE PATIENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

- Objective: The aim of this study was to perform a meta-analysis to examine whether virtual reality (VR) training is effective for lower limb function as well as upper limb and overall function in chronic stroke patients.
- Methods: Three databases, OVID, PubMed, and EMBASE, were used to collect articles. The search terms used were "cerebrovascular accident (CVA)," "stroke," and "virtual reality." Consequently, twenty-one studies were selected in the second screening of meta-analyses. The PEDro scale was used to assess the quality of the selected studies.
- Results: The total effect size for VR rehabilitation programs was 0.440. The effect size for upper limb function was 0.431, for lower limb function it was 0.424, and for overall function it was 0.545. The effects of VR programs on specific outcomes were most effective for improving muscle tension, followed by muscle strength, activities of daily living (ADL), joint range of motion, gait, balance, and kinematics.
- Conclusion: The VR training was effective in improving the function in chronic stroke patients, corresponding to a moderate effect size. Moreover, VR training showed a similar effect for improving lower limb function as it did for upper limb function.

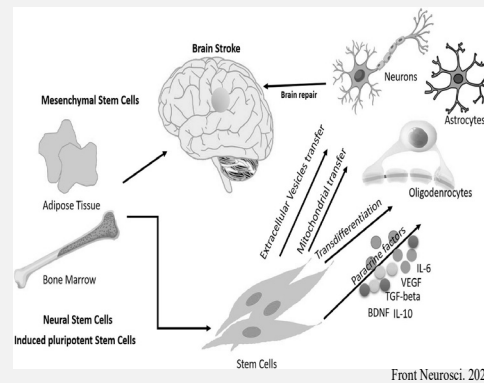
Biomed Res Int 2019

STROKE MANAGEMENT STRATEGIES



Pathophysiology and Treatment of Stroke: Present Status and Future Perspectives, *Int J Med Sci*. 2020 Oct; 21(20):7409

APPLICATION OF STEM CELLS IN STROKE



Front Neurosci. 2020

THANK YOU

Country and year	Study design	Sample size	Stroke type	Cells from	Interventional type	Route of administration	Dose	Time point from onset of inclusion	Follow-up (Months)	Primary outcome indicator	References
South Korea, 2010	Open-label, observer-blinded clinical trial	16/36	Acute	Posterior lac. core	MSCs, Conventional treatment	Intravenous	30 × 10 ⁶	7 days	60	mRS	Lee J. S. et al., 2010
Spain, 2012	Single-blind controlled clinical trial phase I/II	10/10	Subacute	Posterior superior lac. core	BM-MSCs, Conventional treatment	Intravenous	150 × 10 ⁶	Mean 3-9 days post occurrence of stroke	6	mRS, BL, mRS	Montes et al., 2012
India, 2012	Non-Randomized controlled clinical trial	12/12	Chronic	Posterior superior lac. core	BM-MSCs, Conventional treatment	Intravenous	30-40 × 10 ⁶	3 months-2 years post stroke	6	FAA, BI	Sharma et al., 2012
India, 2013		20/20	Chronic	Post superior lac. core	MNC + MSCs	Intravenous	30-40 × 10 ⁶	3 months-2 years post stroke	6	BL, FAA	Sharma et al., 2013
China, 2013		60/60	Chronic	Unilateral cord	UC-MSCs	Subarachnoid + intravenous	100 × 10 ⁶	1 month and 6 years post stroke	3	FAA	Hu et al., 2013
India, 2014	Multicentric phase I parallel phase controlled clinical trial	60/60	Subacute	Posterior lac. core	BMSCs	Intravenous infusion	280.5 × 10 ⁶	7-30 days	6	mRS, BI	Prasad et al., 2014
China, 2014	Randomized, single-blind clinical trial	15/15	Chronic	PBSCs	PBSCs	Stent-assisted	3-8 × 10 ⁶	6 months-3 years	12	mRS, mRS	Chen et al., 2014
China, 2014		90/90	Subacute	Laminar blood centers	UC-MSCs, Conventional treatment	Subarachnoid	100 × 10 ⁶	14-30 days post stroke	2	mRS, mRS	Feng et al., 2014
Spain, 2014	Phase II, Prospective, randomized, double-blind, parallel-controlled, single-center pilot clinical trial	20/20	Acute	Adipose tissue subcutaneous	Adipose tissue	Intravenous administration	1 million cells/kg body weight	2 weeks post stroke	24	mRS, mRS, MRI, Biochemical markers	Sanja-Segura et al., 2014
USA, 2016	Phase I Open-label	10/10	Acute, cortical ischemic stroke	Unilateral cord	Unilateral cord blood infusion	Intravenous administration	3.34 × 10 ⁶	3-9 days	12	mRS	Lindholm et al., 2016
USA, 2016	Phase I, Single arm	25/30	Acute	Bone marrow harvest subcutaneous	BM-MSCs	Intravenous administration	10 million cells/kg body weight	1-3 days	24	mRS, mRS	Wang et al., 2016
China, 2016	Cohort Phase I	9	Hemiparesis from ischemic human fetal spinal cord	Cells derived from NSC-568 primary adherent neural stem cell	Intracerebral injection	Intracerebral injection	Cohort A = 1.2 × 10 ⁶ Cohort B = 2.4 × 10 ⁶ Cohort C = 1.2 × 10 ⁶	Mean 454 days	24	CT, MRI, PET, DTI	Zhang et al., 2016
California, 2019	Phase II Preliminary safety and efficacy studies	Phase I (n = 10) Phase II (n = 21)	Chronic	Allogeneic ischemic tolerant MSCs	Allogeneic ischemic tolerant MSCs	Intravenous transfusion	Phase I (0.5, 1.0, and 1.5 million/kg body weight) Phase II (1.5 million/kg body weight)		12	BL, EEG, CT Scan	Lilly et al., 2019

mRS, Modified Rankin Scale; MRI, Magnetic resonance imaging; PET, Positron emission tomography; CT, Computed tomography; mRS, National Institute of Health Stroke scale; BL, Barthel Index.

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery

6/25(Fri.)

인문학 특강

좌장 : 윤석만(순천향대)

아름다움으로 채우는 일상

윤광준(작가)

아름다움으로 채우는 일상

윤 광 준

작가

* 고흐를 치료했던 의사 레 페릭스의 실수, 거저 줘도 못 챙긴 600억원

: 무지로 그림의 가치를 몰랐던 한 의사의 사례에서 아름다움을 보는 안목과 가치의 환기

* 뭐가 아름다운지 좋은 게 뭔지 아는 게 교양이다

: 진정 소중한 것은 저절로 알아지지 않는다. 아름다움의 실체를 향해 다가서는 노력과 지 속의 힘

* 알려고 하지말고 느껴라

: 스탕달 신드롬을 경험했다면 예술의 세계로 이미 들어간 셈.

* 음악과 미술 제대로 듣고 보려면

: 딥 리스닝의 필요, 저만의 감동으로 그림이 다가오려면

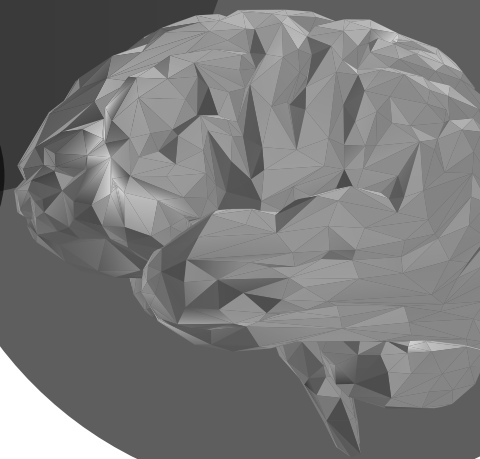
* 살아보니 질리지 않는 놀이는 예술밖에 없더라.

: 허망하지 않은 삶을 위하여

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

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6/25(Fri.)

Free paper II : Agony Session (Complication cases)

좌장 : 김태선(전남대) / 장철훈(영남대)

- | | | |
|-------|---|------------------------|
| FP2-1 | Fatal complication of procedural rupture in unruptured cerebral aneurysm | 진성철
(인제대학교 해운대백병원) |
| FP2-2 | A case of delayed rebleeding following ruptured anterior communicating artery aneurysm embolization | 이성호
(순천향대학교 천안병원) |
| FP2-3 | Delayed rebleeding from ruptured broad-neck posterior communicating artery aneurysm after double-stent assisted coil embolization | 정연구
(성균관대학교 강북삼성병원) |
| FP2-4 | A case of segment occlusion after treatment with a pipeline endovascular device in dissecting aneurysm on dominant VA | 김창현
(양산부산대학교병원) |
| FP2-5 | Direct carotid cavernous fistula after pipeline implantation for a symptomatic large cavernous internal carotid artery aneurysm | 반승필
(분당서울대학교병원) |
| FP2-6 | Superior sagittal sinus occlusion due to probable thrombocytopenic thrombosis after AstraZeneca COVID-19 Vaccination | 최선웅
(가톨릭대학교 부천성모병원) |
| FP2-7 | Acute management of iatrogenic vertebral artery dissection during treatment of proximal vertebral artery stenosis | 하상우
(조선대학교병원) |

Fatal complication of procedural rupture in unruptured cerebral aneurysm

Sung-Chul Jin, Hyungon Lee

Department of Neurosurgery, Inje University, Haeundae Paik Hospital

Objective: Peri-procedural management of procedural rupture can be cardinal in the clinical outcome of the patient with procedural rupture. we presented our painful case of procedural rupture to inform our colleagues of neurointerventionists as to cardinal critical points of peri-procedural management after procedural rupture.

Methods: 47 female patient with growth of right pcoma aneurysm based on serial CT angiography was decided to be treated with coil embolization of intentional packing of bleb like lesion.

Result: procedural ruptured was ceased after about 1 hour of coil packing with double stenting (initial atlas plus LVIS junior). NIOM monitoring showed recovery of MEP and improvement of SSEP. we decided to perform EVD for control of IICP. additionally, we sedated the patient for control of IICP. we hesitated to use antiplatelet medication. about 12 hours after coiling, Rt pupil of the patient was dilatated and brain CT showed low density of Rt hemisphere. Decompressive craniectomy was performed to relieve IICP of the patient. Clinical status of the patient remained moribund.

Conclusion: Antiplatelet medication and careful monitoring of the patient with procedural rupture without sedation can be critical in double stenting assisted coiling of procedural rupture.

A case of delayed rebleeding following ruptured anterior communicating artery aneurysm embolization

Sung-Ho Lee, Jae-Sang Oh, Seok-Mann Yoon

Department of Neurosurgery, Soonchunhyang University Cheonan Hospital

Objective: A 76-year-old female was presented with HHG 3 SAH. Cerebral angiogram showed two aneurysms, which were ruptured lobulated a-com (7.6x13mm with 7.2mm neck) and unruptured right p-com (4.3x5.1mm with 4.5mm neck) aneurysms.

Methods: A-com aneurysm coil embolization was performed with stent assisted technique. However, because contralateral A2 orifice could not be protected by stent, and TE event occurred after stent deployment, intentional partial occlusion of ruptured part was done. Fortunately, left ICA occlusion was recanalized with stent retriever thrombectomy. She recovered well without neurological deficit.

Result: One year later, retreatment of a-com coil compaction as well as unruptured p-com aneurysm coiling were performed without difficulty. However, she was presented with semicomatose consciousness 17 months after 2nd embolization. Brain CT showed thick SAH and IVH. Coil embolization was performed again. Bilateral access to anterior cerebral artery was tried to place stent from contralateral A2 to A1, but failed. Thus, further coil packing was done with double catheter technique. Raymond 3 obliteration was achieved.

Conclusion: Partial coil embolization of ruptured aneurysm may not protect aneurysm rerupture. Frequent follow up and retreatment should be considered.

Delayed rebleeding from ruptured broad-neck posterior communicating artery aneurysm after double-stent assisted coil embolization

Yeongu Chung

Department of Neurosurgery, Sungkyunkwan University School of Medicine, Kangbuk Samsung Hospital

Objective: Stent-assisted coil embolization for the ruptured aneurysm without pre-medication of antiplatelet agents can cause thrombus formation during the procedure. Incomplete coil embolization is inevitable in cases of large thrombus interfere the visualization around the aneurysmal neck.

Methods: Broad-based irregular shaped posterior communicating artery ruptured aneurysm was found from a 56-year-old female patient admitted with altered mentality after severe headache. Initial computed tomography scan revealed the diffuse and thick subarachnoid hemorrhage with Fisher grade IV. The width of aneurysmal neck was 6mm and the height was 3.5mm. After partial deployment of frame coil, stent-assisted coil embolization with Enterprise stent was performed. During the filling of the aneurysmal sac, large filling defect was confirmed at the distal portion of the aneurysm. Intra-arterial tirofiban was injected and near-total resolution of the thrombus was confirmed. And 2 more coils were inserted and additional stent (Neuroform Atlas) was deployed. Final angiogram revealed the no filling of the ruptured aneurysm. And the patient was recovered the mental status despite of severe vasospasm during the post-operative 2 weeks. After that, dual-antiplatelet agents was maintained and keep blood pressure higher than normal.

Result: The patient showed sudden drowsiness and neurologic deterioration with monoparesis of left upper extremity at post-operative 17 days. Computed tomography scan revealed the newly developed subarachnoid hemorrhage suspicious rebleeding from the previous coiled aneurysm. Emergent coil embolization was performed with 4 coils. Her monoparesis was improving and when post-operative 34 days from the initial embolization, the patient underwent lumbar drainage due to hydrocephalus

Conclusion: Thrombo-embolic complications are not rare for emergent stent deployment in cases of the patient did not administered with antiplatelet premedication. It is important to prompt administration of dual-antiplatelet agents as soon as the ruptured aneurysm is secured. If the distal flow is intact, it is essential to make an effort to achieve additional sufficient coil compaction for ruptured aneurysm.

A case of segment occlusion after treatment with a pipeline endovascular device in dissecting aneurysm on dominant VA

Chang Hyeun Kim, Young Ha Kim, Sang Weon Lee, Chi Hyung Lee, Soon Ki Sung, Dong Wuk Son, Geun Sung Song

Department of Neurosurgery, Pusan National University Yangsan Hospital

Objective: Vertebral artery dissecting aneurysm (VADA) is a very rare subtype of intracranial aneurysms associated with significant higher rates of morbidity and mortality when ruptured. Although there have been many discussions and reports of VADAs, the optimal treatment method has not yet been clearly established. Recently, with the development of endovascular devices, treatment case using flow diverter devices (FDD) such as Pipeline Embolization Device (PED; Medtronic Inc., Minneapolis, Minnesota, USA), Flow Redirection Endoluminal Device (FRED; Microvention, Aliso Viejo, California, USA) and Surpass Flow-Diverter (Surpass; Stryker Neurovascular, Fremont, CA, USA) have been reported.

Methods: A 54-year old male patient visited the outpatient clinic due to abnormal finding on the MRAs. His first headache occurred 6 months ago, and there was dissecting aneurysm on the right V4 segment in MRI performed at a local hospital. But the local hospital could not diagnose the lesion. 6 months later, the patient re-visit that hospital due to mild headache, and again taken an MRI and MRA. At that time, the local hospital discovered the lesion, and the size of the dissection segment increased, so the local hospital was referred to our hospital.

Result: We considered the young age of the patient and the lesion of the dominant vertebral artery. It was decided to use FDD as the treatment for the lesion. The procedure was performed successfully, and after 10 minutes, DSA was not able to finding any remarkable finding. Immediately after the procedure and during the admission period, the patient did not complain of neurological symptoms. The patient said that the intermediate headache was also improved in the outpatient clinic. In conventional angiography performed 4 months later, it was confirmed that the entire parent artery where deployed FDD was occluded. Fortunately, the retrograde flow through fetal-type PCoA provide sufficient blood supply to the basilar artery and cerebellar arteries

Conclusion: FDD can be a good treatment option for treatment of un-ruptured vertebral artery dissecting aneurysm, but should be used after sufficient consideration of the whether or not dominant VA, branching artery and exact location of deployment of the device.

Direct carotid cavernous fistula after pipeline implantation for a symptomatic large cavernous internal carotid artery aneurysm

Seung Pil Ban, O-Ki Kwon, Young Deok Kim, Jang Hun Kim

Department of Neurosurgery, Seoul National University Bundang Hospital

Objective: Implantation of flow diverting stents such as Pipeline embolization device (PED) has become an alternative treatment option for large or giant aneurysms. Delayed aneurysm rupture is a rare complication of PED implantation. In the cavernous internal carotid artery (ICA), this complication can lead to a direct carotid cavernous fistula (CCF).

Methods: We present a case of CCF resulting from delayed aneurysmal rupture following PED implantation.

Result: A 66-year-old woman complained of diplopia due to a right incomplete cranial nerve (CN) III palsy. The patient was diagnosed with a 17.4 mm in diameter right cavernous ICA aneurysm. A 4.75X25 mm PED was successfully deployed across the aneurysm neck without complications. The patient had an uneventful course, and the patient was discharged 5 days post-implantation. Two weeks later, the patient returned for the scheduled out-patient clinic. At this time, the patient presented with a worsening right CN III palsy, headaches, and tinnitus. Follow-up images demonstrated interval development of a direct CCF because of delayed rupture of the aneurysm that had been treated with PED. Successful transvenous coil embolization of both the aneurysm sac and fistula point was performed.

Conclusion: This case demonstrates that transvenous embolization can be used for treating CCF after PED implantation. In addition, although the risk of CCF occurrence after PED implantation is low, the operators should be mindful of this risk.

Superior sagittal sinus occlusion due to probable thrombocytopenic thrombosis after AstraZeneca COVID-19 Vaccination

Seon-Woong Choi, Seong-Han Kim, Hoon Kim, Seong-Rim Kim

Department of Neurosurgery, Bucheon St. Mary's Hospital, The Catholic University of Korea

Objective: The authors report a case of superior sagittal sinus occlusion after Astra Zeneca COVID-19 vaccination.

Methods: A 32-year-old male presented with right hemiparesis and drowsy mentality. 12 days ago, the patient was vaccinated against COVID-19. Initial platelet count was 14,000/micro L. CT revealed subcortical ICH of the left cerebral hemisphere. MR venogram showed occlusion of the superior sagittal sinus.

Result: Immunoglobulin was administered to modulate the immune response. Intravenous heparin and transfusion was prohibited for the risk of exacerbation of thrombocytopenic thrombosis. Despite intravenous mechanical thrombectomy of the superior sagittal sinus, venous infarction and subsequent brain edema was rapidly getting worse than expected.

Conclusion: Superior sagittal sinus occlusion with thrombocytopenic thrombosis after Astra Zeneca COVID-19 vaccination is a rare case but can be devastating. Early suspicion is mandatory.

Acute management of Iatrogenic vertebral artery dissection during treatment of proximal vertebral artery stenosis

Sang-woo Ha

Department of Neurosurgery, Chosun University Hospital

Objective: To review the point of caution in the management of proximal VA stenosis involving the ostium.

Methods: A 82-year-old male patient was referred to us from a regional hospital because of severe dizziness and right lower limb weakness. He was diagnosed with cerebellar infarction and was discharged 3 days before admission to our hospital. He was discharged admitted due to recurrent cerebellar infarct.

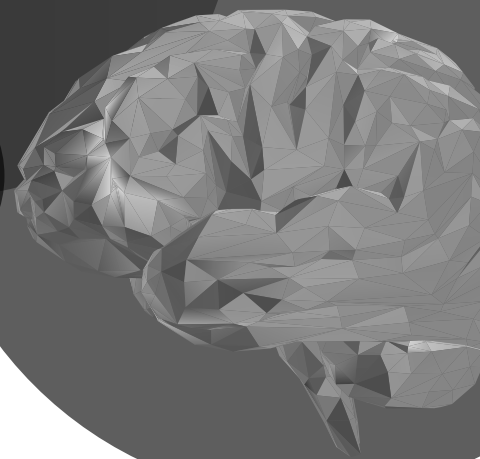
Result: CT angiography showed his left dominant proximal vertebral artery (VA) tandem stenosis involving VA ostium and MRI revealed multiple ischemic strokes newly appearing in the left posterior inferior cerebellar artery (PICA) territory. Due to recurrent attacks, we performed balloon angioplasty and stenting. Follow up angiography showed VA dissection and multiple stenting was done successfully.

Conclusion: This case report aims to review the point of caution in the management of proximal VA stenosis involving the ostium.

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Satellite symposium for nurses and technicians

좌장 : 김태곤(차의과학대) / 심숙영(인제대)

1. Natural history and treatment guidelines of cerebral aneurysm
2. Endovascular treatment of cerebral aneurysm
3. Perioperative care of cerebral aneurysm

오세양(인하대)

김대원(원광대)

고정호(단국대)

Natural history and treatment guidelines of cerebral aneurysm

오 세 양

인하대학교병원 신경외과

INHA UNIVERSITY HOSPITAL

The 15th Annual Korean Conference of Endovascular Neurological Society

ASCENT 2021
대한뇌혈관내치료학회

Theme: Exploring What is Next in Neurovascular Surgery
2021년 6월 25일(금) ~ 26일(토)
인하대학교의료원 그랜드볼룸

Natural history and Treatment guidelines of Cerebral aneurysm

뇌동맥류의 자연 경과와 치료 지침

The 15th ASCENT 2021
2021. 6. 25 ~ 2021. 6. 26

Se-yang Oh
Department of Neurosurgery, Inha University School of Medicine
and Hospital, Incheon, Republic of Korea

뇌동맥류의 자연 경과 : 뇌동맥류의 형성

뇌동맥류의 형성

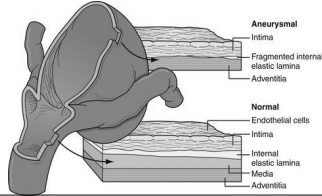
- 뇌동맥류의 유병률 : 전 인구의 3~5%
- 뇌동맥류 파열의 유병률 : 연간 10만 명당 10~11명
- 심각한 뇌출혈 (뇌지주막하출혈, subarachnoid hemorrhage, SAH)의 원인 질환
 - 뇌출혈의 5~15%
- 40~60세 연령층에서 가장 많이 진단됨
- 여성에서 더 흔하다 (1.5~2배)

뇌동맥류의 형성

- 두개강내 혈관의 정상적인 구조
 - 내막 (tunica intima)
 - 내탄성판 (internal elastic lamina)
 - 중막 (tunica media)
 - 외막 (tunica adventitia)
- 두개강외 혈관과 달리 중막과 내막이 덜 발달되어 있다

뇌동맥류의 형성

- 남성 뇌동맥류의 조직 구조
 - 내탄력층 (internal elastic lamina)의 손상 혹은 소실
 - 중막 (tunica media)의 약화 혹은 소실: 중막층 내의 평활근 세포의 소실



뇌동맥류의 형성

- 1. 혈류역학적 (hemodynamic) 요인
 - 혈관벽의 지속적인 혈류역학적 긴장이 가해짐
 - 뇌동맥의 연결부 (junction)
 - 뇌동맥의 분지부 (bifurcation)
 - 뇌동맥의 급격한 각도의 변화를 보이는 부위
 - Wall shear stress (WSS)가 강력히 작용하는 부위
 - WSS의 변화가 심한 부위

뇌동맥류의 형성

- 2. 혈관내피의 기능 이상 (Endothelial dysfunction)
 - WSS에 의해 혈관내피의 기능이상과 혈관벽의 염증 반응 및 remodeling이 촉발
 - 혈류역학적 긴장 -> 혈관내피의 기능이상인 동맥류의 가장 초기 병인 -> 동맥벽의 염증 반응
- 3. 동맥벽의 염증 반응 (inflammatory response)
 - 염증 반응에 의해 평활근 세포의 사멸이 발생
 - 다양한 염증 세포: 대식 세포, 비만 세포 등
 - Cytokine: IL-1b, TNFa 등
 - 활성 산소 (reactive oxygen species)
 - 유전자 발현

뇌동맥류의 형성

- 4. 유전적 요인
 - 뇌동맥류의 발생률이 1명의 발병자가 있는 직계에서 2배 (4%), 2명의 이환이 있는 경우 3배 (8%)의 유병률을 보임
 - 결합 조직 (connective tissue)와 관련된 유전 질환과의 연관성이 높다
 - 상염색체 우성 다낭신 (autosomal dominant polycystic kidney disease)
 - Ehlers-Danlos 증후군
 - Marfan 증후군
 - Fibromuscular dysplasia

뇌동맥류의 형성

- 5. 일반적인 위험 인자
 - 가족력
 - 여성
 - 고령
 - 고혈압
 - 흡연
 - 음주

뇌동맥류의 자연 경과: 뇌동맥류의 성장과 파열

낭성 뇌동맥류의 자연 경과

- 검진 목적, 혹은 경증 증상에 대해 시행한 CT angiography 또는 MRA에서 우연히 발견된 뇌동맥류의 운명은?
- 동맥류는 모두 위험한가?
- 위험하지 않은 뇌동맥류는 무엇인가?
- 뇌동맥류가 파열로 진행되는 위험 요인은 무엇인가?

낭성 뇌동맥류의 자연 경과

- ISUIA (International Study of Unruptured Intracranial Aneurysm)
 - 1998년 12월 발표 (1차)
 - 미국, 캐나다, 유럽의 53개 센터 2621명 대상
 - 8.3 년간 추적 조사
 - 10 mm 미만의 뇌동맥류
 - 뇌지주막하출혈 병력 있는 경우 그렇지 않은 경우에 비해 11배의 파열 위험성 (연 0.5%)
 - 10 mm 이상의 뇌동맥류
 - 뇌지주막하출혈 병력과 관계 없이 연간 1% 정도의 파열 위험성
 - 25 mm 이상의 뇌동맥류
 - 첫째 파열율 6%
 - 선택 편향의 문제가 있었음: 파열 위험성이 낮아 보존적 치료를 하기로 결정한 환자들이 선택됨
 - 10 mm 이상 뇌동맥류의 파열 위험성이 높음을 첫 보고

낭성 뇌동맥류의 자연 경과

- ISUIA (International Study of Unruptured Intracranial Aneurysm)
 - 2003년 (2차)
 - 5년 누적 파열률
 - 7 mm 미만 : 0%
 - 7~12 mm : 2.6%
 - 13~24 mm : 14.5%
 - 25 mm 이상 : 40%
 - 여전히 다른 연구결과에 비해 파열 위험성이 낮게 나타남
 - 선택 편향의 문제점 : 추적 도중 상당수의 환자가 수술 혹은 코일 색전술 받음

낭성 뇌동맥류의 자연 경과

- UCAS (Unruptured Cerebral Aneurysm Study) Japan
 - 2012년 발표
 - 2001~2004, 3 mm 이상의 뇌동맥류를 가진 20세 이상의 5720명의 환자를 대상
 - 연간 파열위험성 : 0.95%
 - 3~4 mm 크기를 기준으로 5~6 mm 는 1.13배, 7~9 mm는 3.35배, 10~24 mm 는 9.09배, 25 mm 이상은 76.26배의 파열위험성을 보임.
 - 중대뇌동맥류를 기준으로 후방순환계는 1.9배, 전교통동맥 2.02배의 파열위험성을 보임
 - Daughter sac이 있는 뇌동맥류는 1.63배의 위험성을 보임

낭성 뇌동맥류의 자연 경과

- Natural history of asymptomatic unruptured cerebral aneurysms evaluated at CT angiograph
 - Vilablanca et al., 2013
 - 평균 2.24년 동안 258개의 비파열 뇌동맥류 중 18%가 성장
 - 이 중 4개 (1.8%, 평균크기 6.2 mm)가 파열됨
 - 성장한 동맥류의 파열률은 2.4%로 성장하지 않은 동맥류의 연간 파열 위험성 0.2%에 비해 12배나 높음

낭성 뇌동맥류의 자연 경과

- 10년 이상의 장기 추적 결과
 - Juvela et al. 2013
 - 누적 파열률 : 10년째 10.5 %, 20년째, 23.0%, 30년째 30.1%
- 5 mm 이하의 paraclinoid aneurysm
 - Jeon et al. 2014
 - 평균 35.4개월간 추적
 - 연간 파열 위험성 0.12%, 연 성장률 1.01%
 - 4mm 이상 고혈압, 다발성의 경우 성장 위험성이 높음

ASCENT 2021

남성 뇌동맥류의 자연 경과

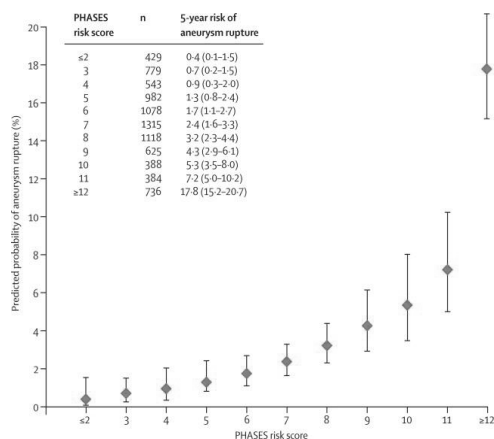
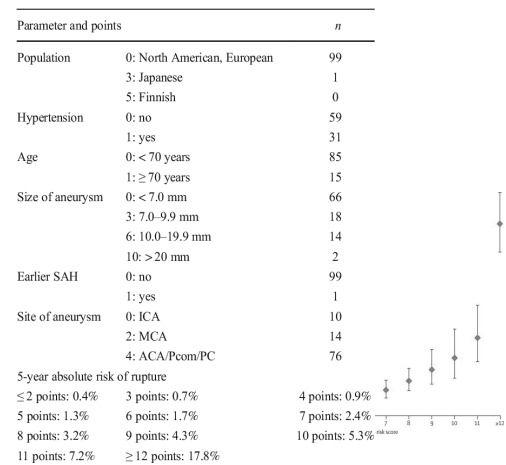
- SUAVE (Small Unruptured Intracranial Aneurysm Verification) study Japan
 - Sonobe et al. 2010
 - 448개의 크기 5 mm 미만의 비파열성 뇌동맥류를 평균 41개월간 추적 관찰
 - 연평균 파열률 : 0.54%
 - 단일 동맥류 : 0.34% / 다발성 동맥류 : 0.95%
 - 50세 미만, 4 mm 이상, 고혈압, 다발성 동맥류에서 유의하게 높은 파열 위험성을 보임
 - 의의: 5 mm 미만의 작은 뇌동맥류에서도 충분히 파열 위험성이 있음

남성 뇌동맥류의 자연 경과

- Natural history of unruptured intracranial aneurysm: A retrospective single center analysis
 - Byoun et al, 2016, Korea
 - 2000년~2008년 1339개의 동맥류를 추적 관찰, 7 mm 미만의 동맥류를 대상
 - 평균 크기 4.5 mm
 - 연간 파열 위험성 : 1%
 - Risk Factors: 동맥류의 크기, 뇌지주막하출혈 병력
 - 크기 7mm 미만이며 뇌지주막하출혈 병력이 없는 동맥류의 연간 파열 위험성 : 0.79%

남성 뇌동맥류의 자연 경과

- 남성 뇌동맥류의 연간 파열 위험성은 1~2%
- 파열의 위험성이 높은 인자
 - 동맥류의 크기 (클수록, 5 mm, 7mm 이상)
 - 동맥류의 위치
 - 전교통 동맥 (anterior communicating artery)
 - 후방 순환계 (basilar, vertebral, SCA, PCA...)
 - 뇌지주막하출혈 (SAH) 과거력
 - 불규칙한 모양 : multilobarity, daughter sac
 - Dome-to-neck ratio
 - 다발성 동맥류, 유증상 동맥류, 성장하는 동맥류
 - 여성, 가족력, 관련된 유전병, 흡연, 음주



뇌동맥류의 치료 지침

비파열뇌동맥류의 치료 지침

- Guidelines for the Management of Patients With Unruptured Intracranial Aneurysms
 - 2015년 Stroke지에 발표
 - Stroke. 2015;46:2368-2400
 - AHA (American Heart Association) / ASA (American Stroke Association)
 - 가장 최근의 guideline

비파열뇌동맥류의 치료 지침

- 동맥류의 생성과 성장, 파열의 위험 인자에 대한 권고
 - 1. 흡연은 비파열뇌동맥류 생성의 위험을 증가시키므로, 비파열뇌동맥류 환자는 금연의 중요성에 대한 상담을 받아야 한다. (Class I; Level of Evidence B)
 - 2. 고혈압은 뇌동맥류의 성장과 파열에 중요한 역할을 하므로, 비파열뇌동맥류 환자는 혈압 감시를 반드시 해야 하고, 고혈압 치료를 받아야 한다. (Class I; Level of Evidence B)
 - 3. 동맥류의 성장은 파열의 위험성을 높이므로 비파열뇌동맥류를 보존적으로 관찰하는 환자의 경우 정기적인 추적 검사가 고려되어야 한다. (Class I; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 임상 양상에 대한 권고
 - 1. 동맥류 파열에 의한 뇌지주막하출혈 환자는 동시에 존재하는 비파열뇌동맥류에 대한 평가가 반드시 이루어져야 한다. (Class I; Level of Evidence B)
 - 2. 동맥류가 원인이 되어 발생한 뇌신경마비를 보이는 환자의 뇌동맥류는 조기 치료의 적응증이다. (Class I; Level of Evidence C)
 - 3. 허혈성뇌혈관질환의 예방을 위한 비파열뇌동맥류 치료의 효용성은 불확실하다. (Class IIb; Level of Evidence C)

비파열뇌동맥류의 치료 지침

- 진단과 영상검사에 대한 권고
 - 1. DSA는 수술적 혹은 혈관내치료가 고려되는 뇌동맥류의 진단 및 평가에 있어 비침습적 영상검사에 비해 유용하다. (Class IIa; Level of Evidence B)
 - 2. DSA는 치료된 뇌동맥류의 추적 검사에 있어 가장 민감도가 뛰어나다. (Class I; Level of Evidence C)
 - 3. CTA와 MRA는 비파열뇌동맥류의 발견과 추적 관찰에 유용하다. (Class I; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 진단과 영상검사에 대한 권고
 - 4. 치료된 뇌동맥류의 추적 검사를 위해 MRA를 시행하는 것은 적절하고, 치료 결정을 위해 DSA의 시행이 요구된다. (Class IIa; Level of Evidence C)
 - 5. Wider neck/dome diameter 형태의 코일이 시행된 뇌동맥류가 residual filling을 보이는 경우 반드시 추적 검사를 하여야 한다. (Class I; Level of Evidence B)
 - 6. 재발 위험성이 높지 않은 비파열뇌동맥류의 혈관내 치료 후 영상검사의 중요성은 불분명하나, 영상 검사는 대개 필요하다. (Class IIa; Level of Evidence C)

비파열뇌동맥류의 치료 지침

- 선별 검사(screening)에 대한 권고
 - 1. 직계 가족 중 뇌동맥류 혹은 뇌지주막하출혈의 병력이 있는 자가 2명 이상일 경우 CTA 또는 MRA를 통한 동맥류 선별 검사가 제안된다. 직계 가족에서 뇌동맥류 발생의 위험성이 높은 요인에는 고혈압, 흡연, 여성이 포함된다. (Class I; Level of Evidence B)
 - 2. 상염색체우성 다낭신증후군 환자의 경우 특히 뇌동맥류 가족력이 있는 경우, CTA 또는 MRA를 통한 선별 검사가 제안된다. (Class I; Level of Evidence B) 대동맥축착증 (coarctation of the aorta)과 microcephalic osteodysplastic primordial dwarfism환자의 경우 CTA 또는 MRA 검사를 받는 것이 합리적이다. (Class IIa; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 자연 경과 (Natural History)에 대한 권고
 - 1. 이전의 동맥류성 뇌지주막하출혈 병력은 다른 작은 비파열뇌동맥류에 의해 2차적으로 발생하는 새로운 뇌출혈의 독립적 위험인자로 고려된다. (Class IIb; Level of Evidence B)
 - 2. 추적 관찰 기간 동안의 뇌동맥류의 크기 증가 변화가 있는 환자는 치료에 대한 금기 질환이 없다면 반드시 치료받아야 된다. (Class I; Level of Evidence B)
 - 3. 뇌동맥류의 가족력이 있는 비파열뇌동맥류 환자는 동맥류가 작은 크기라 할지라도 치료하는 것이 합리적이다. (Class IIa; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 결찰 수술 (Surgical clipping)에 대한 권고
 - 1. 비파열 뇌동맥류의 치료를 위한 결찰 수술을 고려할 때, 환자의 연령, 동맥류의 위치 및 크기 등의 요인을 고려하여야 한다. (Class I; Level of Evidence B)
 - 2. 완전 제거와 불완전 제거 여부에 따라 수술 후 동맥류의 성장 및 재출혈의 위험도가 달라지므로 동맥류 제거 여부를 기록할 수 있는 수술 후 영상 검사가 권고된다. (Class I; Level of Evidence B)
 - 3. 동맥류의 재발 혹은 새로운 동맥류 발생의 위험성이 있으므로 결찰 수술 후에도 장기간의 추적 영상검사가 고려된다. 장기 추적 검사는 완전 결찰이 이루어지지 않은 동맥류의 경우 특히 중요하다. (Class IIb; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 결찰 수술 (Surgical clipping)에 대한 권고
 - 4. 비파열뇌동맥류의 수술적 치료는 수술 건수가 많은 병원 (연간 20건 이상)에서 받는 것이 권고된다. (Class I; Level of Evidence B)
 - 5. 수술 중 vessel compromise 또는 residual aneurysm을 피하기 위해 특화된 intraoperative tool & technique의 사용은 비파열뇌동맥류 수술 후 불량한 결과를 감소시키기 위해 고려된다. (Class IIb; Level of Evidence C)

비파열뇌동맥류의 치료 지침

- 혈관내 치료 (Endovascular treatment)에 대한 권고
 - 1. 혈관 내 혈류전환 (Endoluminal flow diversion)은 주의 깊게 선택된 case에서 고려된다. (Class IIb; Level of Evidence B)
 - 이 외의 비파열뇌동맥류 치료에 있어 새로 소개되고 있는 기술도 주의 깊게 선택된 cases에서 고려된다. (Class IIb; Level of Evidence C)
 - 새로운 치료법의 장기적인 효과는 대부분 알려져 있지 않다. 추가적인 trial data에서 기존의 치료보다 안전성과 효용성에서 더 우월한 발전이 입증될 때까지 FDA의 지침을 지켜야 한다. (Class IIa; Level of Evidence C)

비파열뇌동맥류의 치료 지침

- 혈관내 치료 (Endovascular treatment)에 대한 권고
 - 2. Coated coil의 사용은 bare-metal coil에 비해 이득이 없다. (Class IIa; Level of Evidence C)
 - 3. 비파열뇌동맥류의 혈관내 치료는 치료 건수가 많은 병원 (high-volume centers)에서 받는 것이 권고된다. (Class I; Level of Evidence B)
 - 4. 방사선 노출에 의한 시술 위험성은 혈관내치료의 동의 과정에서 명확히 검토되어야 한다. (Class I; Level of Evidence C)

비파열뇌동맥류의 치료 지침

- 결찰 수술과 코일 색전술의 효용성 비교에 대한 권고
 - 1. 결찰 수술은 치료가 고려되는 비파열뇌동맥류의 효과적인 치료법이다. (Class I; Level of Evidence B)
 - 2. 혈관내 코일 색전술은 치료가 고려되는 선택된 비파열뇌동맥류의 효과적인 치료법이다. (Class IIa; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 결찰 수술과 코일 색전술의 효용성 비교에 대한 권고
 - 3. 치료가 고려되는 비파열뇌동맥류 환자는 혈관내 치료와 결찰 수술 방법 모두의 위험성과 이점에 대해 완전한 정보를 제공받아야 한다. (Class I; Level of Evidence B)
 - 4. 코일 색전술은 선택된 cases에서 결찰 수술보다 procedural morbidity & mortality가 낮으나 재발의 위험성이 결찰 수술보다 높다. (Class IIb; Level of Evidence B)

비파열뇌동맥류의 치료 지침

- 치료받지 않은 동맥류 추적 관찰에 대한 권고
 - 1. 수술 혹은 혈관내 시술이 시행되지 않고 경과 관찰 중인 비파열뇌동맥류 환자는 주기적인 MRA 또는 CTA 와 같은 추적 영상 검사가 적용된다. 추적에 권고되는 적절한 기간과 간격은 불명확하다. (Class I; Level of Evidence B)
 - 2. 수술 혹은 혈관내 시술이 시행되지 않고 경과 관찰 중인 비파열뇌동맥류 환자는, 첫 발견 후 6~12개월 후에 추적 검사, 이어서 1~2년 간격의 추적 검사를 하는 것이 합리적이다. (Class IIb; Level of Evidence C)
 - 3. MRI검사를 받을 수 없는 경우가 아니라면 반복적인 장기 추적 검사를 위해 CTA 보다 TOF MRA검사를 고려하는 것이 합리적이다. (Class IIb; Level of Evidence C)

Conclusions: Recommendations

- 비파열뇌동맥류의 적절한 치료를 위해 고려되는 요소 (Class I; Level of Evidence C)
 - 크기 (Size)
 - 위치 (Location)
 - 형태의 특징 (Morphological characteristics)
 - 연속적인 영상 검사상의 동맥류의 성장(Growth)
 - 연령 (Age)
 - 동맥류성 지주막하출혈의 과거력
 - 뇌동맥류의 가족력
 - 다발성 동맥류의 존재여부
 - 뇌출혈의 위험성을 높이는 뇌동정맥기형 또는 다른 뇌혈관질환 또는 유전성 질환의 유무

Conclusions: Recommendations

- 치료가 고려되는 비파열뇌동맥류 환자는 비파열뇌동맥류의 안전성 확보와 출혈 방지를 위한 혈관내 치료와 결찰 수술 방법 모두의 위험성과 이점에 대해 완전한 정보를 제공받아야 한다. (Class I; Level of Evidence C)
- 비파열뇌동맥류의 치료 결과는 low-volume centers가 우월하지 못하므로 higher-volume center에서 치료받는 것이 권고된다. (Class I; Level of Evidence B)

Conclusions: Recommendations

- 여러 나라 및 국제적 다기관 연구를 통한 다수의 전향적, 후향적 연구 data를 통해
 - 내구성(낮은 재발률) : 결찰 수술이 우월함
 - 이환률, 사망률, 재원 기간, 치료 비용: 혈관내 치료가 우월함
 - 선택적인 경우, 특히 결찰 수술의 위험성이 높은 기저동맥첨부 (basilar apex)와 고령의 환자에서 혈관내 치료의 선택은 합리적이다.
- (Class IIb; Level of Evidence C)

Conclusions: Recommendations

- 비파열뇌동맥류환자의 치료 위험성은 고령, 동반된 질환, 동맥류의 위치, 크기와 연관이 있다. 따라서 65세 이상의 고령이며 동반된 다른 질환이 있는 무증상의 비파열 뇌동맥류, 출혈 위험성이 낮은 위치, 크기, 모양, 가족력과 이외의 유의한 요인이 있는 경우 관찰 (Observation)은 합리적인 대안이다. (Class IIb; Level of Evidence B)

뇌동맥류 치료 지침 : 국내의 권고 사항

- 대한 뇌졸중 학회 (Korean Stroke Society)
- 2013년 발간

뇌동맥류 치료 지침 : 국내의 권고 사항

- 치료를 하지 않고 경과관찰을 결정한 경우, 고혈압치료와 금연을 권고하며, 증상이 없더라도 주기적 영상 추적 검사를 권고한다. (근거수준: III, 권고수준: B)
- 증상이 있는 비파열뇌동맥류는 치료가 원칙이다. 단, 동반된 내과적 병력이나 고령, 동맥류의 모양, 위치 등에 의해 치료의 위험성이 매우 높은 경우 이를 고려하여 치료 여부를 결정한다. (근거수준: IIa, 권고수준: B)
- 증상이 없는 경막외뇌동맥류는 일반적으로 치료가 추천되지 않는다. (근거수준III, 권고수준B)

뇌동맥류 치료 지침 : 국내의 권고 사항

- 증상이 없는 비파열뇌동맥류는 치료의 위험도를 고려해 볼 때 환자의 여명이 약 10년 이상이면 다음과 같은 경우에 치료의 검토가 추천된다.
 - 1) 파열의위험도가상대적으로높은경우
 - ①크기가 5 mm이상(근거수준III, 권고수준B)
 - ②후방순환, 전교통동맥 및 후교통동맥 뇌동맥류(근거수준IIb, 권고수준B)
 - ③지주막하출혈 병력이 있는 환자(근거수준IIb, 권고수준B)
 - ④뇌동맥류의 가족력이 있는 환자(근거수준III, 권고수준B)
 - ⑤경과관찰 도중 크기의 증가나 모양의 변화가 있는 뇌동맥류(근거수준: IV, 권고수준: C)
 - ⑥50세 미만의 고혈압환자에서 다발성 병변이있을때(근거수준III, 권고수준B)
 - ⑦종횡비 (aspect ratio, 동맥류 경부의 크기에 대한 동맥류 높이의 상대적인 크기비율) 또는 크기 비 (size ratio, 모동맥 크기에 대한 동맥류의 상대적인 크기 비율)가 크거나 다엽성(multilobular) 또는 수포성(bleb) 변화를 보이는 뇌동맥류(근거수준III, 권고수준B)
 - 2) 환자가 비파열뇌동맥류 진단으로 한 불안, 우울증이 심할 경우(근거수준IV, 권고수준C)

뇌동맥류 치료 지침 : 국내의 권고 사항

- 비파열뇌동맥류가 발견된 경우, 환자의 나이, 동반질환, 건강상태 등 '환자 인자' 및 뇌동맥류의 크기, 위치 및 모양 등의 '병변 인자'를 고려하여 치료 여부를 결정을 하는 것이 권고된다. 또한 치료 방법은 병원의 시설 및 치료 성적도 고려하여 결정한다. 이러한 결정 과정에서, 환자 또는 환자 가족에게 충분한 설명을 한 후 고지된 동의를 받는 것이 필수적이다. (근거수준IV, 권고수준C)
- 비파열뇌동맥류의 치료 시 혈관내치료를 결찰술과 비교하여결과가 나쁘지 않으며, 치료위험도와 재발률 등을 고려하여 치료 방법을결정한다. (근거수준Ib, 권고수준A)
- 비파열 뇌동맥류의 치료 후 장기간 경과관찰이 권고된다. 특히 혈관내치료 후에는 불완전 패색이나 재개통 등을 확인하기위해 경과관찰을 하는 것이 권고된다. (근거수준IIb, 권고수준B)

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- Korean Clinical Practice Guidelines for Aneurysmal Subarachnoid Hemorrhage
 - 대한신경외과학회지 발표 (2018년)
 - J Korean Neurosurg Soc 61(2):127-166, 2018
 - AHA (American Heart Association) / ASA American Stroke Association)의 2012년 guideline, European Stroke Organization (ESO)의 2013년 guideline, Japanese Society on Surgery for Cerebral stroke (JSSCS)의 2008년 guideline을 토대로 제창

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 위험 요인에 대한 권고 사항 (근거수준III, 권고수준B)
 - 동맥류성뇌지주막하출혈의 위험 요인
 - 흡연
 - 고혈압
 - 과도한 음주
 - 동맥류의 크기, 위치
 - 환자의 연령과 건강 상태
 - 위험 요인 및 가족력이 있는 환자에게 선별 검사가 권고된다.

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 진단에 대한 권고 사항
 - 내원 시 Modified-WFNS scale, GCS : 예후 판단에 유용하다. (근거수준III, 권고수준B)
 - 신경학적 결손이 있거나, 없다 하더라도 40세 이상의 경부통, 경부강직, 의식 소실, 활동중의 갑작스런 두통 증상을 보이는 환자에게 brain CT가 권고된다. (근거수준III, 권고수준B)
 - Non-contrast CT에서 SAH가 확인되지 않았을 때 동맥류의 확인을 위해 CT angiography가 권고된다. (근거수준III, 권고수준B)

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 진단에 대한 권고 사항
 - SAH가 진단되었을 때 정확한 치료 방침 결정을 위해 DSA가 권고된다. DSA가 불가능한 환자에서 대안적으로 multidetector CT angiography가 실행될 수 있다. (근거수준III, 권고수준B)
 - 내원 시 CT angiography와 DSA에서 동맥류가 발견되지 않은 경우 시간 경과 후 반복적인 DSA가 권고된다. (근거수준III, 권고수준B)

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 재출혈 방지를 위한 권고사항
 - 약물 치료
 - 결찰 수술 혹은 혈관내 수술이 이루어질때까지 철저한 혈압 조절 (수축기혈압 160이하)이 권고된다. (근거수준III, 권고수준B)
 - 치료 시점
 - 치료에 특별한 방해 요인이 없다면 재출혈 방지를 위해 뇌출혈 발생 72시간 이내에 파열된 동맥류가 피로되는 것이 합리적이다. (근거수준IIa, 권고수준B)

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 결찰 수술과 코일 색전술에 대한 권고
 - 결찰 수술과 코일 색전술이 모두 가능할 경우 코일 색전술이 먼저 권고된다. (근거수준Ib, 권고수준A)
 - 스텐트 (stent)의 사용은 제한된 cases에서 다른 치료적 대안이 없을 경우 주의깊게 사용되어야 한다. (근거수준III, 권고수준B)

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 결찰 수술과 코일 색전술에 대한 권고
 - 결찰 수술을 먼저 고려해야 하는 경우
 - 40세 이하 (근거수준IIa, 권고수준B)
 - 감압 혹은 제거를 고려할 정도의 용적을 차지하는 혈종이 있는 경우 (근거수준III, 권고수준B)
 - 중대뇌동맥의 뇌동맥류 (근거수준IIa, 권고수준B)
 - 넓은 경부(wide-necked)의 뇌동맥류 (근거수준III, 권고수준B)
 - 동맥류에서 혈관이 분지 (근거수준III, 권고수준B)

파열된 뇌동맥류 (동맥류성 뇌지주막하출혈)의 치료 지침

- 코일 색전술을 먼저 고려해야 하는 경우
 - 70세 이상 (근거수준IIa, 권고수준B)
 - 신경학적 상태가 불량한 경우 (WFNS grade IV, V) (근거수준III, 권고수준B)
 - 후방순환계 동맥류 (근거수준IIa, 권고수준B)
 - 경부가 좁은(narrow-necked) 동맥류 (근거수준III, 권고수준B)
- 코일 색전술의 경우 재발이 가능성이 있어 장기간의 추적 관찰이 권고된다. (근거수준IIb, 권고수준B)

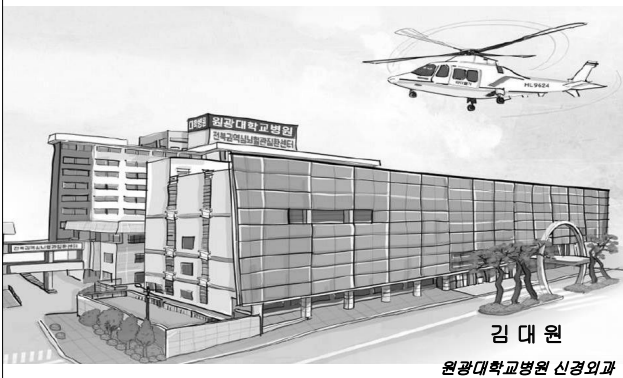
Endovascular treatment of cerebral aneurysm

김 대 원

원광대학교병원 신경외과

제 15차 ASCENT 2021

Endovascular treatment of cerebral aneurysm



Contents

- History
- Principles of endovascular treatment
- Evolution of treatment methods (e.g. instruments...)



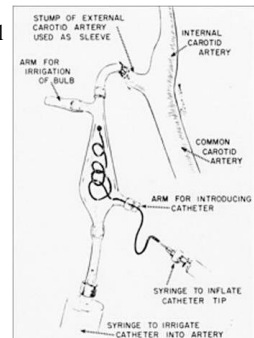
History

- 1937년 Dandy 교수가 처음 brain aneurysm clipping을 마친 다음 한 말 : "An aneurysm at the circle of Willis is not entirely hopeless"
- 그 이후 surgical clipping이 brain aneurysm을 치료하는데 가장 합리적인 치료 과정으로 되어 갔음.
- 1980년대 중반 Yasargil 교수가 aneurysm clipping 에 관한 책을 발간한 이후 수술에 대한 지견이 혁신적으로 발전하였음.
- 반면 수술의 invasiveness (craniotomy, brain retraction, arachnoid dissection, aneurysm manipulation) 때문에 덜 침습적인 방법을 생각함.



History

- 1964년 Georgetown University Hospital in Washington의 **Lussenhop** and **Velasquez** : 처음으로 brain vessel에 catheterization & AVM 치료 시도.



History

- Early 1960,
- Fedor **Serbinenko** (Burdenko Neurosurgical Institute in Moscow
- 300명 이상의 환자를 Non-detachable & detachable balloon을 이용하여 치료.
- 냉전시대로 인해 1974년 서방에 소개됨.

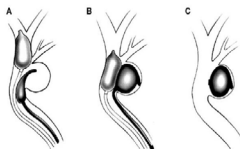
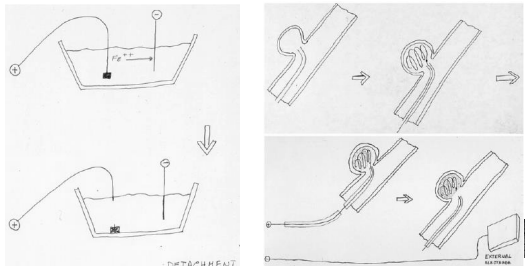


FIGURE 8. Serbinenko with friend and pupil Victor Sheglov (left) in 1979.

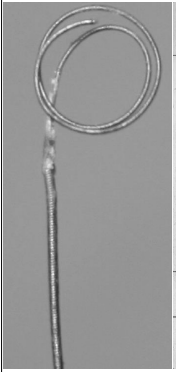
FIGURE 9. Aneurysm balloon embolization technique inspired by Serbinenko and used by Sheglov. Two balloon catheters are advanced into the internal carotid artery. A, the nondetachable balloon catheter is advanced beyond the cerebral aneurysm and acts as a "shepherd balloon" that guides the detachable balloon into the aneurysm sac. The

History

- 1989년 University of California (U.C.L.A)의 Guglielmi라는 endovascular neurosurgeon에 의해 획기적인 방법이 고안됨



History



Target Therapeutics

Guglielmi Electrolytic MicroCoil (GEM)

Part Number: 350001
Lot Number: R0366

Coil Shape: 4 mm J
Coil Length: 10 cm
Shaft Length: 175 cm
Max. shaft Diameter: 0.010"

Contents: One Unit and One Torque Device

This device is intended for one (1) use only. Read the accompanying directions prior to use.

(Inv A) Patent Pending 01/29

CAUTION:
Do not use if the coil is damaged or if the coil is not properly sealed. Read directions prior to use.

Target Therapeutics, Inc.
San Jose, California 95134 USA
(800) 345-0498

- 1995년 : GDC (Guglielmi detachable coil) 보급
- 1996년 : 우리나라 4개 병원에서 75 case 뇌동맥류 치료

Principles of endovascular aneurysm treatment

- **Adequate embolization of aneurysm**
 - Determine a working projection
 - Determine a coiling technique
 - Choose a GC system
 - Choose a MC w or w/o shaping
 - Aneurysm selection (Navigate MCs)
 - Deploy coils
- **Prevent complications**
 - ; parent artery, branch occlusion
 - ; premature rupture
 - ; thrombosis

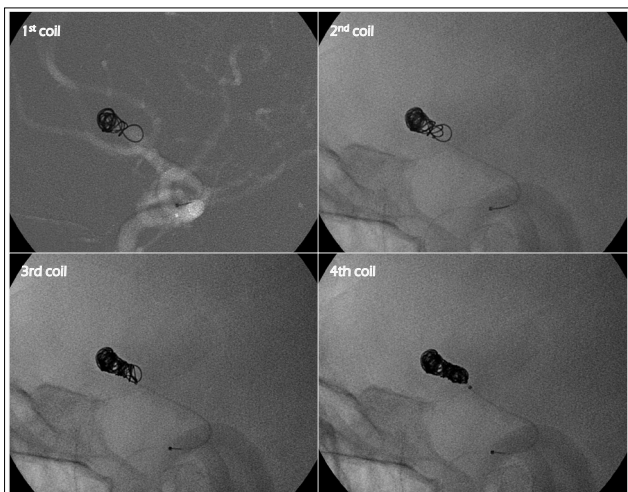
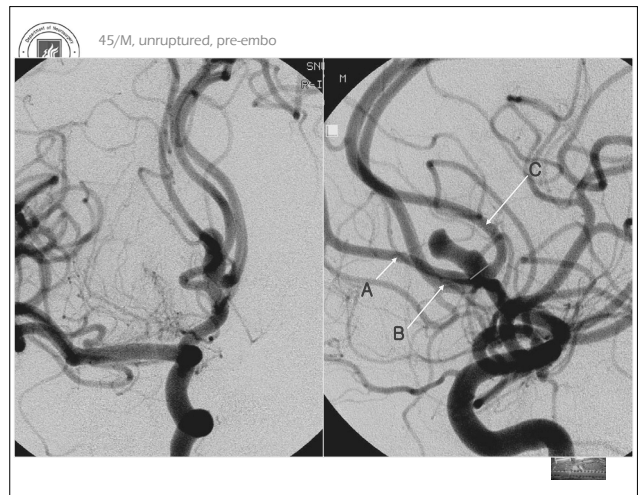
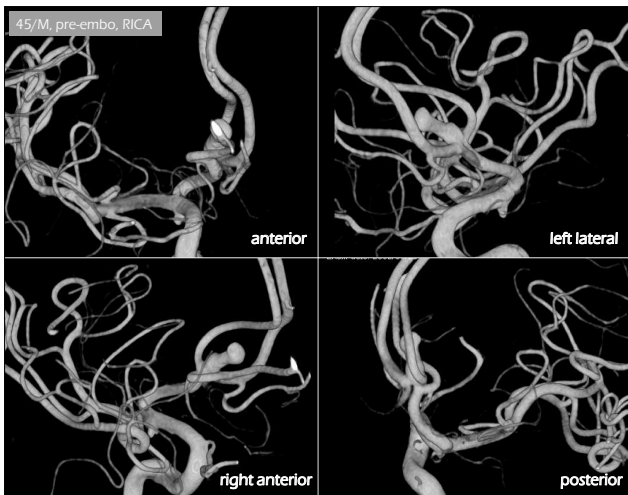
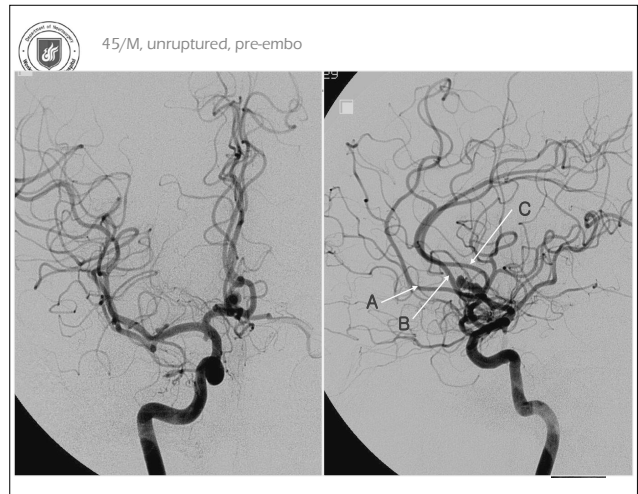
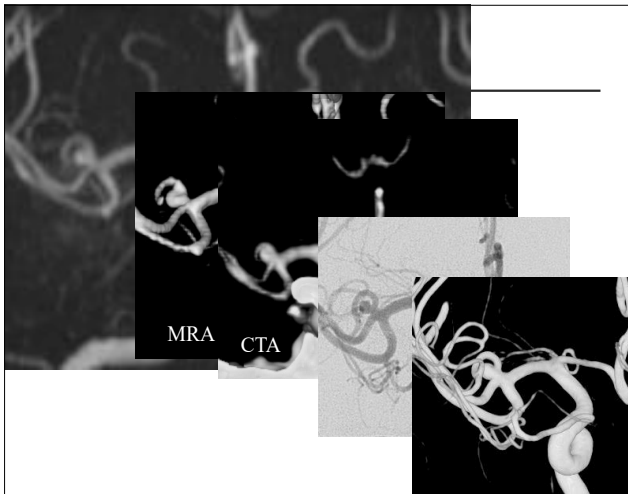
General preparation

- When?
 - ASAP in ruptured cases
- Pre-embo. Medication in unruptured cases
 - ; ASP + clopidogrel
- General anesthesia or Deep sedation
- A-line monitoring (Sheath)
- Systemic heparinization during the procedure
 - ; heparin bolus: 3000 IU + 1000 IU/hr
- Post-embo. heparinization or antiPLT in selected cases

1. Determine a working projection

- Aneurysm shape & relation to parent artery
- By using
 1. DSA with 3D reconstruction
 2. CTA 3D reconstruction
 3. MRA 3D reconstruction
- Orientation of Important branch
 - ant. Choroidal artery
 - ophthalmic artery.....

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Prerequisites for success

- Adequate support of GC system
- Adequate support of MC
- Adequate choice of coils
- How to overcome the tortuosity
- How to make a supportable shape



2. Determine a coiling technique

- Single MC
- Double MC
- Balloon-assisted
- Stent-assisted
- Catheter-assisted



3. Choose a GC System

- 5F: single MC (10") compatible with GDC 10
- 6F: single or double MC (14"+14")
- 7F: double MC or balloon cath.+single MC
- 8F (Envoy 7F): double MC + balloon or stent
- Coaxial system: GS (Shuttle Flexor)+GC
- Should check the flow after placement
- Frequently check heparinized saline dripping

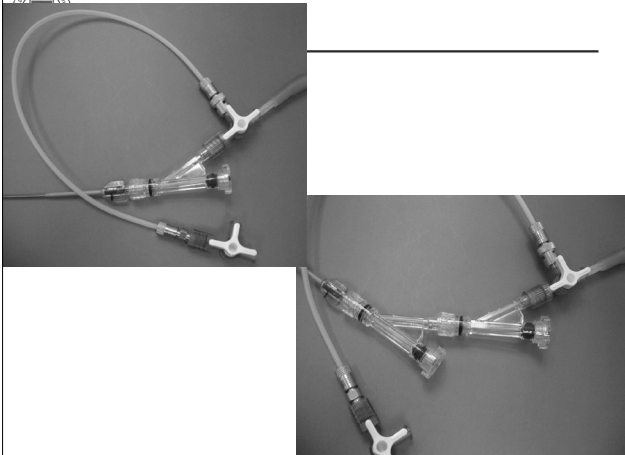


7F Guiding Catheters

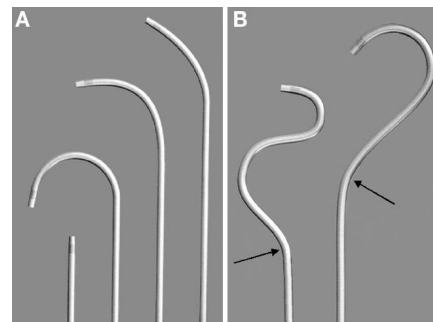
	ENVOY 7F	Guider soft tip 7F
Outer diameter	7F	7F
Inner diameter	0.078 inch	0.073 inch
Length	90 / 100cm	90 / 100cm
Construction	Stainless Steel hybrid braiding	Stainless Steel Conventional braiding
Material : Proximal	Nylon	Nylon
Material : Distal	Polyurethane	Polyurethane
Inner liner	PTFE coating	PTFE coating
M/C Compatible	3 M/C	2 M/C

F/52 unruptured basilar tip aneurysm

Coaxial guiding system



4. Preshaped microcatheter

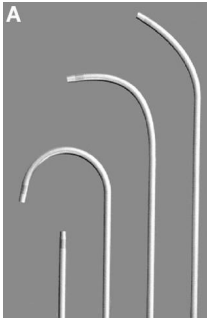




5. Shape microcatheter I

Primary shapes

- Straight
- 45°
- 90°
- J



A





5. Shape microcatheter II

Secondary shapes

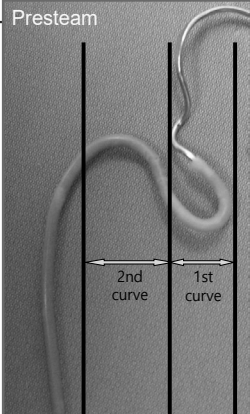
- S series
 - S-Simple
 - S-long 2nd curve
 - S-Rt, S-Lt
- Pigtail
 - Pigtail-Simple
 - Pigtail-Rt, Pigtail-Lt





S-Simple

Presteam



Poststeam



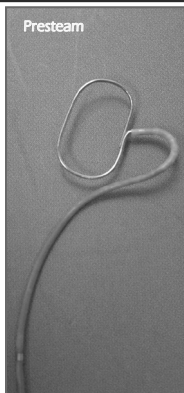
2nd curve

1st curve

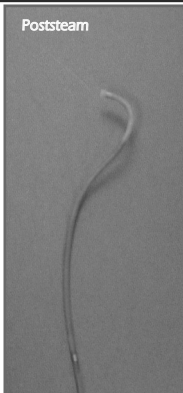


S-long 2nd curve

Presteam



Poststeam

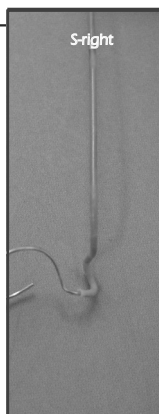






S-Rt & S-Lt shapes

S-right



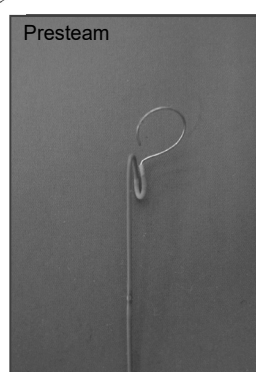


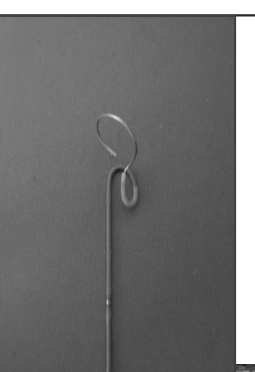




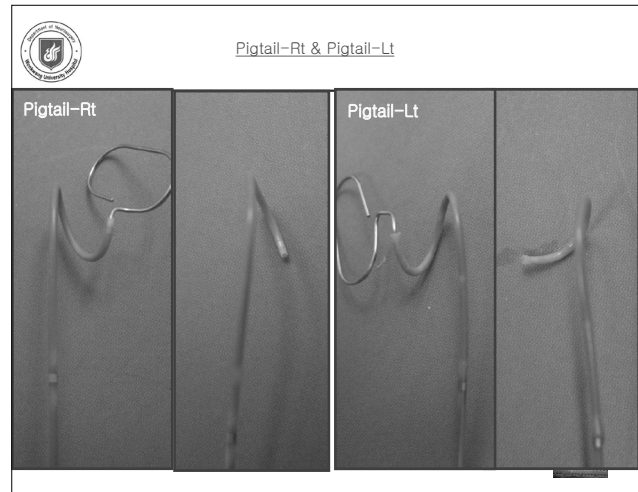
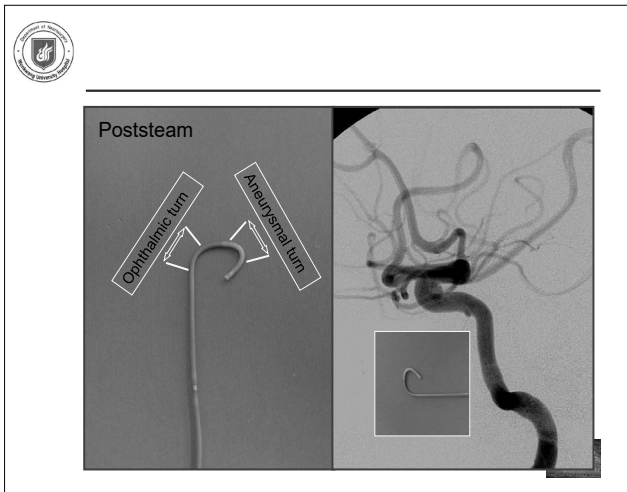
Pigtail-simple

Presteam









6. Aneurysm selection (Navigate MCs)

1. Antegrade (routine)
2. Retrograde
3. Wire-rotating
4. Looping & withdrawing
5. Coil-guided
6. **Wire-guided**

- All efforts to avoid rupture



7. Deploy coils: considerations

- Frame vs. fill vs. finishing
- Coil Shapes: 3D or complex/helical
- Coil Softness: Standard/soft/US
- Pusher stiffness
- Bare/Coated coil



Superiorly directed

unruptured paraclinoid, superiorly directed Steam-shaped S-curve + Withdrawing

This slide illustrates a 'Superiorly directed' approach. It includes a 3D model of a paraclinoid aneurysm on the left and a photograph of a physical coil with a 'Steam-shaped S-curve' on the right, demonstrating the 'Withdrawing' technique.

Department of Neurosurgery, Wonkwang University Hospital

This slide shows two angiograms side-by-side, demonstrating the deployment of a coil into an aneurysm. The bottom of the slide includes the text 'Department of Neurosurgery, Wonkwang University Hospital' and a small logo.

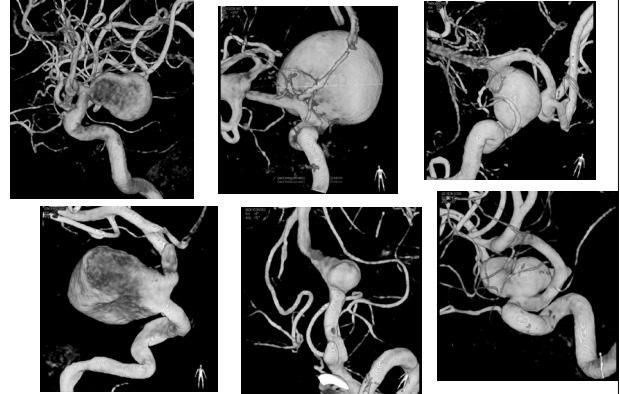


Evolution of treatment methods

- Evolution of balloon
: Hyperform, Hyperglide, Scepter.....
- Evolution of stent
: Major role in the development of endovascular aneurysm treatment
: Neuroform
: Enterprise, Solitaire, Lvis blue or Jr,
: **Flow diverter**
- PED, Surpass, FRED.....
: **Flow disrupter**
- WEB.....



Flow diverter

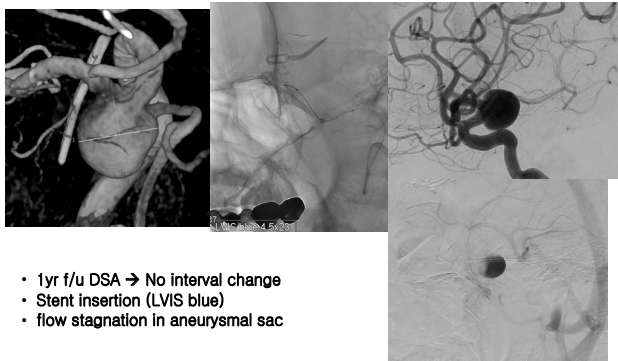


Flow diverter

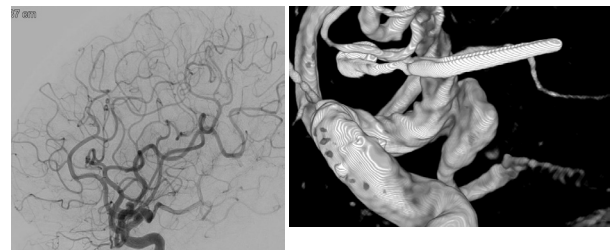
- A/S : 61/F
- C/C : Dizziness c headache
- P/Hx : Non specific
- N/EX
- Mental : alert
- Motor : intact



- Clipping failure
- Flow diverter (Neck portion에서 Fetal type P-com 분지)



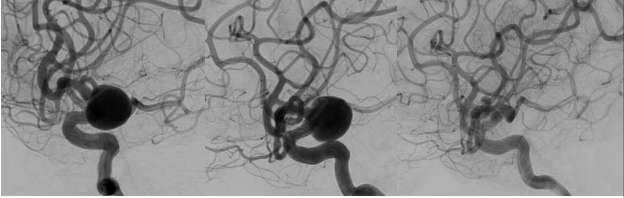
- 1yr f/u DSA → No interval change
- Stent insertion (LVIS blue)
- flow stagnation in aneurysmal sac



- 2yrs f/u DSA → Marked occlusion of aneurysm
- Fetal type P-com flow : intact







Flow diverter insertion 1yr f/u DSA
Stent insertion 2yrs f/u DSA



Summary

- How to increase the GC support?
- How to shape a MC tip?
- How to navigate a MC?
- Coaxial GC system/ heavy duty buddy wire
- Thorough comparative evaluation of a parent artery & aneurysm in the relative directions
- Choose the most safe & practical way



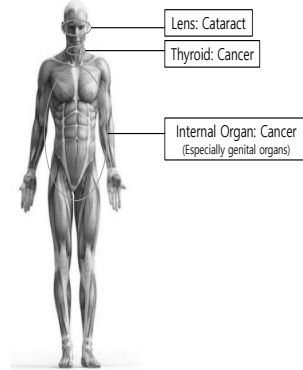
Radiation Exposure

TABLE 4.1 Effective Doses of Diagnostic X-ray Examinations and Environmental Background Phenomena

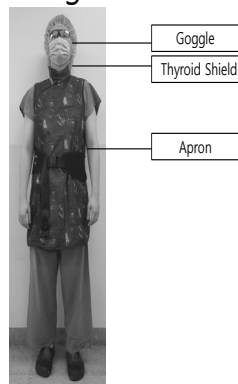
Medical Procedure	Effective Dose (mSv) Per Procedure
Chest x-ray	0.05-0.14
Lumbar spine	1.8
Thoracic spine	1.4
Barium upper GI study	2.0
Coronary angiogram (diagnostic)	0.6-23.2 (median 4.6)
Coronary intervention	1.0-37.0 (median 6.0)
Barium enema	6.4
Abdominal aortogram	6.0-10
Abdomen CT	8.8
Head CT	1.11-2.0
Environmental Source	Effective Dose (mSv) Per Year
Radiation exposure	2.0
Cosmic radiation	0.27
Long haul flight personnel	0.2-8.1
Ingested materials in food	0.39
Total average exposure	3.6
Regulatory dose limits for radiation workers	20



Protection Clothing



Protection Clothing



Radiation induced alopecia



General consideration

• Contrast media



Estimating creatinine clearance

Cockcroft & Gault equation
(modified)

$$\text{Men: CrCl} = \frac{1.23 \times (140 - \text{Age}) \times \text{Wt}}{\text{SrCr}}$$

$$\text{Women: CrCl} = \frac{1.04 \times (140 - \text{Age}) \times \text{Wt}}{\text{SrCr}}$$

CrCl = Creatinine clearance (ml/min)

Age (Years)

Wt = Weight (kg)

SrCr = Serum creatinine (micromole/L)

Ref: Ref: Cefalu CA. Clinical Pharmacology. In: Burke MM & Laramie JA. Primary Care of the Older Adult. 2000, p. 92.

General consideration

• Contrast media

For Prevention of contrast media induced nephropathy

: IV sodium bicarbonate

N-acetylcysteine 600mg 2 times/d P.O.

For prevention of anaphylaxis at 4 hours before treatment

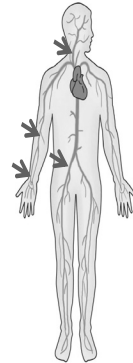
: prednisone 50 mg P.O

hydrocortisone 200 mg IV

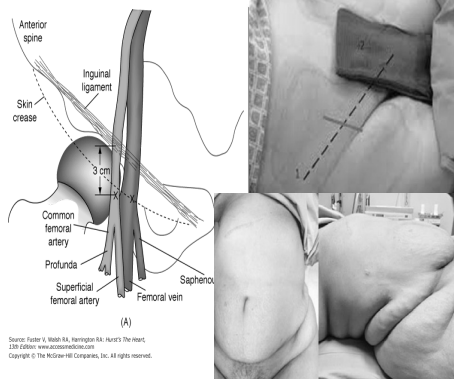
phenylamine etc.

Location of Puncture site

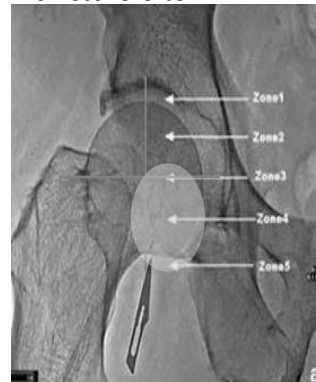
- Femoral Artery
- Radial Artery
- Brachial Artery
- Direct Carotid Artery



Level of Puncture site



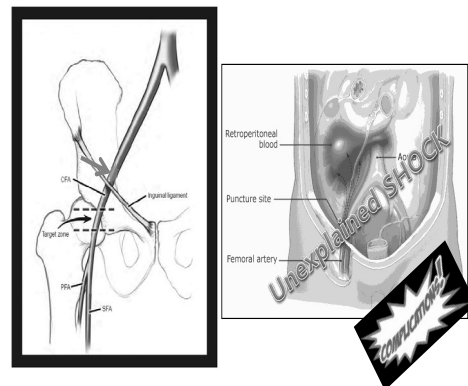
Level of Puncture site



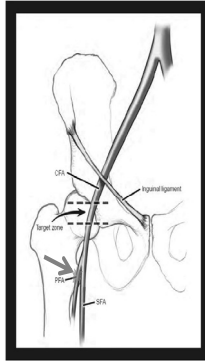
Level of puncture site



Incorrect puncture site



Incorrect puncture site



Pulsatile, painful mass on puncture site



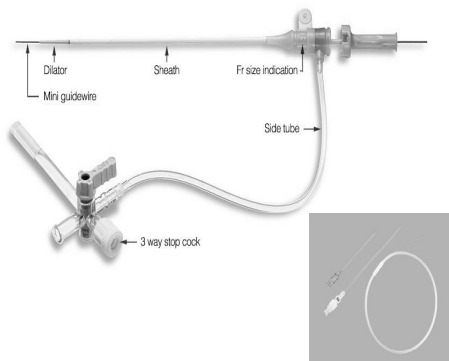
Pseudoaneurysm

Risk factors:

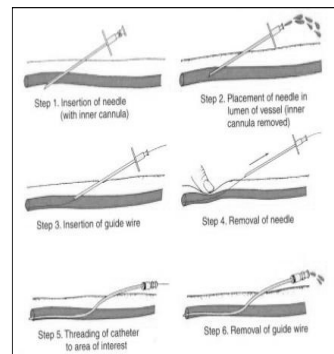
- Incomplete hemostasis
- Large bore sheath
- Anticoagulant
- Age > 65yrs
- Obesity
- Hypertension
- Peripheral arterial disease
- Incorrect puncture site



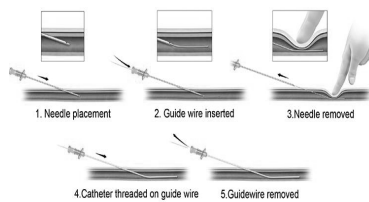
Introducer Sheath



Seldinger Technique



Single wall puncture



Source: Khaleel M. Elsayes, Sandra A. A. Odham: Introduction to Diagnostic Radiology: www.accessmedicine.com
Copyright © McGraw-Hill Education. All rights reserved.

Preparation



Femoral puncture



Guide wire and catheter

A catheter has to follow a road the guide wire has passed .



Guide wire and catheter

A catheter has to follow a road the guide wire has passed .

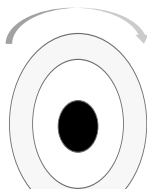


Aortography



Catheter movement

- Co-axial rotation



- Push and Pull

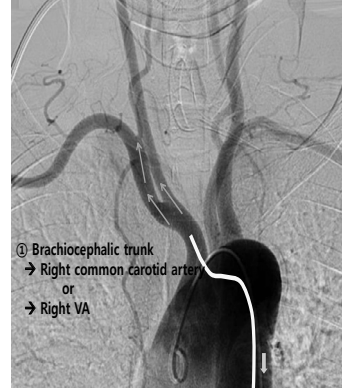
Branches Selection on Aortic Arch



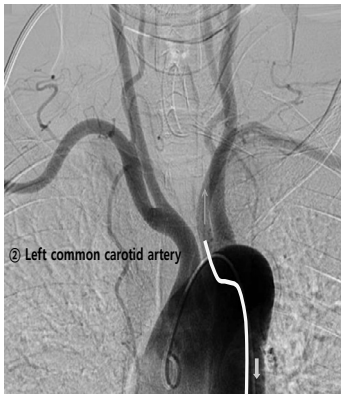
Branches Selection on Aortic Arch



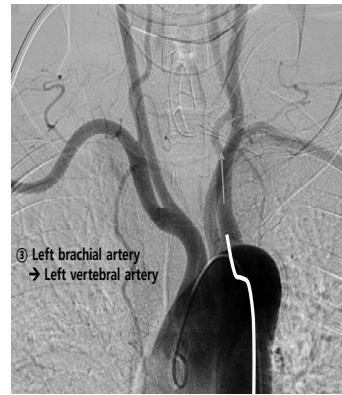
Branches Selection on Aortic Arch



Branches Selection on Aortic Arch



Branches Selection on Aortic Arch



Branches Selection on Aortic Arch



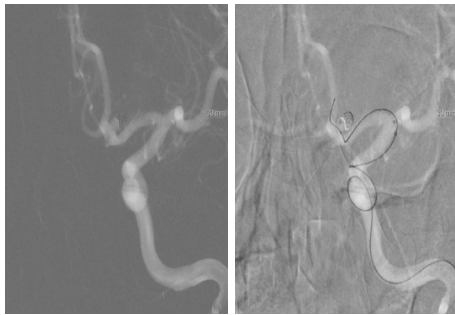
Road Map Technique



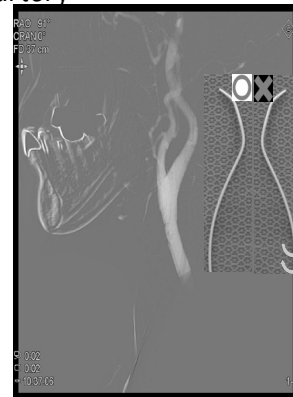
Most essential technique for intervention

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Road Map Technique



Carotid artery



Iatrogenic dissection



Iatrogenic vasospasm

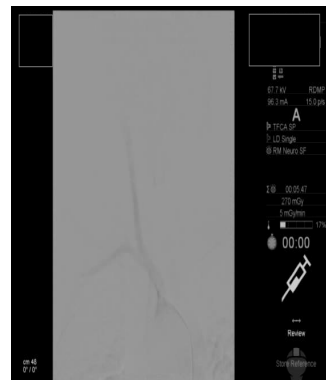


Contrast injection rate

TABLE 2.4 Suggested Injection Rates for Adults

Vessel	Linear Rise (sec)	Rate (cc/sec)	Total Volume (cc)
Common carotid	0.2-1	7-10	10-14
Common carotid for bifurcation disease	0.2-1	6-8	6-8
Common carotid for AVM	0.2-1	10	12-14
Internal carotid	0.5-1	6-8	8-10
Internal carotid with aneurysm and acute subarachnoid hemorrhage (SAH) (may be better done with common carotid injections or hand injections to reduce the risk of reuptaking the aneurysm)	0.5-1	4-6	6
External carotid proximal to facial artery	0-0.2	3	6-8
Total external carotid	0.5-1.0	2-3	6
Vertebral artery (may be better done by hand injection in the setting of a recently ruptured aneurysm)	0.5-1.0	4-5	10
Vertebral artery for AVM	0-0.2	5	10-12
Subclavian artery with sphygmomanometer cuff inflated	0-0.2	2	4-6
Cervical and thoracic trunks	0	1-2	4-6
Facial, lingual, occipital, ascending pharyngeal arteries	0	12-30	30-40
Aortic arch	0	2	4
Intercostal, lumbar arteries	0	6-10	10-12
Internal iliac arteries	0		

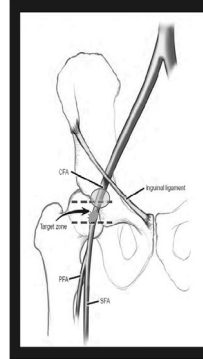
Right ICA



Hemostasis of Puncture site

- Manual compression
 - Safe
 - Economic
 - Available for re-puncture
 - But need compression and bed rest a longer time
- Instrumental compression
- Closing device

Manual compression



1. Proximal compression using 2 finger
2. Compression of minimal pressure without leakage of blood
3. Check pulsation of dorsalis pedis
4. For 20 minutes
5. Sandbag compression up to 6-8 hours



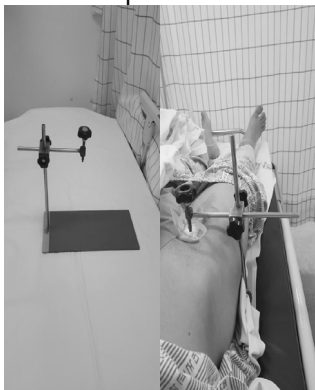
Hemostasis of Puncture site

- Manual compression
- Instrumental compression
- Closing device

Hemostasis of Puncture site

- Manual compression
- Instrumental compression
 - Convenient
 - Can keep constant pressure of compression
- Closing device

Instrumental compression



Instrumental compression



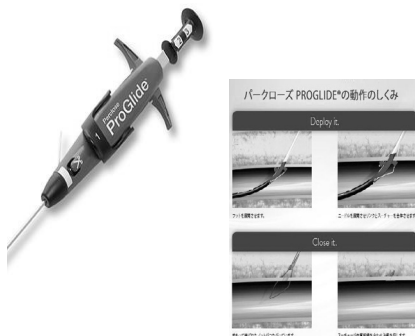
Hemostasis of Puncture site

- Manual compression
- Instrumental compression
- Closing device

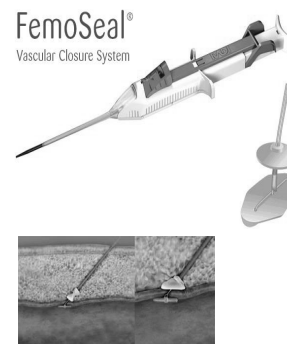
Hemostasis of Puncture site

- Manual compression
- Instrumental compression
- Closing device
 - Shorter closing time
 - Early ambulation (after 2hours)
 - But no available for repuncture within 3 mos
 - Risk of occlusion
 - If fail, massive bleeding will be occurred

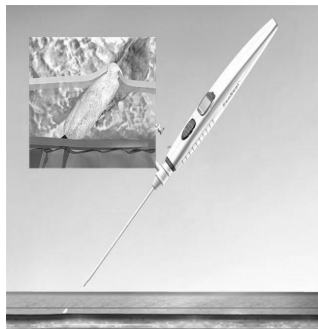
Closing device



Closing device

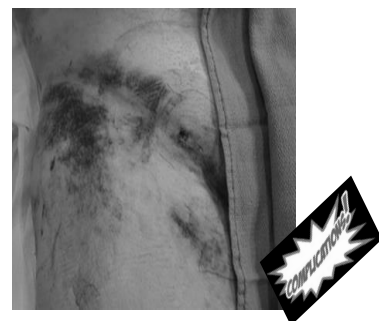


Closing device



Incomplete hemostasis

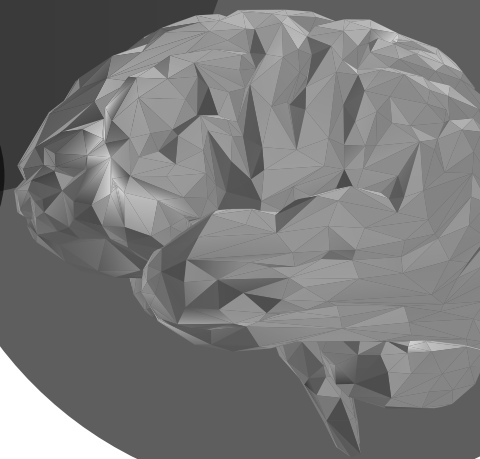
- Hematoma (most common) : Pain



The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/26(Sat.)

Basic endovascular training course

좌장 : 유승훈(울산대) / 장인복(한림대)

1. Imaging of carotid stenosis
2. Review of devices
3. Patient selection, technical tips and basic tactics
4. Escape from complicated situation

이아름(순천향대 영상의학과)

윤원기(고려대)

신병국(동원의료원)

김영우(가톨릭대)

Imaging of carotid stenosis

이 아 름

순천향대학교 부천병원 영상의학과

Carotid Stenosis Imaging: Imaging beyond the lumen

Aleum Lee

Department of Radiology

Soonchunhyang University Bucheon Hospital

2021.06.26

ASA/ACCF/AHA/AANN/ AANS/ACR/ASNR/CNS/SAIP/SCAI/ SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease

Developed in Collaboration with the American Academy
of Neurology and Society of Cardiovascular Computed
Tomography

Classification of Recommendations and Levels of Evidence

		SIZE OF TREATMENT EFFECT			
		CLASS I	CLASS IIa	CLASS IIb	CLASS III
		Benefit >>> Risk Proven/Treatment SHOULD be performed/ administered	Benefit >> Risk Additional studies with further evidence needed if IT IS REASONABLE to perform procedure/treatment Proven/Treatment SHOULD BE CONSIDERED	Benefit > Risk Additional studies with further evidence needed if IT IS REASONABLE to perform procedure/treatment Proven/Treatment MAY BE CONSIDERED	Benefit = Risk Additional studies with further evidence needed if IT IS NOT REASONABLE to perform procedure/treatment Proven/Treatment IS NOT RECOMMENDED
LEVEL A	Multiple populations consistent Data derived from multiple randomized clinical trials or meta-analysis	Recommendation that procedure or treatment is useful/effective Sufficient evidence from multiple randomized trials or meta-analysis	Recommendation in favor of treatment or procedure being useful/effective Sufficient evidence from multiple randomized trials or meta-analysis	Recommendation's usefulness/effectiveness has not been established Sufficient conflicting evidence from multiple randomized trials or meta-analysis	Recommendation that procedure or treatment is not useful/effective and may be harmful Sufficient evidence from multiple randomized trials or meta-analysis
	LEVEL B	Limited populations consistent Data derived from a single randomized trial or nonrandomized studies	Recommendation that procedure or treatment is useful/effective Evidence from single randomized trial or nonrandomized studies	Recommendation in favor of treatment or procedure being useful/effective Sufficient evidence from single randomized trial or nonrandomized studies	Recommendation's usefulness/effectiveness has not been established Sufficient conflicting evidence from single randomized trial or nonrandomized studies
LEVEL C	Lowest level of evidence Data derived from nonrandomized studies or expert opinion, case reports, case studies, or standard of care	Recommendation that procedure or treatment is useful/effective Only strong expert opinion, case studies, or standard of care	Recommendation in favor of treatment or procedure being useful/effective Only strong expert opinion, case studies, or standard of care	Recommendation's usefulness/effectiveness has not been established Only strong expert opinion, case studies, or standard of care	Recommendation that procedure or treatment is not useful/effective and may be harmful Only expert opinion, case reports, or standard of care
		Suggestive phrases for writing recommendations	should is recommended is indicated is preferred/effective	is reasonable can be considered/effective is probably recommended or indicated	may be considered may be reasonable usefulness/effectiveness is uncertain/unclear is not well established
Comparative effectiveness phrase*		Treatment strategy A is probably superior/effective to preference to treatment B Treatment A should be chosen over treatment B It is reasonable to choose treatment A over treatment B	Treatment strategy A is probably superior/effective to preference to treatment B Treatment A should be chosen over treatment B It is reasonable to choose treatment A over treatment B		

*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as gender, age, history of diabetes, history of prior myocardial infarction, history of heart failure, and prior aspirin use. A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important clinical questions addressed in the guidelines do not have answers to clinical trials. Even though randomized trials are not available, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.
The comparative effectiveness recommendations (Class I and IIa, Level of Evidence A and B only) studies that support the use of comparative verbs should involve direct comparisons of the treatments or strategies being evaluated.

Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

- Evaluation of Asymptomatic Patients at Risk of Extracranial Carotid Artery Disease

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Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis



In asymptomatic patients with known or suspected carotid stenosis, duplex US, performed by a qualified technologist in a certified laboratory, is recommended as the initial diagnostic test to detect hemodynamically significant carotid stenosis.



It is reasonable to perform duplex US to detect hemodynamically significant carotid stenosis in asymptomatic patients with carotid bruit.

Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



It is reasonable to repeat duplex US annually by a qualified technologist in a certified laboratory to assess the progression or regression of disease and response to therapeutic interventions in patients with atherosclerosis who have had stenosis greater than 50% detected previously. Once stability has been established over an extended period or the patient's candidacy for further intervention has changed, longer intervals or termination of surveillance may be appropriate.

Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



Routine serial imaging of the extracranial carotid arteries is not recommended for patients who have no risk factors for development of atherosclerotic carotid disease and no disease evident on initial vascular testing.

Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

• Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of Extracranial Carotid Artery Disease

Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD



The initial evaluation of patients with transient retinal or hemispheric neurological symptoms of possible ischemic origin should include noninvasive imaging for the detection of ECVD.



Duplex US is recommended to detect carotid stenosis in patients who develop focal neurological symptoms corresponding to the territory supplied by the left or right internal carotid artery.

Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



When an extracranial source of ischemia is not identified in patients with transient retinal or hemispheric neurological symptoms of suspected ischemic origin, CTA, MRA, or selective cerebral angiography can be useful to search for intracranial vascular disease.



When the results of initial noninvasive imaging are inconclusive, additional examination by use of another imaging method is reasonable. In candidates for revascularization, MRA or CTA can be useful when results of carotid duplex US are equivocal or indeterminate.

Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD



Routine, long-term follow-up imaging of the extracranial carotid circulation with carotid duplex US is not recommended (Class III; Level of Evidence B). (New recommendation)

CAS vs. CEA



- It is reasonable to consider patient age in choosing between CAS and CEA. For older patients (ie, older than ≈70 years), CEA may be associated with improved outcome compared with CAS, particularly when arterial anatomy is unfavorable for endovascular intervention. For younger patients, CAS is equivalent to CEA in terms of risk for periprocedural complications (ie, stroke, MI, or death) and long-term risk for ipsilateral stroke (Class IIa; Level of Evidence B).

Relative Indications for CEA vs. CAS

- Carotid Endarterectomy
 - Calcified carotid plaque
 - Antiplatelet agent intolerance
 - Calcified or tortuous aortic arch
- Carotid Artery Stent
 - High carotid bifurcation
 - Prior neck radiation
 - Recurrent stenosis following prior CEA
 - High cardiac risk of general anesthesia
 - Younger patients
 - Contralat. occlusion with symptomatic perfusion deficits

Role of Imaging study for Carotid stenosis

- Risk Assessment
 - Carotid plaque morphology
 - Carotid stenosis
- Peri-/post-procedural Complication
- Clinical outcome
 - Ischemic infarction
 - Re-stenosis
 - Improvement of cerebral perfusion state (CBF) after CEA or CAS
 - Evaluation of progression of high-risk plaque

Risk Assessment – USG/ MRI

- **Carotid plaque morphology**
Ulcerated carotid plaque increasing degree of carotid stenosis, and longer carotid lesions are aspects of carotid disease associated with increased risk for stroke
- **Degree of carotid artery stenosis**

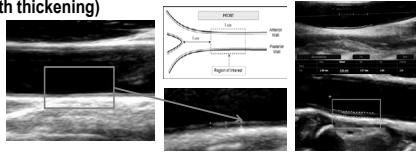
Carotid USG

research

- **Carotid plaque area & IMT in prediction of first-ever ischemic stroke: a 10-yr FU of 6584 men & women: the Tromsø Study.**
Stroke 2011; 42: 972-978
- **CCA IMT progression as a predictor of stroke in multi-ethnic study of atherosclerosis.**
Stroke 2011; 42: 3017-3021
- **Value of carotid IMT and significant carotid stenosis as markers of stroke recurrence.**
Stroke 2011; 42: 3099-3104

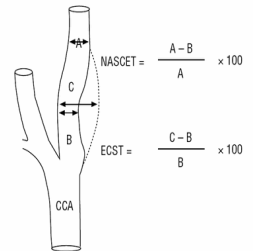
Intima-media thickness (IMT)

- Distance between blood-intima interface and media-adventitia interface
- Imaging surrogate marker of systemic atherosclerosis
- Imaging approaches:
 - Distal CCA (1cm), far wall, end-diastolic image
 - IMT hyperplasia (> 1mm, loss of hypoechoic component of the IMT with thickening)



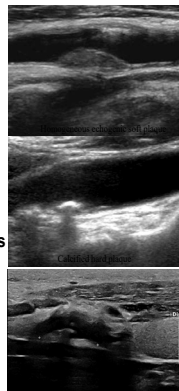
Stenosis evaluation

- NASCET (North American Symptomatic Carotid Endarterectomy Trial) method (*)
- ECST (European Carotid Surgery Trial) method



Plaque Characterization

- **Homogeneous**
 - Uniform echo pattern and smooth surface
 - Fibrous (soft) / Calcified (hard)
- **Heterogeneous**
 - Complex echo pattern (>50% sonolucency)
 - Intra-plaque hemorrhage or ulceration
 - Unstable, potential for embolic ischemic attacks

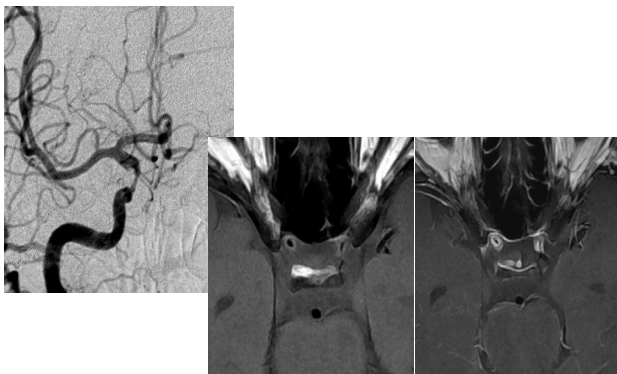


Lumen vs. Wall

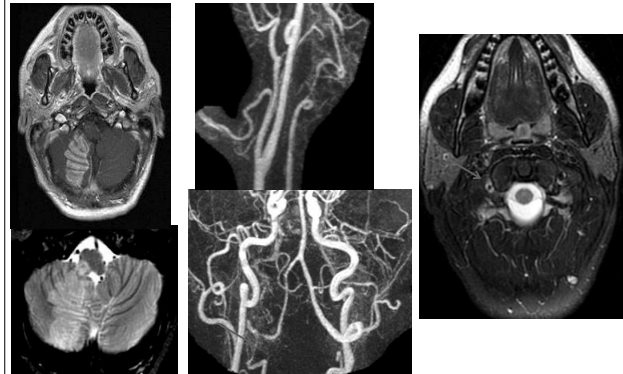
Indicator of stenosis

- **Stenosis degree**
- **Plaque composition**
- **Remodelling**
- **Inflammation**
- **Limitation**
 - Uncovering plaque size & volume (underestimation due to remodeling)
 - Not characterize plaque component

Lumen vs. Wall

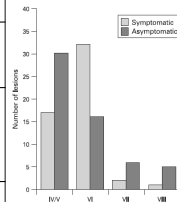


Lumen vs. Wall



Modified American Heart Association (AHA) criteria

Type I/II	near normal wall thickness, no calcification
Type III	diffuse intimal thickening or small eccentric plaque with no calcification
Type IV/V : at risk lesion with LRNC	plaque with a lipid or necrotic core surrounded by fibrous tissue with possible calcification
Type VI : most important	complex plaque with possible surface defect, hemorrhage or thrombus
Type VII	calcified plaque
Type VIII	fibrotic plaque without lipid core and possible small calcifications



J Neurol Neurosurg Psychiatry
2008;79:905-912

High risk plaque

- Lipid rich necrotic core
- IPH

In Vivo Accuracy of Multispectral Magnetic Resonance Imaging for Identifying Lipid-Rich Necrotic Cores and Intraplaque Hemorrhage in Advanced Human Carotid Plaques

Circulation. 2001;104:2051-2056

- 18 patients scheduled for carotid endarterectomy
- Preop MRI at 1.5T (within 1 week), TOF, T1WI, PD, and T2WI.
- Matched histological sections of the excised specimen
- Overall accuracy of multispectral MRI was 87% (80% to 94%), sensitivity was 85% (78% to 92%), and specificity was 92% (86% to 98%).
- Good agreement between MRI and histological findings, with a value of $k = 0.69$ (0.53 to 0.85).

Methods used for spatial correlation between MR images and histological slices

- Patients scheduled for carotid endarterectomy
- Preoperative carotid MRI
- Distance from carotid bifurcation

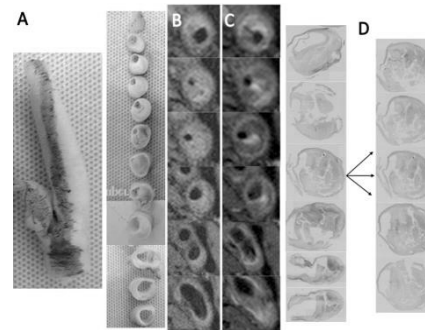


TABLE 1
Contrast at MR Imaging of Main Components of Atherosclerotic Plaque

Plaque Component	TOF	T1 Weighted	Intermediate Weighted	T2 Weighted
Recent hemorrhage	High	High to moderate	Variable	Variable
Lipid-rich necrotic core	Moderate	High	High	Variable
Intimal calcification	Low	Low	Low	Low
Fibrous tissue	Moderate to low	Moderate	High	Variable

Note.—Tissue contrast is relative to signal intensity of sternocleidomastoid muscle.

Yuan, C, et al. Radiology 2001;221:285-299

Concept of CE-VWI

- Gd-clearance is delayed in carotid AS- plaques with thin fibrous caps (< 60 μ m): inflammation and endothelial dysfunction *Wasserman 2002*
- Delayed enhancement of coronary vessel wall in patients with CAD *Maintz 2006; Yeon 2007*
- Enhanced contrast uptake in the coronary vessel wall of patients 6 days after AMI and decreased 3 months later parallel to the declines in CRP

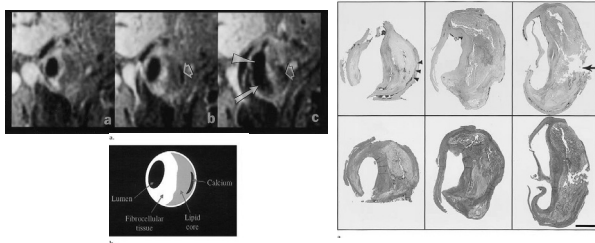
Ibrahim 2009

ASCENT 2021

Carotid Artery Atherosclerosis: In Vivo Morphologic Characterization with Gadolinium-enhanced Double-oblique MR Imaging—Initial Results¹

Radiology 2002; 223:566–573

- In our cases, the enhancing tissue clearly corresponded to areas of fibrosis. Enhancement of fibrous tissue has long been observed with MR imaging.



Inflammation in Carotid Atherosclerotic Plaque : A Dynamic Contrast-enhanced MR Imaging Study

Radiology 2016; 241:459-468

- To prospectively evaluate if there is an association between plaque enhancement at MR imaging and proinflammatory cardiovascular risk factors and plaque content.
- Strong CE suggests the presence of a vascular supply to the plaque and increased endothelial permeability that facilitates the entry of the contrast agent from the blood plasma. Because neovasculature growth into the plaque and increased endothelial permeability are associated with plaque inflammation, plaque enhancement has been argued to be a sign of plaque inflammation.

Inflammation in Carotid Atherosclerotic Plaque : A Dynamic Contrast-enhanced MR Imaging Study

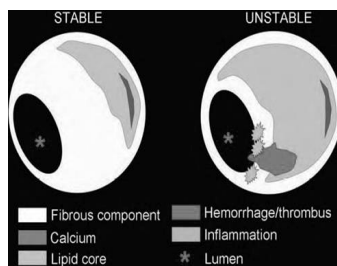
Radiology 2016; 241:459-468

- Such a link has considerable clinical potential because inflammation has been linked to an increased risk of clinical vascular events. Plaque inflammation may have multiple effects that weaken plaque structural integrity, including inhibition of collagen production and dissolution of the fibrous matrix by means of matrix metalloproteinases. If plaque enhancement is a sign of inflammation, then CE MRI may be a tool for detecting plaque inflammation prior to fibrous cap disruption (not proved histopathologically). Wasserman et al and Yuan et al both proposed that patchy CE in advanced plaques might be indicative of increased inflammatory activity.

Clinical and histological significance of gadolinium enhancement in carotid atherosclerotic plaque

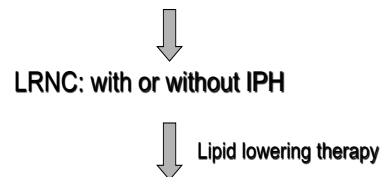
Stroke 2012 43(11): 3023-3028

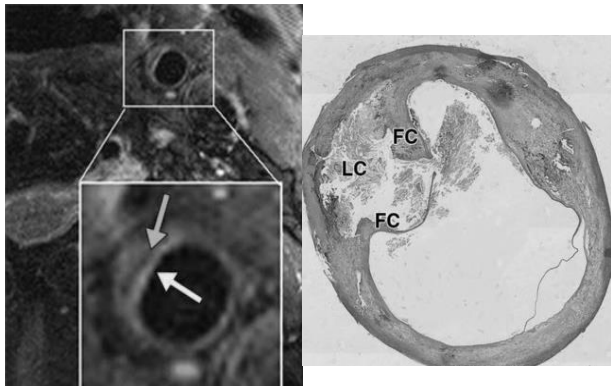
- This is one of the first studies to confirm that gadolinium enhancement is more frequent in symptomatic plaque and associated with vulnerable plaques according to standard histological classifications (ATA)- spatial association of CE with inflammation and neovascularization



Lipid Rich Necrotic Core

- T2: low signal + T1 and PD: Iso
- Contrast-enhanced MR: No enhanced area





MRI techniques

- Specialized sequences targeting specific components

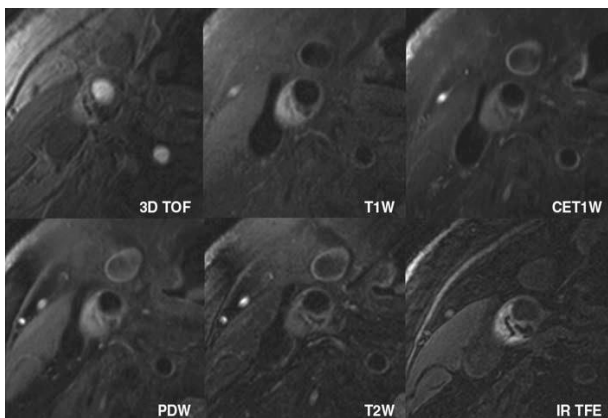
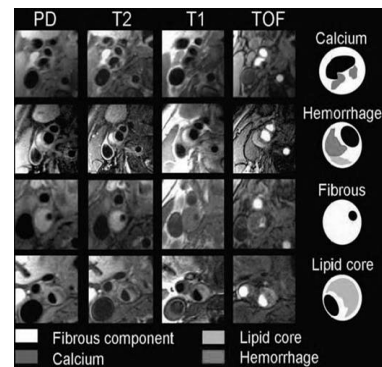
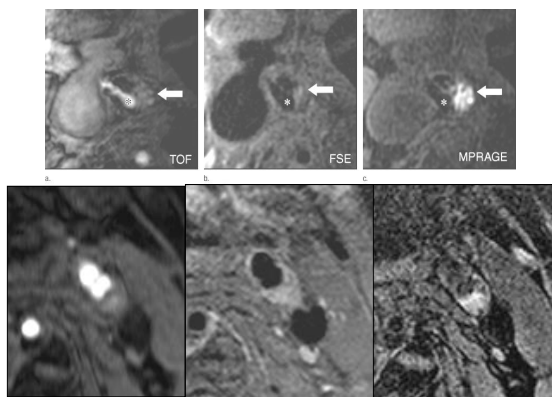
1. IPH

- Methemoglobin, shortened longitudinal relaxation constant T1, hyperintensity property on T1WI, TOF
- MP-RAGE : sensitivity of 80% and specificity of 97%

Radiology 2010; 254:551-563

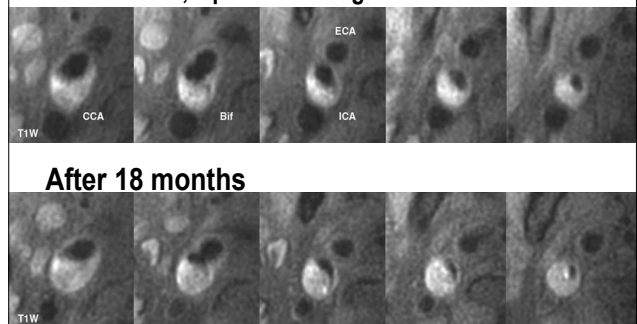
IPH

Radiology, 2010 Feb;254(2):551-63.



JACC 2009; 2:883-89

IPH , a potent atherogenic stimulus



Circulation 2005; 111:2768-277

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Hemorrhage in the Atherosclerotic Carotid Plaque: A High-Resolution MRI Study

Stroke. 2004;35:1079-1084

- Purpose: to develop criteria for the identification of the stages of intraplaque hemorrhage using high-resolution MRI
- 27 patients, scheduled for CEA, 1.5T (TOF, T1W, PD, T2W)
 - 13 patients: TIA or stroke 90 days before surgery
 - 14 patients: asymptomatic with a carotid stenosis >70%
- IPH: fresh, recent, and old categories
- Histologic identification and staging of hemorrhage :145/189 (77%)
- MRI detected intraplaque hemorrhage with high sensitivity (90%) but moderate specificity (74%).
- Moderate agreement in classifying stages occurred between MRI and histology (Cohen 0.7, 95% CI: 0.5 to 0.8 for reviewer 1 and 0.4, 95% CI: 0.2 to 0.6 for reviewer 2), with moderate agreement between the 2 MRI readers (0.4, 95% CI: 0.3 to 0.6).

Prevalence of High-Risk Plaque Features

- High-risk plaque in minimal to moderate stenosis : Type VI lesions
 - in 1/3 with asymptomatic 50-79% stenosis
 - and 1/10 with 16-49% stenosis
- Numerous studies compared the prevalence of high-risk features in symptomatic vs asymptomatic plaques
 - thin fibrous caps, IPH, ulceration, Gd enhancement of adventitia, type VI lesion : significant

Plaque Characteristics and Clinical Outcome

- Prospective observational studies
- 154 subjects with 50–79% carotid stenosis, asymptomatic, mean f/u period of 38.2 months
- 12 patients developed cerebrovascular events (4 strokes and 8 TIAs)
- Associations between ischemic events and
 - thin or ruptured fibrous cap (17.0; $P < 0.001$)
 - IPH (hazard ratio, 5.2; $P = 0.005$)
 - larger mean necrotic core area (hazard ratio for 10mm² increase, 1.6; $P = 0.01$)
 - maximal wall thickness (hazard ratio for 10mm² increase, 1.6; $P = 0.01$)

Stroke 2006; 37:818–822

Plaque Characteristics and Clinical Outcome

- The importance of IPH in predicting cerebrovascular complications
 - 1) 91 subjects with 50–70% carotid stenosis, asymptomatic, mean f/u period of 25 months
 - 6 cerebrovascular events occurred
 - IPH at baseline (hazard ratio, 3.6; $P < 0.001$)
 - 2) 64 subjects with 30-69% carotid stenosis, symptomatic, mean f/u period of 28 months
 - At 39 IPH → 13 developed ipsilateral ischemic events (hazard ratio, 9.8; $P = 0.03$)
 - No baseline IPH → only one TIA

Radiology 2009; 252:502–508

J Vasc Surg 2008; 47:337–342

Plaque Characteristics and Complication

- The importance of IPH in choosing treatment options
 - 1) The existence of hyperintense signal on T1 WI of carotid lesions
 - 56 patients undergoing carotid artery stenting (CAS)
 - 25 patients undergoing CEA
 - silent ischemic lesions, 61% in CAS, 13% in CEA, $P = 0.006$
- 2) Among 112 patients undergoing CAS,
 - Hyperintense signals consistent with IPH on TOF images, higher likelihood of periprocedural symptoms (embolism) 7/38, 18.4% vs 1/74, 1.4%, $P = 0.003$

Atherosclerosis 2011; 215:399–404

Stroke 2011; 42:3132–3137

Complication

High-Intensity Signal on Time-of-Flight Magnetic Resonance Angiography Indicates Carotid Plaques at High Risk for Cerebral Embolism During Stenting

Shinichi Yoshimura, MD, PhD*, Kyofumi Yamada, MD*, Masaru Kawasaki, MD, PhD, Takahiko Kawanishi, MD, Shunichi Kawanishi, MD, Masahito Takemura, MD, Akira Imai, MD, PhD, Tetsu Iwama, MD, PhD

Background and Purpose: A single distribution of carotid artery stenosis (CAS) is not enough to predict cerebral embolism during CAS. Thus, identifying a single method to discriminate high-risk plaques on periprocedural magnetic resonance imaging and periprocedural ischemic symptoms were evaluated.

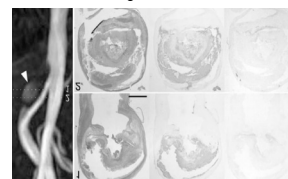
Results: The prevalence rate of carotid artery stenosis (CAS) was significantly higher in high-risk plaques (14.9%–15.9%) than in low-risk plaques (0.9%–1.9%; $P < 0.0001$). Periprocedural ischemic symptoms on different magnetic resonance imaging in high-risk plaques (CAS) (15.9%) than in low-risk plaques (CAS) (1.9%; $P = 0.002$). Periprocedural ischemic symptoms were more frequently observed in high-risk plaques (CAS) (15.9%) than in low-risk plaques (CAS) (1.9%; $P = 0.002$). Multivariate logistic regression analysis identified IPH on TOF-MRA as an independent predictor of periprocedural ischemic symptoms (odds ratio, 15.08; 95% confidence interval, 1.76–128.0).

Conclusion: High-risk plaques on TOF-MRA performed for screening carotid stenosis plaques at high risk for cerebral embolism during CAS. (Stroke. 2011;42:3132–3137)

Key Words: carotid artery stenosis • carotid stenosis • risk factors • stenting

A: Through carotid artery stenosis (CAS) is the threshold. B: Taking a single method to discriminate plaques at high risk.

- High SI in the plaques on MRA
 - Associated with intraplaque hemorrhage and MQ infiltration on pathological analysis
 - Associated with ischemic lesions on DWI and ischemic symptom after carotid stenting



Complication

High-Intensity Signal on Time-of-Flight Magnetic Resonance Angiography Indicates Carotid Plaques at High Risk for Cerebral Embolism During Stenting

Shinichi Yoshimura, MD, PhD*, Kazuhiko Yamada, MD*, Masaru Kawanishi, MD, PhD, Takahiro Asano, MD, Masahiko Kawanishi, MD, Masahiko Takakura, MD, Akira Imai, MD, PhD, Taro Imai, MD, PhD

Background and Purpose: In a large retrospective study of carotid artery stenting (CAS), the increased risk of cerebral embolism, thus, establishing a single method to discriminate high-risk plaques or progressive embolic embolism is important. The present study examined whether high-intensity signal (HIS) in the plaque on time-of-flight (TOF) MRA, performed for screening, can discriminate plaques at high risk for cerebral embolism during CAS.

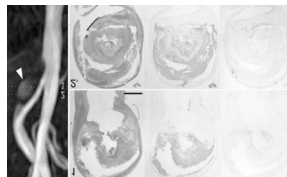
Methods: In the 31 patients treated using carotid endarterectomy, relationships between pathological findings of the plaque and TOF-MRA findings were analyzed. In the 12 patients treated using CAS, postoperative ipsilateral ischemic lesions on diffusion-weighted imaging and postoperative ischemic symptoms were analyzed.

Results: The percentage of embolic embolism (percentage of embolism) was significantly larger in HIS-positive plaques (34.3% vs 15.4%) than in HIS-negative plaques (15.4% vs 15.4%, $P=0.001$). Postoperative ischemic lesions on diffusion-weighted imaging were more frequent in the HIS-positive plaques (27.9% vs 15.4% than in the HIS-negative plaques (15.4% vs 15.4%, $P=0.001$). Postoperative ischemic symptoms were more frequently observed in HIS-positive plaques (27.9% vs 15.4% than in HIS-negative plaques (15.4% vs 15.4%, $P=0.001$). Multivariate logistic regression analysis identified HIS on TOF-MRA as an independent predictor of postoperative ischemic symptoms (odds ratio, 13.08; 95% confidence interval, 1.76–1026).

Conclusions: HIS on TOF-MRA performed for screening could discriminate plaques at high risk for cerebral embolism during CAS. (Stroke. 2001;42:3132–3137)

Key Words: carotid endarterectomy • carotid stenosis • risk factors • stenting

A: Through carotid endarterectomy (CEA) to be established. B: Using a single method to discriminate plaques at high risk.



- Reperfusion injury – HARM sign
 - Associated with intraplaque hemorrhage and MQ infiltration on pathological analysis
 - Associated with ischemic lesions on DWI and ischemic symptom after carotid stenting

Complication : reperfusion injury HARM sign

- HARM (+) other than stroke
- Any situations which makes BBB disruption
 - with transient hemodynamic alterations, besides acute ischemia or reperfusion injury
 - 1) Cardiac surgery : 50% after cardiac surgery
 - 2) Carotid stenting : 60% after CAS
 - 3) Post-seizure
 - 4) Hemianopsia in nonketotic hyperglycemia

Stroke 2011; 42:3132–3137

Complication : reperfusion injury HARM sign

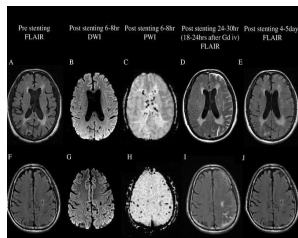
Simple consequence of Gd leakage through disrupted BBB in the normal perfusion state

- Mild form of reperfusion injury instead of hyperperfusion syndrome (HPS) in CAS or CEA

- Imaging finding

: not observed sulcal hyper-SI before stenting
- appeared after contrast injection during intervention (stent insertion)
- rapidly disappeared within several hours to days

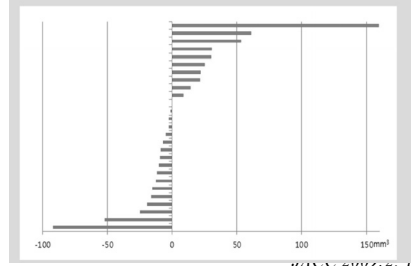
- Clinical course
 - Reversible neurological deterioration
 - Cause : transient reversible diffuse hemispheric disruption of BBB
 - Symptomatic HARM (+)



Clinical Outcome

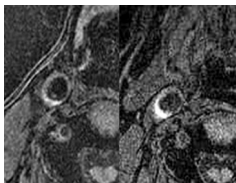
Dynamic Change of Carotid Intraplaque Hemorrhage Volume in Subjects with Mild Carotid Stenosis

• median follow-up time of patients: 33.3 months; 25 pts.

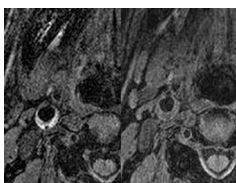


1381-1389

Clinical Outcome



A 75-year old man with IPH progression after 33 months. (Rt) Baseline. (Lt) MR imaging after 33 months.



A 75-year old man with IPH regression after 69 months. (Rt) Baseline. (Lt) MR imaging after 40 months.

JACC 2009;2: 1381-1389

Plaque Characteristics and Clinical Outcome

- Hypothesis: IPH, a potent atherogenic stimulus
- 29 patients, at baseline and f/u MRI (18 months)
- : volume of wall, lumen, necrotic core, IPH
- IPH at baseline, markedly accelerated progression in
 - wall volume (6.8% vs -0.15%, $P=0.009$)
 - LR-NC (28.4% vs -0.15%, $P=0.001$)
 - new plaque hemorrhages (43% vs 0%, $P=0.006$)
- 67 asymptomatic patients with 16–49% stenosis, IPH, accelerated progression in carotid wall volume (44.1 ± 36.1 vs 0.8 ± 34.5 mm³ per year, $P < 0.001$).

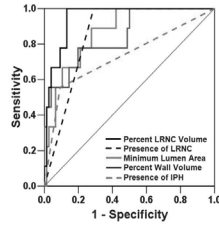
Circulation 2005; 111:2768-2775

JACC 2009;2: 1381-1389

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Plaque Characteristics and Clinical Outcome

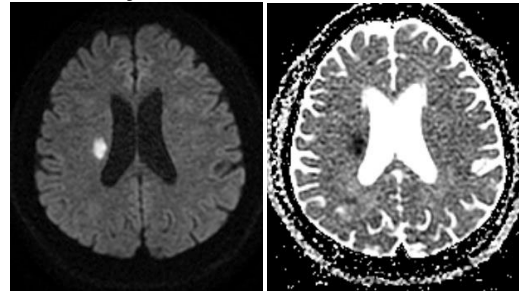
- Baseline plaque characteristics associated with important pathologic changes during 36 month f/u
- 108 asymptomatic Pt with 50-79% stenosis
- At baseline, 21.3% (23/108) with surface disruption
- After 3 years, 10.6% (9/85) with new surface disruption
- Size of the LR-NC at baseline, the strongest predictor (AUC: 0.95)
- IPH, weaker classifier (AUC=0.73)



AJNR 2010; 31:487-493

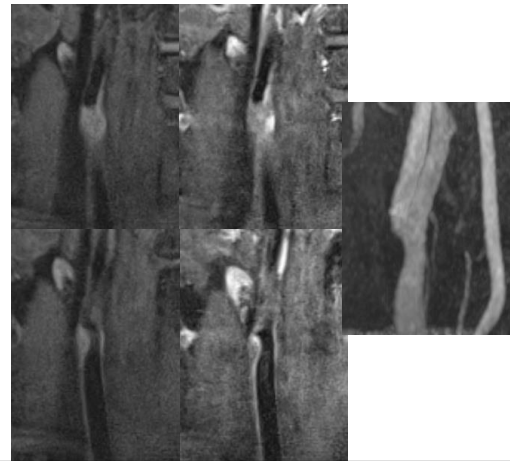
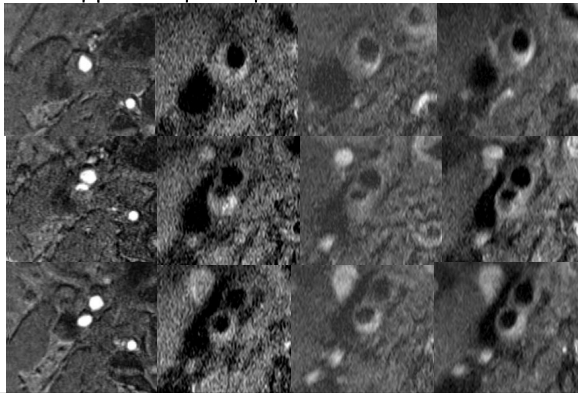
Case 1

- 61/M, dysarthria



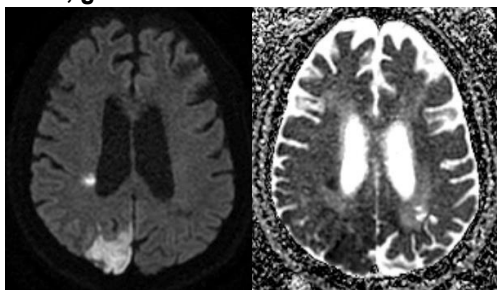
Case 1

- TOF, preT1WI, T2WI, T1CE

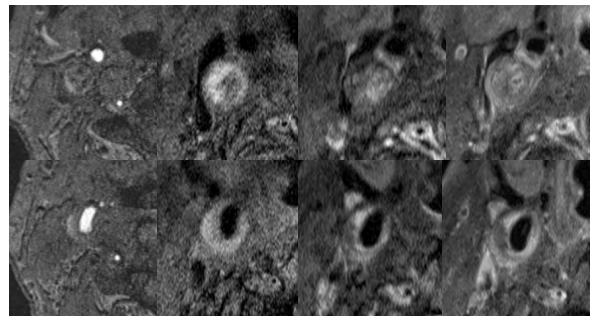


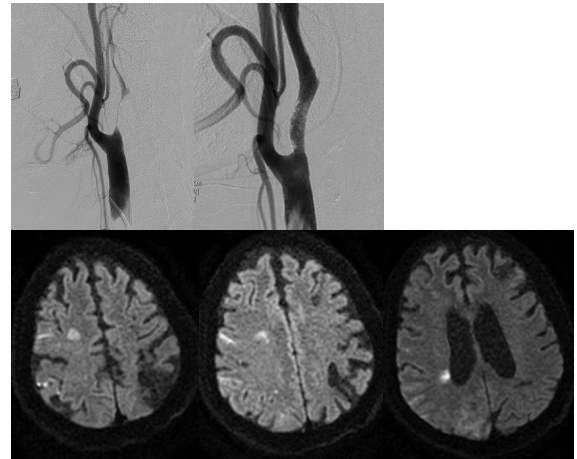
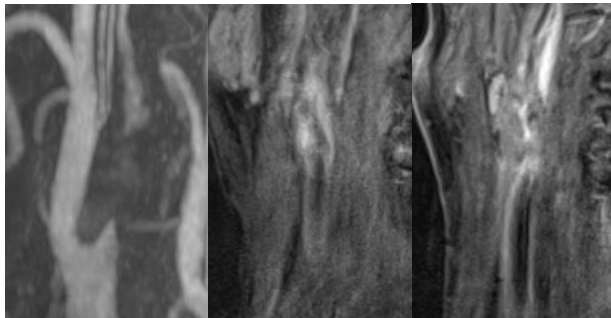
Case 2

- 62/M, gait disturbance



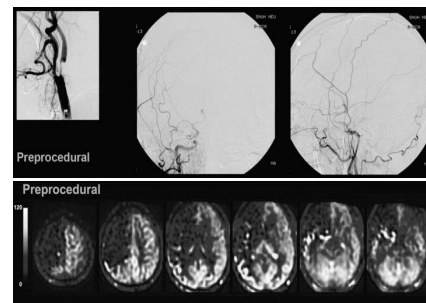
- TOF, preT1WI, T2WI, T1CE



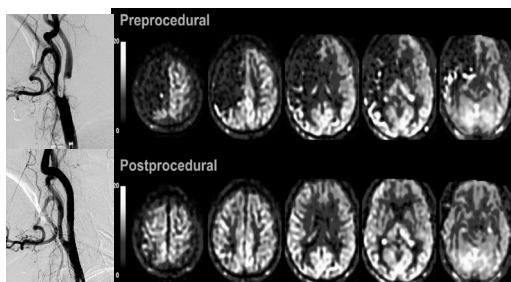


ASL perfusion MRI

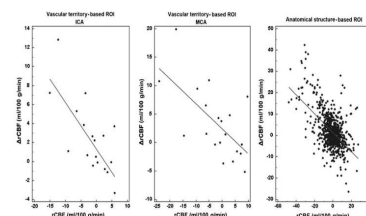
- Identification of brain tissue at risk for ischemia has obvious benefits in operative planning and postoperative follow-up
- ASL in carotid artery stenosis
 - Identification of CBF
 - Identification of collaterals : intra-arterial signal
 - Identification of postoperative change : repeatability



Courtesy of Prof. Yun, SNUH



Courtesy of Prof. Yun, SNUH

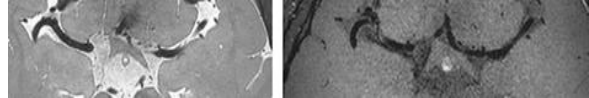


- Basal CBF impairment $\propto$ CBF benefit after carotid artery stenting
- Greater perfusion deficits prior to stenting have greater improvement in perfusion after stenting

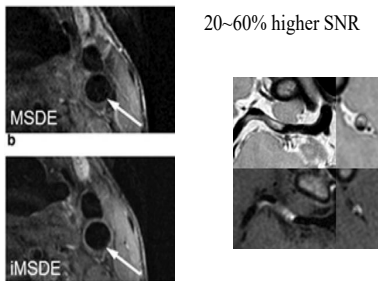
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Challenges

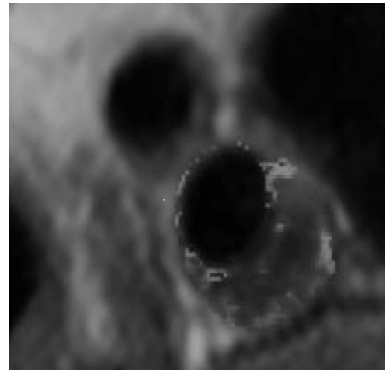
High resolution : better delineation of vessel wall



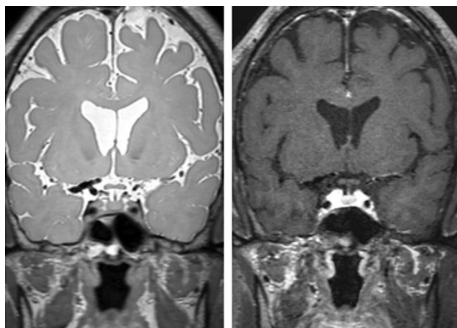
High resolution : better delineation of vessel wall



Neovascularization : perfusion MRI - inflammation



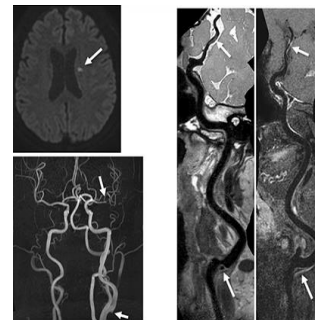
Coverage-whole brain



Low resolution : hard to delineation vessel wall

Simultaneous carotid-intracranial vessel wall imaging

- FOV: 19cm
- 5m 19s



Simultaneous carotid-intracranial vessel wall imaging

RESEARCH

Open Access



Co-existing intracranial and extracranial carotid artery atherosclerotic plaques and recurrent stroke risk: a three-dimensional multicontrast cardiovascular magnetic resonance study

Yilan Xu¹, Chun Yuan^{2,3}, Zichen Zhou², Le He², Donghua Ma³, Rui Li², Yuanxian Cui², Yilong Wang^{4,5}, Yongjun Wang^{6*}, Gailen Liu^{6*}, Zhaoshuo Zheng⁶ and Xihai Zhao^{6*}

Abstract

Background: As a systemic disease, atherosclerosis commonly affects intracranial and extracranial carotid arteries simultaneously which is defined as co-existing plaques. Previous studies demonstrated that co-existing atherosclerotic diseases are significantly associated with ischemic cerebrovascular events. The aim of this study was to investigate the characteristics of co-existing intracranial and extracranial carotid atherosclerotic plaques and their relationships with recurrent stroke by using 3D multi-contrast magnetic resonance (MR) vessel wall imaging.

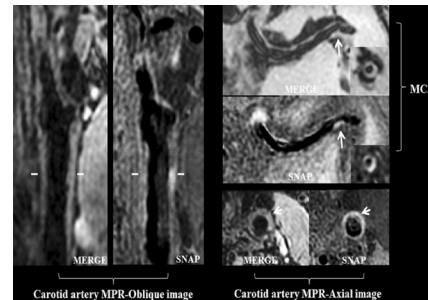
Methods: Patients with recent cerebrovascular symptoms in anterior circulation and at least one carotid plaque were recruited. All patients underwent cardiovascular magnetic resonance (CMR) for brain and intracranial and extracranial arteries. Presence/absence of atherosclerotic plaque at each arterial segment was identified. The maximum wall thickness (Max WT), length, stenosis of each plaque was measured. The presence/absence of calcification, lipid-rich necrotic core (LRNC), and intraplaque hemorrhage (IPH) was assessed. Cerebral old and acute infarcts in anterior circulation were evaluated.

Results: Fifty-eight patients (mean age: 58.3 ± 8.5 years old, 34 males) were recruited. Of the 58 patients, co-existing intracranial and extracranial carotid artery plaques were found in 45 patients (77.5%), of which 7 (15.6%) had first time acute stroke and 20 (44.4%) had recurrent stroke. For these 33 patients with stroke, the number of intracranial plaques (OR = 11.26; 95% CI, 1.27–102.0; $p=0.039$) and co-existing intracranial and extracranial carotid artery plaques (OR = 2.42; 95% CI, 1.04–5.64; $p=0.042$) was significantly associated with recurrent stroke. After adjusting for traditional risk factors, the number of co-existing plaques was still significantly correlated with recurrent stroke (OR = 3.33; 95% CI, 1.09–10.08; $p=0.035$). No correlations were found between recurrent stroke and Max WT, length, stenosis, and compositions of plaques.

Conclusions: Co-existing intracranial and extracranial carotid artery plaques are prevalent in symptomatic patients and the number of co-existing plaques is independently associated with the risk of recurrent stroke.

Keywords: Intracranial artery, Carotid artery, Atherosclerosis, Cardiovascular magnetic resonance, Recurrent stroke

Simultaneous carotid-intracranial vessel wall imaging



Take home message

- Carotid plaque features identifiable by Vessel Wall MRI are closely linked to the development of ischemic events and outcome in patient with carotid stenosis.
- Carotid MRA and brain MRI helps predict complication of CAS or CAE.

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Thank you for your attention!

Review of devices

윤원기

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KOREA UNIVERSITY



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Korea University Medical Center

ASCENT 2021

Currently Available Devices for CAS

in Korea

Korea University Medical Center, Seoul, Korea
Neurosurgery,
Wonki Yoon MD, PhD



90 YEARS OF
KOREA UNIVERSITY
MEDICINE

Disclosure
NONE

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Consideration Points during CAS

- Access
 - Tortuosity
 - Type of aortic arch
 - Selection of guiding catheter
- Age over 70 – CAS vs CEA
- Plaque
 - Soft vs Hard Calcified
 - Vulnerable vs Stable
 - Embolic complication, passage, restoration of vessel diameter
- Predilation or Postdilation
- Selection of Balloon
 - Stent design
 - Stent size
 - Stent profile for passage
- Selection of Stent
 - Protection vs No-protection
- Selection of protection device
 - Filter vs Membrane
 - Distal vs Proximal

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CREST (CAS performed with RX Acculink)

Table 2. Composite Primary End Point and Components of the Primary End Point

	4-Year Study Period (Including Periprocedural Period*)		Absolute Treatment Effect of CAS Versus CEA (95% CI) Percentage Points	P†
	CAS (N=1262)	CEA (N=1240)		
Stroke				
Any stroke	105 (10.2±1.1)	75 (7.9±1.0)	2.3 (-0.6 to 5.2)	0.03
Major (ipsilateral)	16 (1.4±0.3)	6 (0.5±0.2)	0.8 (0.1 to 1.6)	0.05
Minor (ipsilateral)	52 (4.5±0.6)	36 (3.5±0.6)	1.0 (-0.7 to 2.7)	0.10
Primary end point (any periprocedural stroke, myocardial infarction, or death or post procedural (ipsilateral stroke))	85 (7.2±0.8)	76 (6.8±0.8)	0.4 (-1.7 to 2.6)	0.51

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Guiding Catheter

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WK YOON

FEATURE	IDEAL CHARACTERISTIC	INTENDED BENEFIT
Braided construction	Torqueable	1:1 torque control for excellent maneuverability , pushability, and kink resistance
Proprietary Polymer Technology	Trackable	Excellent curve retention and back-up support
Large Lumens & PTFE liner	Device Compatibility	Large working channel with smooth lubricous surface to facilitate smooth device passage
Stainless Steel Braid & Tungsten Tip	Radiopaque	High visibility for easy, accurate placement
Soft Tapered Tip	Atraumatic Tip	Atraumatic access, and gentle engagement
Variety of Tip Shapes (16)	Large Selection	More clinical choices with excellent back-up support.

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Standard Guide	Guide with Flow control	Standard Sheath	Premium Sheath
Guider Softip XF (Stryker)	FlowGate2 (Stryker)	Shuttle (Cook)	AXS Infinity LS Long Sheath (Stryker)
Benchmark (penumbra)	Merci (Stryker)	Raabe (Cook)	Neuron MAX 088 (Penumbra)
Chaperon (Microvention)	Cello (Medtronic)	Arrow (Teleflex)	
Envoy (Codman)	MoMA (Medtronic)	Pinance Destination (Microvention)	
Vista Brite Tip (Cordis)			
Fubuki (Asahi Intecc)			
Mach 1 (Boston Scientific)			

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Standard Guide	Guide with Flow control	Standard Sheath	Premium Sheath
Guider Softip XF (Stryker)	FlowGate2 (Stryker)	Shuttle (Cook)	AXS Infinity LS Long Sheath (Stryker)
Benchmark (penumbra)			Neuron MAX 088 (Penumbra)
Chaperon (Microvention)	Cello (Medtronic)	Arrow (Teleflex)	
Envoy (Codman)	MoMA (Medtronic)		
Vista Brite Tip (Cordis)			
Fubuki (Asahi Intecc)			
Mach 1 (Boston Scientific)			

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Standard Guide	Guide with Flow control	Standard Sheath	Premium Sheath
Guider Softip XF (Stryker)	FlowGate2 (Stryker)	Shuttle (Cook)	AXS Infinity LS Long Sheath (Stryker)
Benchmark (penumbra)			Neuron MAX 088 (Penumbra)
Chaperon (Microvention)	Cello (Medtronic)	Arrow (Teleflex)	
Envoy (Codman)	MoMA (Medtronic)		
Vista Brite Tip (Cordis)			
Fubuki (Asahi Intecc)			
Mach 1 (Boston Scientific)			

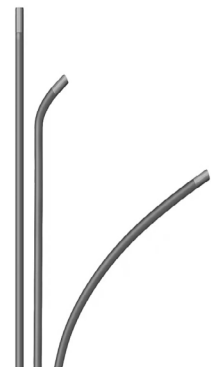
WK YOON

Guider Softip XF

Guide Catheter

Designed for support.

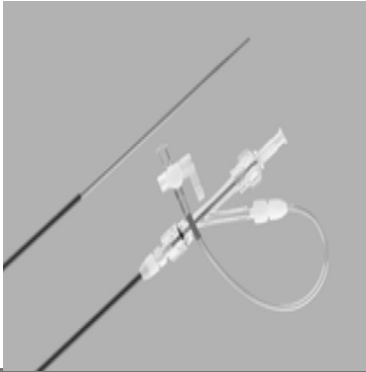
The Guider Softip XF Guide Catheter features a braided multi-durometer shaft for proximal support with distal flexibility.



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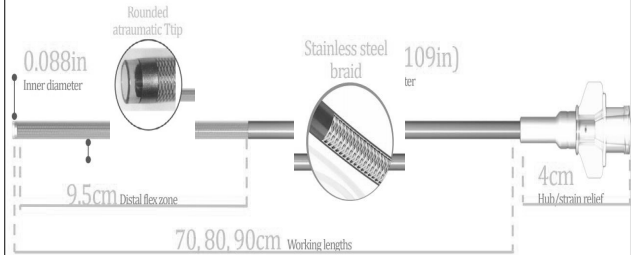
Flexor Shuttle Select Sheath (Cook)



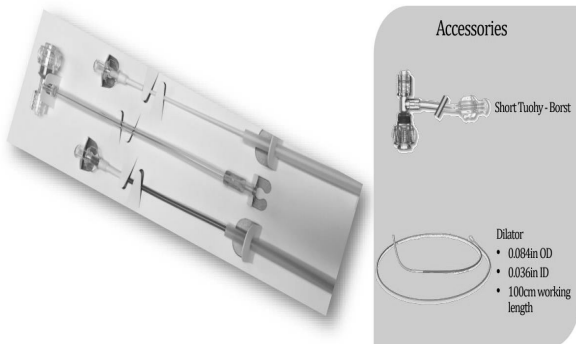
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AXS Infinity LS specifications

stryker



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Structure

Dilator kit



ASAHI FUBUKI Dilator Kit *	Tip Shape	Hydrophilic Coating	Inner Diameter	Outer Diameter	Usable Length
4Fr Kit (6Fr GC)	Angle/ Straight	150mm	1.80mm (0.071")	2.09mm (6Fr)	80cm, 90cm, 100cm, 110cm
5Fr Kit (7Fr GC)	Angle/ Straight	150mm	2.05mm (0.081")	2.40mm (7Fr)	80cm, 90cm, 100cm, 110cm
6Fr Kit (8Fr GC)	Straight	50mm	2.28mm (0.090")	2.70mm (8Fr)	80cm, 90cm, 100cm, 110cm

* Dilator kit contains a guiding catheter and a dilator. Excl. 4 Fr Kit contains 6 Fr FUBUKI Guiding catheter with a dilator

Internal Use ONLY.

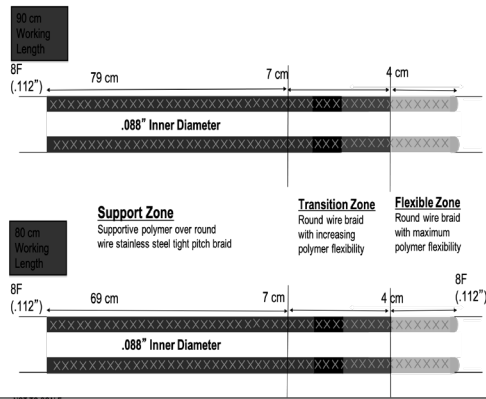
NeuronTM MAX 088 Large Lumen Intracranial Access System

NeuronTM MAX 088
Large Lumen Intracranial Access System



Penumbra, Inc. Confidant[®] - Neuron 088 is a Neuron 088 and CC-Medical Company

Neuron MAX 088 Large Lumen Catheter: Shaft Construction in Detail



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Balloon

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Sterling SL Balloon Catheter (Boston Scientific)



- Semi-compliant Pebax® Balloon Material
- Designed to be scratch and puncture resistant
- Hydrophilic coating (Bioslide™) designed to facilitate advancement through complex lesions
- Excellent re-wrap for smooth withdrawal



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Sterling SL Balloon Catheter (Boston Scientific)

- Distal shaft
 - Tri-layer inner (blue):
 1. High-density polyethylene inner layer designed to provide low-friction surface for superb wire movement
 2. Tie layer bonds lubricious inner to rigid outer layer
 3. Pebax® outer
 - Pebax® outer (clear)
- Nylon proximal shaft

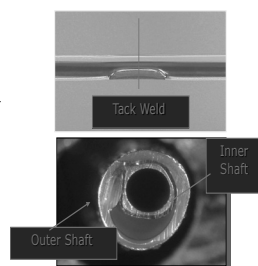
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Sterling SL Balloon Catheter (Boston Scientific)

Sterling® and Sterling SL Monorail® Balloon Catheter



- Located 3 cm from the proximal balloon bond
- Bonds inner to outer shaft
- Intended to improve column support, enabling advancement and pushability



Photos property of Boston Scientific Corporation

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Submarine Rapido balloon catheter (Medtronic)

Catheter design	Rapid exchange
Range of diameter	Ø 2 – 7 mm
Range of lengths	20, 30, 40, 60, 80 mm
Usable Catheter length	135 cm
Guidewire compatibility	0.018"
Guide catheter compatibility	6F*
Balloon Material	FLEXITEC™ LP
Coating	Balloon and distal shaft LFC-hydrophilic coated, PTFE on Hypotube
Nominal/ Rated burst pressure	7/ 17 bar
Shaft diameter	Hypotube: 2.3F, RX-section: 3.5F

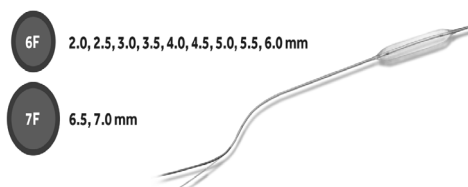
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Submarine Rapido balloon catheter (Medtronic)

Tri-folding balloon technology
Swaged (zero profile) radiopaque markers

Guiding Catheter compatibility:



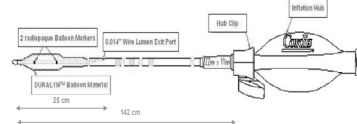
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AVIATOR[®] Plus



PTA Dilatation Catheter
– for efficiency
in carotid
and renal peripheral
endovascular
interventions

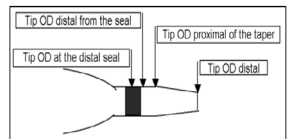
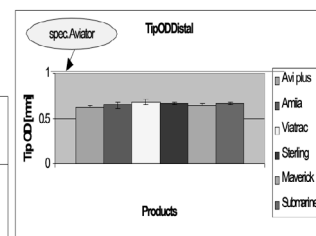
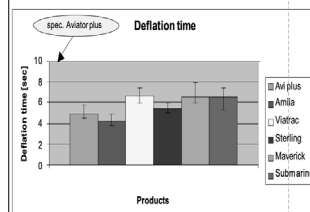
Product Specifications



0.014" rapid exchange balloon catheter

- Balloon range:**
 - 4.0, 4.5, 5.0, 5.5, 6.0 and 7.0 mm diameters
 - 15, 20, 30 and 40 mm lengths
- Balloon material: DURALYN[™] – NO coating
- Rated Burst Pressure: 14 atm (4 – 6 mm Ø), 12 atm (7 mm Ø)
- Shaft:** 3.3F, 142 cm length (stiffening wire 117 cm length / coaxial rapid exchange shaft distal 25 cm length)
- CSI / Guiding Catheter compatibility:** 4F / 6F (* 5F CSI fit for 7 mm Ø)
- Shelf life:** 2 years

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A systematic review and meta-analysis of predilation and postdilation in transfemoral carotid artery stenting

Behrad Ziapour, MD,¹ Marc L. Schermerhorn, MD,² Mark D. Iafrati, MD,³ Luis B. Suarez, MD,³ Shahab TourSavadjkhi, MD,⁴ and Payam Salehi, MD, PhD,¹ Boston, Mass. and Baltimore, Md

ABSTRACT

Objective: In this review, we evaluate the short-term impact of different ballooning combinations on hemodynamic instability, neurologic events, and mortality associated with carotid artery stenting.

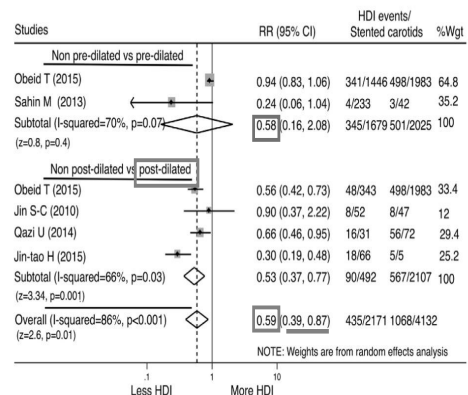
Methods: We used a search strategy to identify studies in the Cochrane Library trials register, PubMed, EMBASE, Google Scholar, and the US National Library of Medicine clinical trial databases up to May 2019. Studies reporting either hemodynamic instability, neurologic events, or mortality were included according to the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-analysis. Fixed and random models were used to summarize the effects.

Results: Of seven included cohort studies for qualitative review, six were selected for meta-analysis. Patients without postdilation had significantly less hemodynamic instability in the random effects model (risk ratio, 0.53; 95% confidence interval, 0.37-0.77; $P = .001$). Regardless of the dilation type, the overall summary effect in the fixed model showed a significant decrease in the risk of developing short-term neurologic events (risk ratio, 0.67; 95% confidence interval, 0.47-0.97; $P = .03$). Last, the exclusion of either of the two dilation techniques had no significant effect on mortality.

Conclusions: Avoiding postdilation reduces perioperative hemodynamic instability and this benefit lasts at least up to 30 days. Regardless of the type, fewer dilations during carotid artery stenting possibly decreases the neurologic events during and 30 days after the procedure. The data also suggest that the residual stenoses above current practiced standard may provide a safer threshold to prompt postdilation. Statements about the long-term effects of dilation techniques requires more study. [Vasc Surg 2020;72346-55](https://doi.org/10.1016/j.vasc.2020.72346-55)

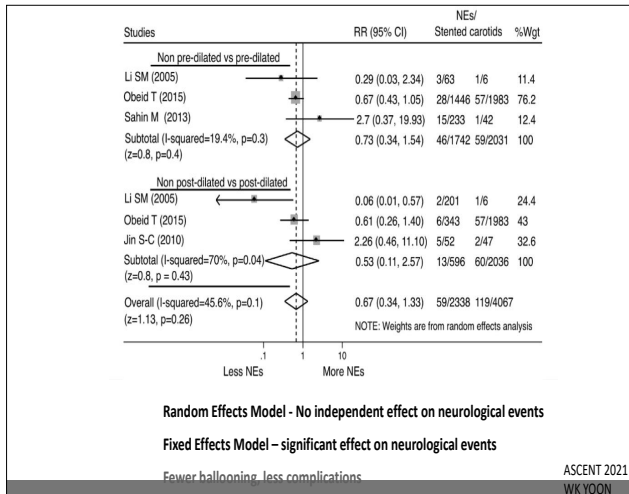
Keywords: carotid artery stenosis; Carotid stenting; Predilation; Postdilation

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Primary outcome – short term hemodynamic instability
Postdilation increases short term hemodynamic instability

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Stent

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Stent Design

Stents designs	Advantages	Disadvantages
Balloon-expandable design stents		
Self-expandable closed design stents		
Self-expandable open-cell design stents		
Two-layer design stents		
Hybrid-cell design stents		

Cristallo (Invatec, Italy)

EXPERT REVIEW OF CARDIOVASCULAR THERAPY
2020, VOL 18, NO 12, 891-904

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Stent design

- Open Cell Stent (OCS)
 - Free cell area more than 5mm
 - Flexible
 - Navigate tortuous vessels
 - Adapt well to the vessel contour without shortening
 - Cover less region
 - Prolapse of atheroma
 - More thromboembolic risk
- Closed Cell Stent (CCS)
 - Less free cell area
 - Better scaffold support
 - Less embolic complication
 - Stiffer
 - Kink or injure the vessel
 - Poorer wall apposition

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CAROTID STENT DESIGN

DIFFERENT DESIGN

A: Precise Open-cell/cylindrical | B: Acculink Open-cell | C: Protege Open-cell stepped design | D: Xact - Closed-cell design
E: Wallstent - Braided wire mesh design | F: Cristallo ideale - Hybrid, open-cell ends and closed-cell in the middle

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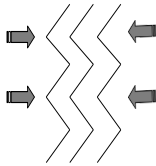
Design: Sequential Ring

- Rings consist of a series of "V" shaped structural elements (struts)

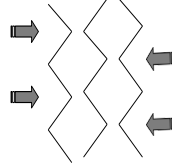
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Design: Ring Layout

- Peak-to-Valley



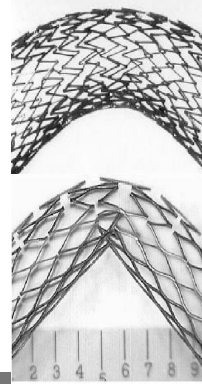
- Peak-to-Peak



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Conformability

y



Peak-to-Valley

- Countourability
- Smooth Wall Apposition
- Smooth Lumen

Peak-to-Peak

- Erratic-to-Sharp wall apposition
- Interrupted Lumen

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Design: Ring Connectors

- Offset



- Peak to Valley



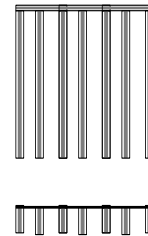
- Peak to Peak



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Scaffolding

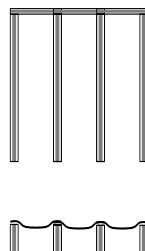
- Stent rings support vessel wall much like a floor joist supports the floor decking in your home
- More joists/rings per foot/mm transmits load and minimizes deflection/prolapse



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Scaffolding

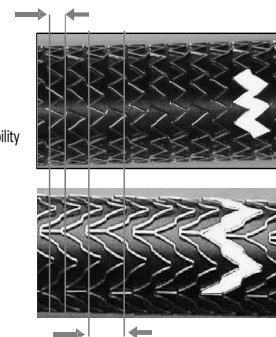
- With fewer joists/rings per foot/mm load is greater at each joist/ring and deflection/prolapse is greater



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Ring Width

- SMART MicroMesh
 - Segmented Design
 - 2mm ring width
 - Short strut length
 - Superior contourability



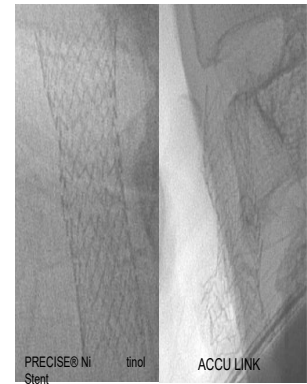
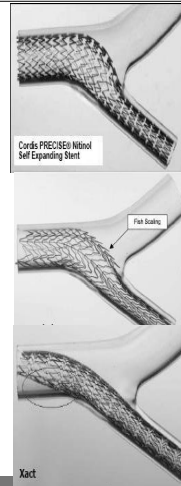
- Stent X
 - Overlapping struts
 - Long struts
 - Long connectors
 - Large cells

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Conformability or Flexibility

- Ability to conform to tortuous anatomy during deployment
- Short struts and segmented design allows stent to conform to minute changes in vessel
- Ring connector position impacts stent conformability and ultimately wall apposition

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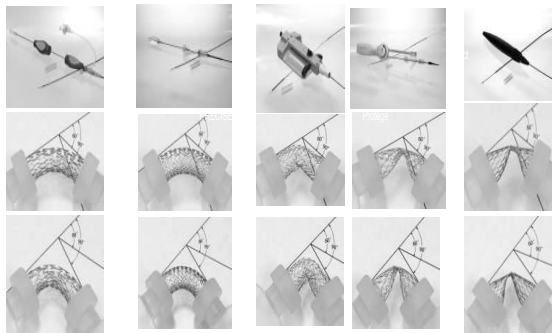
Protege

Precise RX

Acculink

NexStent

Xact



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Open Area

- Ratio of vessel material to stent material
- A lower ratio means more metal, increasing risk of intimal hyperplasia
- Micro-mesh verse large lattice

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Consideration Points during CAS

- Access
 - Tortuosity
 - Type of aortic arch
 - Selection of guiding catheter
- Age over 70 – CAS vs CEA
- Plaque
 - Soft vs Hard Calcified
 - Vulnerable vs Stable
 - Embolic complication, passage, restoration of vessel diameter
- Predilation or Postdilation
- Selection of Balloon
- Selection of Stent
 - Stent design
 - Stent size
 - Stent profile for passage
- Protection vs No-protection
- Selection of protection device
 - Filter vs Membrane
 - Distal vs Proximal

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Carotid Anatomy



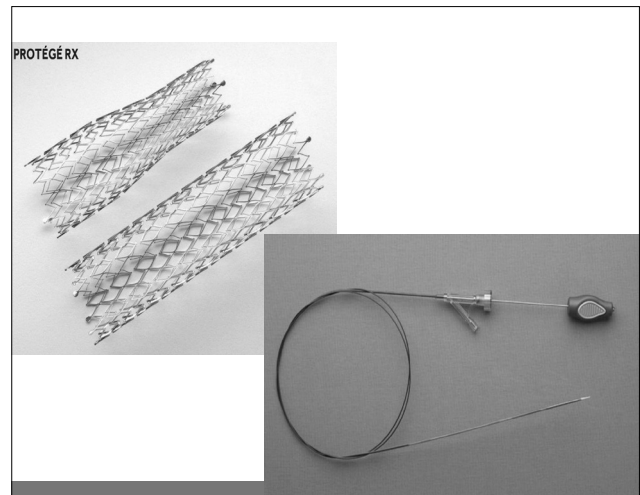
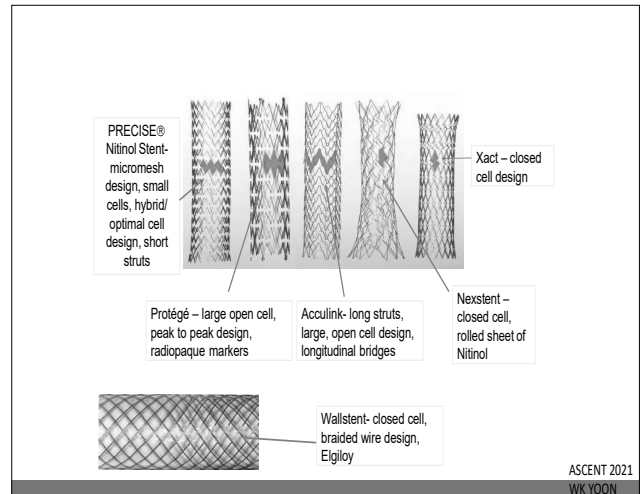
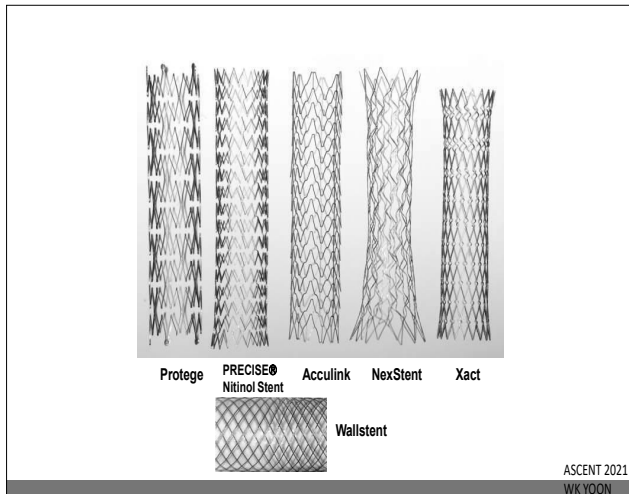
TABLE 2. Reproducibility of Geometric Parameters

Geometric Parameter	Mean	SD*
Bifurcation angle	61.5°	4.1°
ICA angle	28.4°	4.6°
ICA planarity	9.1°	4.3°
CCA tortuosity	0.014	0.005
ICA tortuosity	0.065	0.009
ICA/CCA	0.74	0.03
ECA/CCA	0.67	0.04
ECA/ICA	0.91	0.04
Area ratio	1.01	0.08

*Mean intraindividual SD calculated as the square root of the average within-subject variance.

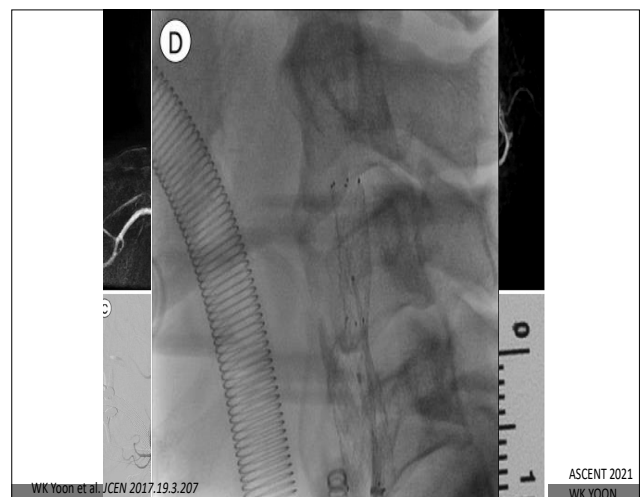
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	Straight	Tapered
Wire compatibility	0.014"	
Introducer sheath compatibility	6F	
Stent diameter (mm)	6, 7, 8, 9, 10	8x6, 10x7
Stent length (mm)	20, 30, 40, 60	30, 40
Radiopaque markers	Yes	
Catheter length (cm)	135	

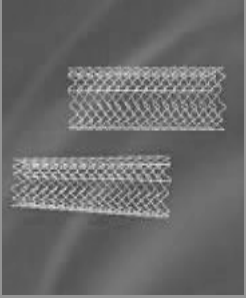
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Abbott

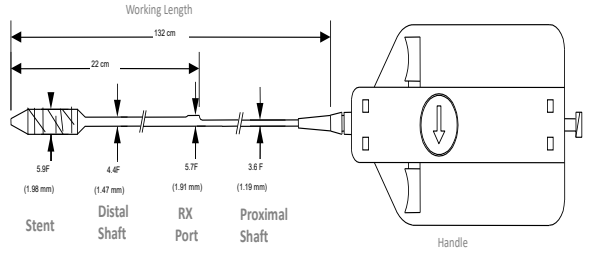
RX Acculink Carotid Stent System

ACCURACY MADE EASY



1 of 76

RX Acculink Carotid Stent System Delivery System Schematic



Working Length 132 cm

22 cm

5.9F (1.98 mm) Stent

4.4F (1.47 mm) Distal Shaft

5.7F (1.91 mm) RX Port

3.6F (1.19 mm) Proximal Shaft

Handle

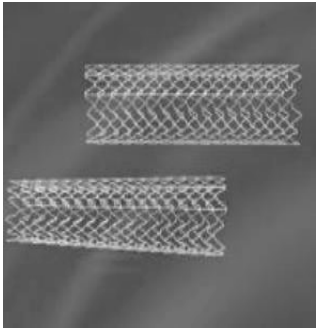
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- Unique handle design
 - Design enables one hand deployment
 - Eliminates “push-pull” technique
 - Placed on table or leg, stabilizing system for accurate placement

Pullback Handle

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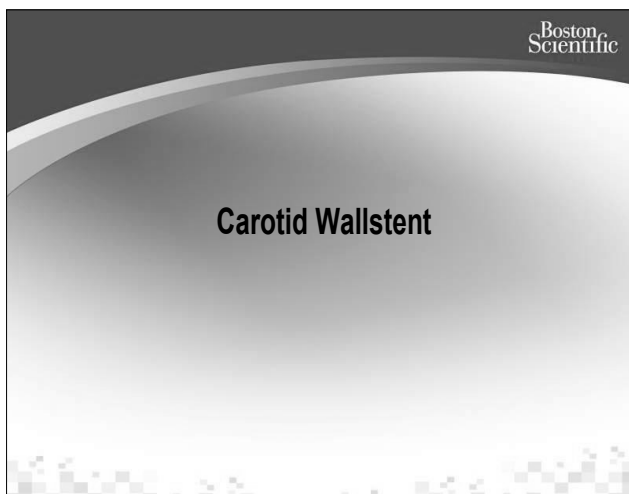
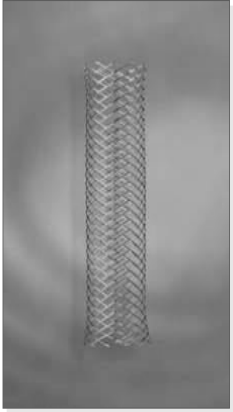
- Stent diameters:
 - Straight: 5-10 mm
 - Tapered: 6-8 mm, 7-10 mm
- Stent lengths: 20, 30*, 40* mm

*Tapered diameters available.

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Boston Scientific

Carotid Wallstent

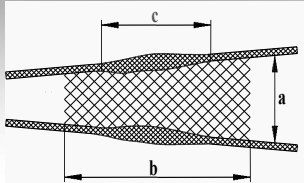



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Size Selection of Carotid Wallstent Boston Scientific

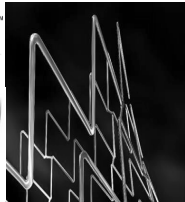
- Wallstent diameter = Vessel diameter (a) + 1 or 2 mm
- Wallstent length (b) = Lesion length (c) + 10 mm (i.e. 5 mm on each side)



Carotid Artery Stenting PRECISE

PRECISE
Nitinol Stent System

PRECISE RX
Micro Stent System

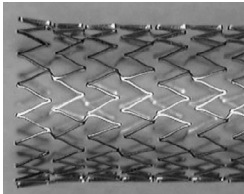


Cardinal Health
Medical Segment (China) 培训学院

Cordis PRECISE® Nitinol Stent

Characteristics

- Nitinol
- Multisegmented Design
- Micromesh Geometry
- Peak to Valley Design



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Cardinal Health
Medical Segment (China) 培训学院

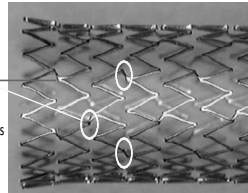
Cordis PRECISE® Nitinol Stent

Multisegment Design Features

- 18 circumferential 'V's
- Connected every 3rd V
- Bridges alternating up and down
- Every V is 2 mm long and acts as a separate stent

Benefits:

- Immediate and continuous wall apposition
- Excellent contourability



2 mm

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Cardinal Health
Medical Segment (China) 培训学院

Cordis PRECISE® Nitinol Stent

Peak to Valley design: enables conformability

Segment 2mm **Bridges**

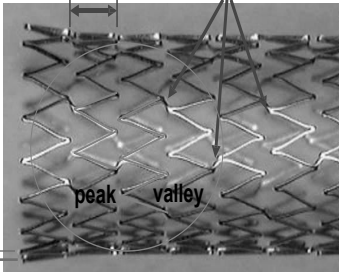
peak **valley**

1mm Flaring

1cm

5 segments

Peak to valley: when the stent is in a bend, the peak fits into a valley and no stress is added to the stent. The stent gets max flexibility.



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Medical Segment (China) 培训学院

CASPER Double layer Stent - Microvention

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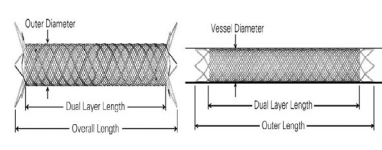
- ❖ CASPER Carotid Stent System is indicated for use in patients with carotid arterial atherosclerotic disease.
- ❖ CASPER stent has a dual layer micromesh design with a very small cell size (375-700μ).

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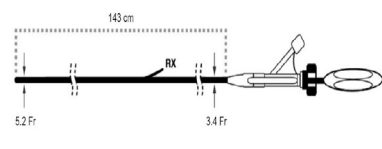
PRODUCT DESIGN – SPECIFICATIONS

CASPER[®] RX
Carotid Artery Stent System

Stent Platform
Construction: dual layer, braided micro-mesh
Material: Nitinol
Stent Diameters: 5-10mm (3-9mm vessels)
Stent Lengths: 16-40mm unconstrained (20-60mm in-vessel) dual-layer length

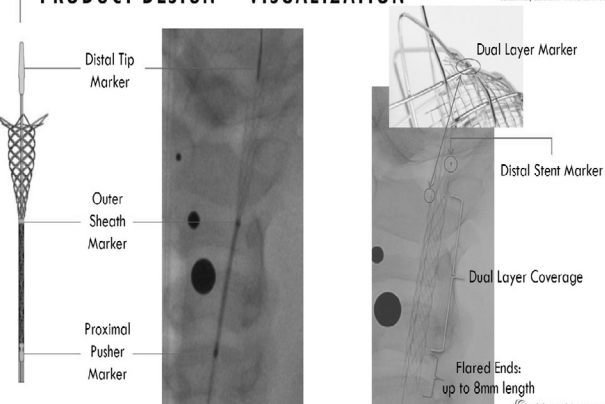


Stent Delivery System
Guidewire compatibility: 0.014" (0.36mm)
Introducer sheath compatibility: 5.0F (ID > 0.074")
Delivery system construction: rapid exchange, RX segment length 30cm
Usable catheter length: 143cm



PRODUCT DESIGN – VISUALIZATION

CASPER[®] RX
Carotid Artery Stent System



Microvention
TERUMO
WK YOON

CASPER CAS VS FRED AND FRED JR FLOW DIVERTERS

	CASPER [®] RX	FRED	FRED JR
Indications for Use	Indicated for use in patients with carotid arterial atherosclerotic disease	Intended for endovascular embolization of intracranial neurovascular aneurysms; also for use with embolic coils for the treatment of intracranial neurovascular lesions. NOT INDICATED FOR CAROTID USE.	
Construction	Dual-layer Nitinol Braid	Dual-layer Nitinol Braid	Dual-layer Nitinol Braid
Inner Layer	48 wire Nitinol braid	48 wire Nitinol braid	36 wire Nitinol braid
Outer Layer	12 wire Nitinol braid	16 wire Nitinol braid	16 wire Nitinol braid
Dual-layer markers	3 helical markers at both ends that connect inner to outer layer	2 helical markers at both ends that connect inner to outer layer	2 helical markers at both ends that connect inner to outer layer
Flare end markers	1 R/O marker on distal end	4 R/O markers on both ends	4 R/O markers on both ends
Radial Force	Higher vs FRED/Jr	Lower vs CASPER	Lower vs CASPER
Stent Diameters	5 – 10mm	3.5 – 5.5mm	2.5 – 3.0mm
Delivery Method	pre-loaded in RX delivery system	Load through microcatheter	Load through microcatheter
Deployment Technique	Pin & Pull	Push & Pull	Push & Pull
Resheathability	"Up to 50%"	"Up to 50%"	"Up to 50%"

1

Stent Design and Thromboembolic complication

- Long debate
- J Neurointerv Surg 2018; 10:1149–1154.

ORIGINAL RESEARCH

Ischemic Stroke

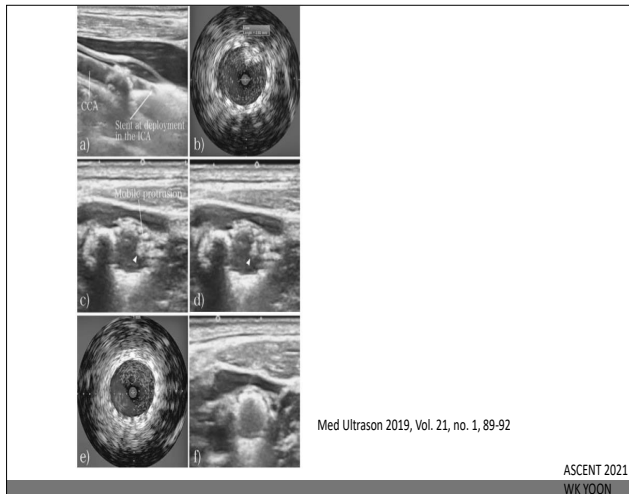
Influence of stent design and use of protection devices on outcome of carotid artery stenting: a pooled analysis of individual patient data

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	Pts (n)	Events (n, %)	Pts (n)	Events (n, %)	Risk ratio (95% CI)	P-value	Risk ratio (95% CI)
	Open cell		Closed cell				
Stent design	595	61 (10.3)	962	58 (6.0)	1.76 (1.23-2.52)	0.002	

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REVIEW

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Is it possible to prevent cerebral embolization by improving the design and technology of carotid stent implantation?

Olesia Osipova, Irina Popova, Vladimir Starodubtsev, Savr Bugurov and Andrey Karpenko

Center for Vascular and Hybrid Surgery, Meshalkin National Medical Research Center, Ministry of Health of the Russian Federation, Novosibirsk, Russian Federation

ABSTRACT

Introduction: The prevention of atherosclerotic plaque fragmentation during carotid artery stenting is a fundamental problem in decreasing the risk of disability of patients. The goal of this review is to clarify whether the stent design can have a decisive impact on the rate of intraoperative and postoperative complications.

Areas covered: Different designs of the carotid stents are briefed and the advantages and disadvantages of different stent designs are discussed as well as the results of their clinical use. Various solutions are presented to reduce cerebral embolism during carotid artery stenting.

Expert opinion: The stent design cannot completely resolve the problem of cerebral embolism. The stent design cannot completely resolve the problem of cerebral embolism. The stent design cannot completely resolve the problem of cerebral embolism.

Abbreviations: CAS, carotid artery stenting; CE, carotid endarterectomy; DW-MRI, diffusion-weighted magnetic resonance imaging; ECA, external carotid artery; ICA, internal carotid artery; IVUS, intravascular ultrasound examination; OCT, optical coherence tomography

ARTICLE HISTORY

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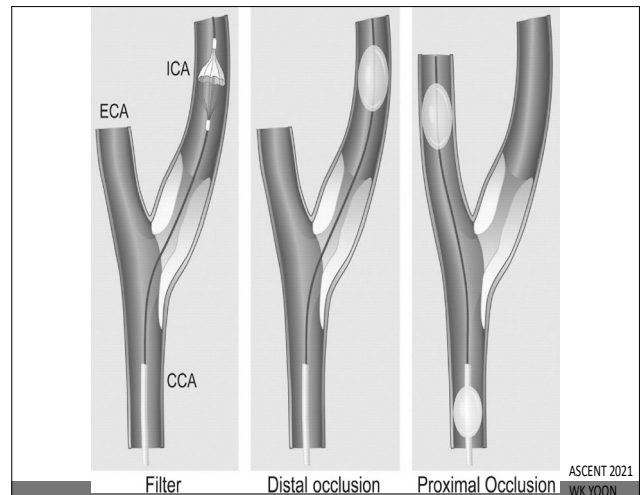
KEYWORDS

Carotid artery; carotid stenosis; carotid stenting; stent design; plaque protrusion; cerebral embolism; protection device

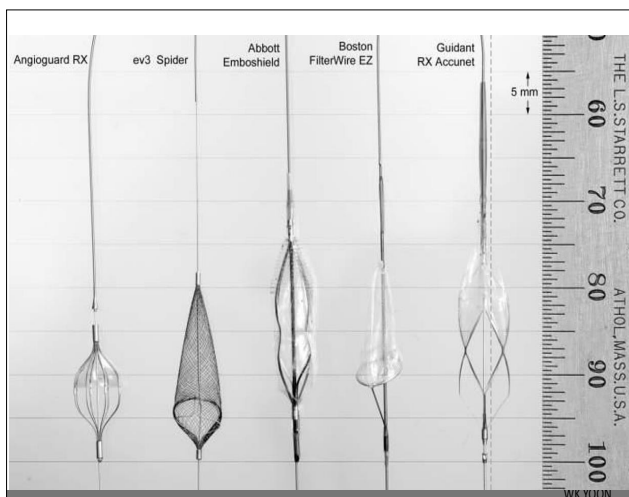
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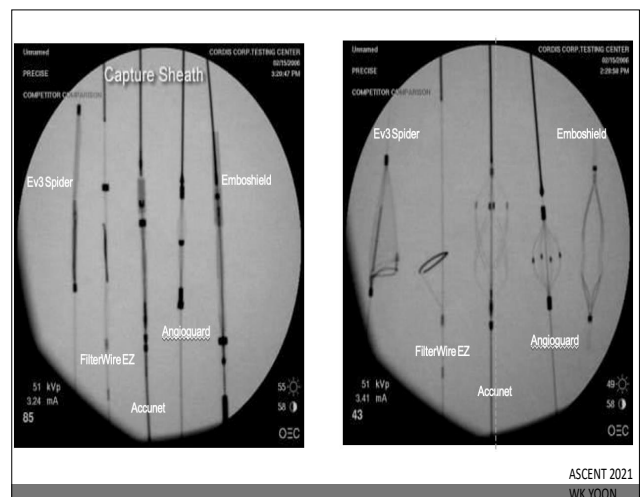
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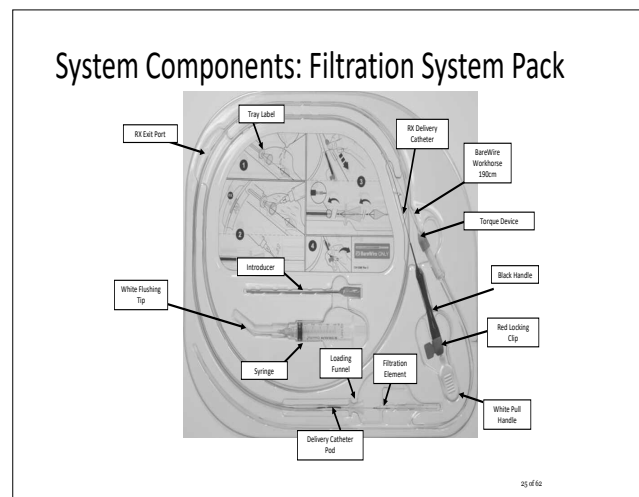
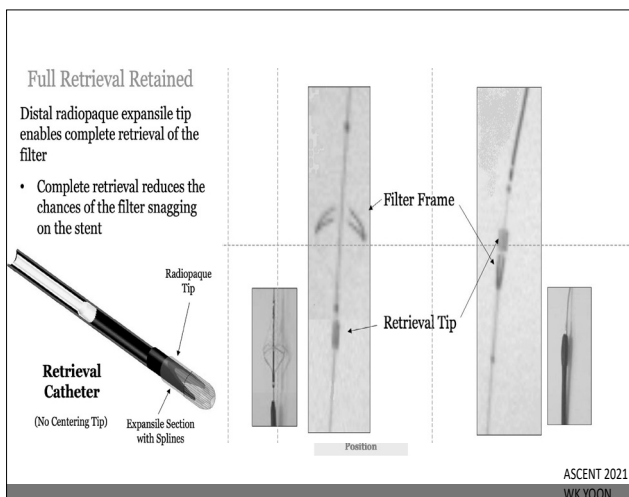
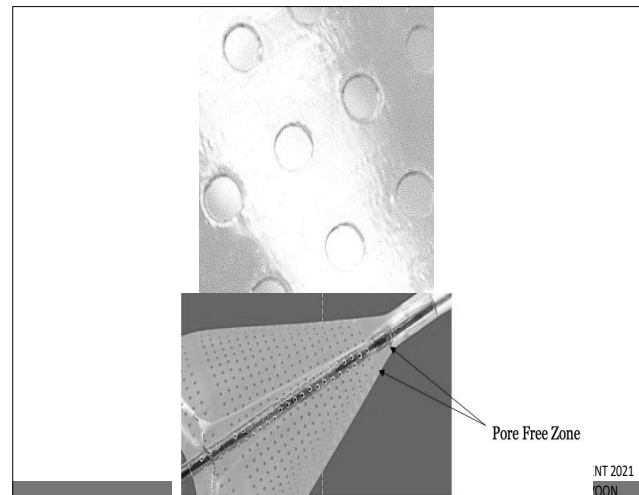
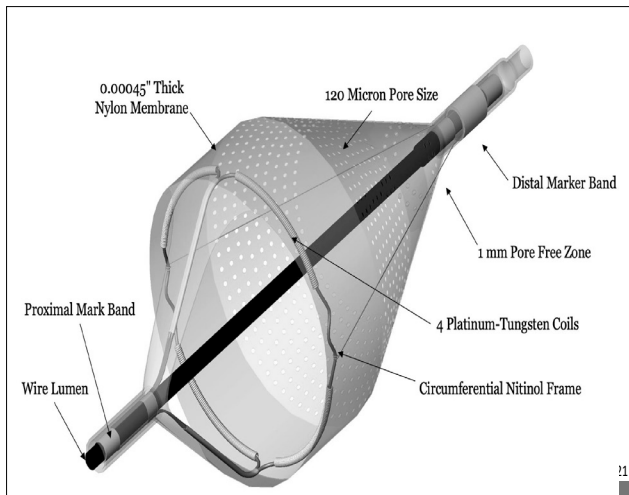
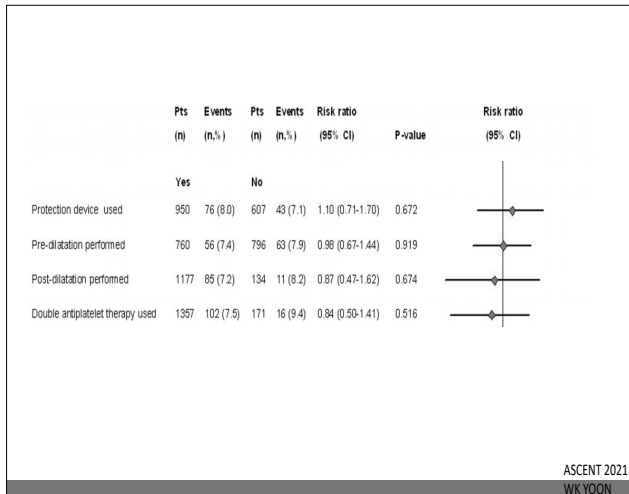
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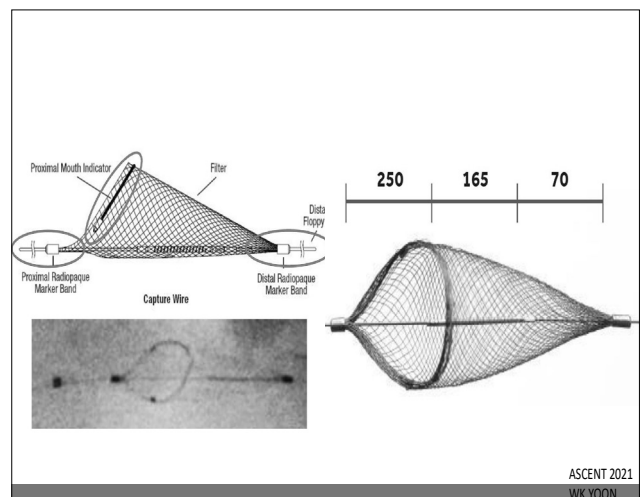
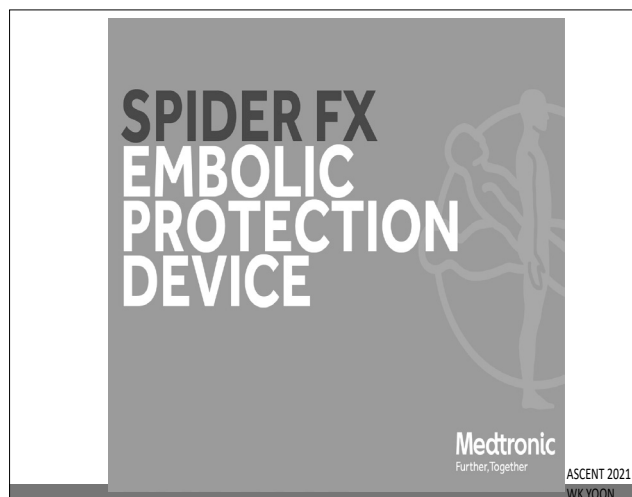
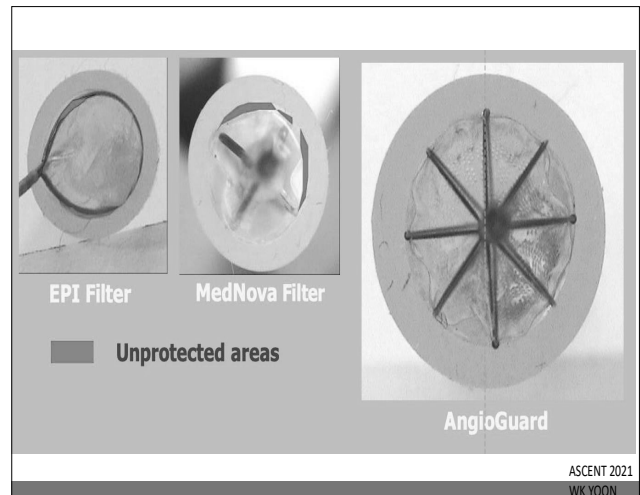
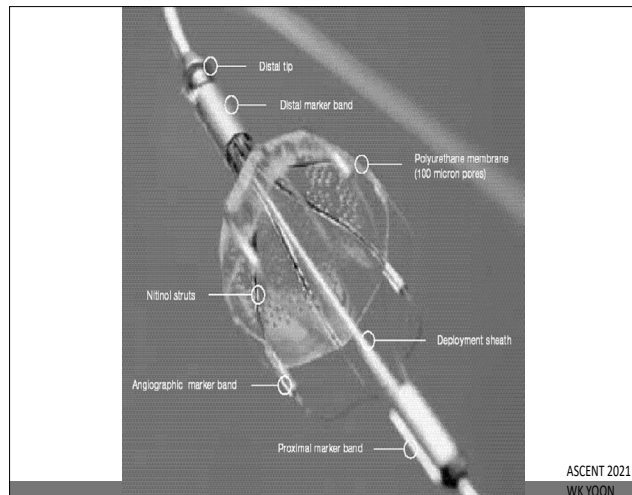
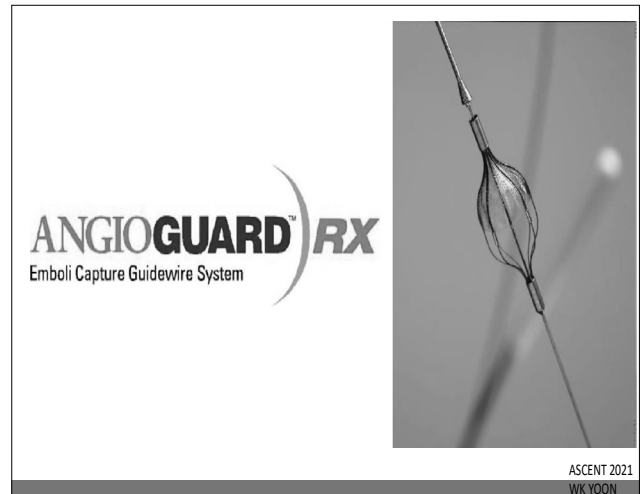
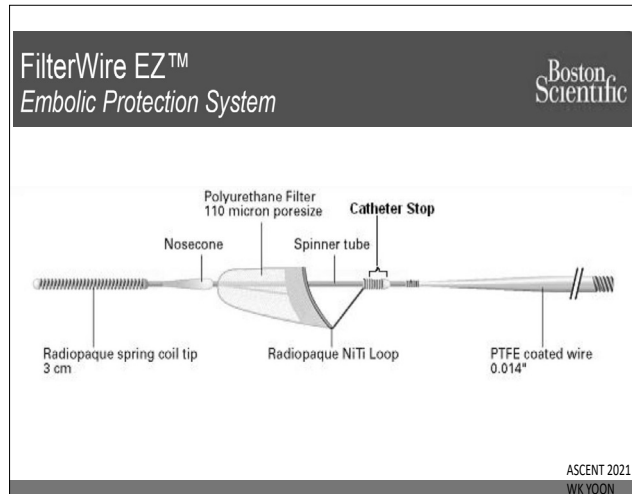
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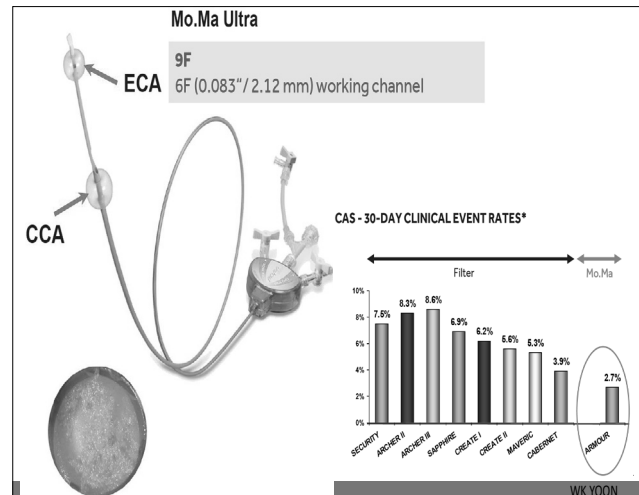
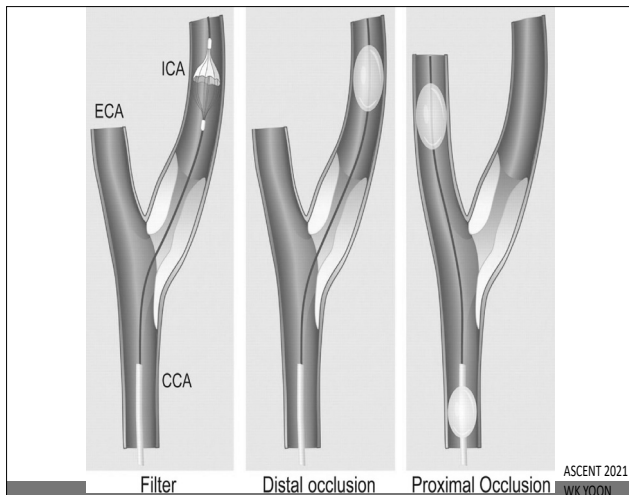
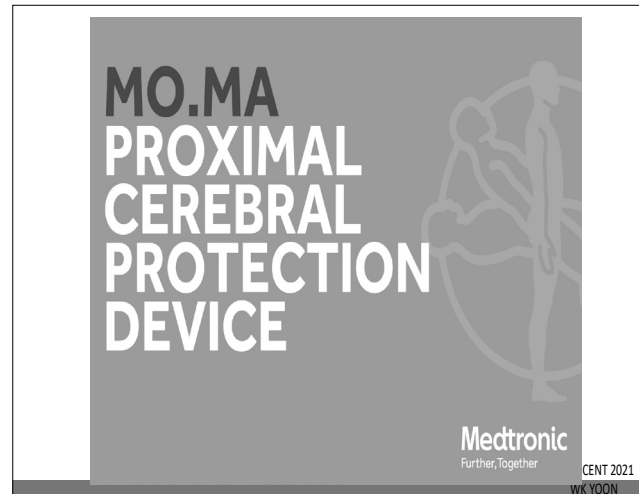
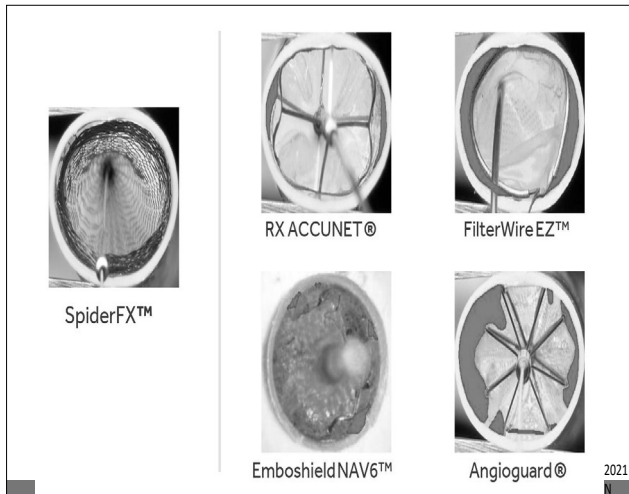


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Carotid Stenting in Patients With High Risk Versus Standard Risk for Open Carotid Endarterectomy (REAL-1 Trial)

Joaquin De Haro, MD^a, Ignacio Michel, MD, Silvia Bleda, MD, Cristina Cañibano, MD, and Francisco Acin, MD, PhD

Carotid stenting (CAS) has been mainly offered to those patients considered at "high risk" for open carotid endarterectomy based on available data from large randomized clinical trials. However, several recent studies have called medical "high risk" into question for CAS indication. The REAL-1 trial evaluated the safety and perioperative and long-term effectiveness in patients with significant carotid artery stenosis with "high-risk" criteria treated with CAS and proximal protection device (MOMA) compared with those with standard surgical-risk features. This nonrandomized double-arm registry included 125 patients (40% symptomatic), 71 (56%) with "standard-risk" and 54 (44%) with "high-risk" criteria. The primary end point was the cumulative incidence of any major adverse event, a composite of stroke, myocardial infarction, and death within 30 days after the intervention or ipsilateral stroke after 30 days and up to 4 years. There was no significant difference in primary end point rate at 30 days between patients at "standard risk" and those with "high risk" (1.4% vs 1.9% respectively; hazard ratio for "standard risk" 1.1; 95% CI 0.8 to 1.2, $p = 0.77$) nor estimated 4-year rate of ipsilateral stroke (1.3% vs 1.8%; hazard ratio for "standard risk" 1.05, 95% CI 0.86 to 1.14, $p = 0.9$). In conclusion, 4-year postprocedure results demonstrated that CAS with proximal device (MOMA) is safe and effective for patients with and without "high-risk" for carotid endarterectomy. © 2017 Elsevier Inc. All rights reserved. (Am J Cardiol 2017;120:322–326)

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Carotid Wallstent Versus Roadsaver Stent and Distal Versus Proximal Protection on Cerebral Microembolization During Carotid Artery Stenting

JACC Cardiovasc Interv. 2020 Feb 24;13(4):403–414.

130-140°

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Carotid Wallstent Versus Roadsaver Stent and Distal Versus Proximal Protection

JACC Cardiovasc Interv.
2020 Feb 24;13(4):403-414.

TABLE 4 MES Counts During the Different Phases of Carotid Artery Stenting

Step	FW		Mo.Ma		p Value	
1+2	6.8 (5.0-9.3)		5.9 (4.2-8.2)		0.50	–
3	24.2 (20.4-28.8)		1.5 (1.1-2.0)		<0.0001	–
4	9.6 (4.9-18.7)		3.2 (0.4-22.9)		0.11	–
5	8.9 (6.5-12)		1.6 (1.2-2.1)		<0.0001	–
	CW	RS	CW	RS	Mo.Ma and FW	RS vs. CW
6	40.2 (33.6-48.1)	32.5 (25.8-41.1)	2.7 (1.4-5.1)	2 (1.3-3.2)	<0.0001	0.06
7	19.2 (15.2-24.1)	21.3 (16.1-28.3)	2.1 (1.3-3.4)	1.4 (1.0-1.9)	<0.0001	0.66
8	5.8 (3.9-8.6)	4.2 (3.0-6.0)	9.5 (6.7-13.4)	7.4 (4.8-11.5)	0.038	0.18
6-8	16.5 (13.9-19.6)	14.3 (12-17.1)	3.9 (2.8-5.4)	2.8 (2.1-3.6)	<0.0001	0.032
6-8 + SM	12.2 (9.4-15.9)	9.4 (7.6-11.5)	3.4 (2.3-4.9)	2.4 (1.82-3.2)	<0.0001	0.016

Values are geometric mean (95% confidence interval). Steps 1 and 2, target vessel engagement with diagnostic catheter (step 1) and guide/sheath or Mo.Ma positioning (step 2); step 3, lesion crossing with either the FW or a 0.014-inch coronary wire in the Mo.Ma group after common carotid artery occlusion; step 4, lesion pre-dilation; step 5, lesion crossing with the stent; step 6, stent deployment; step 7, stent dilation; and step 8, FW/Mo.Ma system retrieval/deflation.

SM = spontaneous microembolic signals; other abbreviations as in Table 1.

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REVIEW

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Eur J Vasc Endovasc Surg (2017) 53, 617-625

Choices of Stent and Cerebral Protection in the Ongoing ACST-2 Trial:
A Descriptive StudyD.D. de Waard^{1,2}, A. Halliday^{3,4}, G.J. de Bont⁵, R. Bulbulia⁶, A. Huibers⁷, R. Casana⁸, L.H. Bonati⁹, V. Tolve¹, on behalf of the

Table 5. Interventionalists' choice in cerebral protection (excluding distal balloon devices).

	CPD usage Used (n = 726)	Not used (n = 105)	Total (n = 831)	p	Type of CPD used Distal filter (n = 580)	Proximal occlusion (n = 142)	Total (n = 722)	p
Specialty								
Surgeons	365 (98.4)	6 (1.6)	371	<.001	297 (81.6)	67 (18.4)	364	.324
Radiologists	318 (76.3)	99 (23.7)	417		246 (78.1)	69 (21.9)	315	
Cardiologists	43 (100)	0 (0)	43		37 (86.0)	6 (14.0)	43	
Plaque echolucency								
Nonecholucent	245 (88.1)	33 (11.9)	278	.401 ^a	201 (82.7)	42 (17.3)	243	.888 ^b
Echolucent	226 (90.4)	24 (9.6)	250		185 (82.2)	40 (17.8)	225	
Not assessed	255 (84.1)	48 (15.8)	303		194 (76.4)	60 (23.6)	254	
Ipsilateral carotid diameter reduction (%)								
<90	571 (88.4)	75 (11.6)	646	.096	459 (80.8)	109 (19.1)	568	.535
90-99	155 (83.4)	30 (16.2)	185		121 (78.6)	33 (21.4)	154	
Contralateral carotid disease (%)								
<50	462 (89.4)	55 (10.6)	517	.057	369 (80.2)	91 (19.8)	460	.584
50-99	209 (85.0)	37 (15.0)	246		164 (79.2)	43 (20.8)	207	
Occluded	55 (80.9)	13 (19.1)	68		47 (85.5)	8 (14.5)	55	

Take Home Message

- Which one is the best?
- Which Combination is the best?
- Simple but Tailored Approach - Effectiveness
- Get used to and Become an Expert
- Mind Training, Repeated Simulation
- Dual antiplatelet
- Preoperative Evaluation of Plaque Characteristics and Vascular Anatomy

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90 YEARS OF
KOREA UNIVERSITY
MEDICINE

Patent selection, technical tips and basic tactics

신 병 국

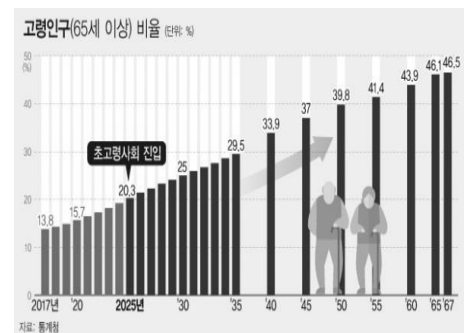
동원의료원 신경외과

Basic Endovascular Training Course

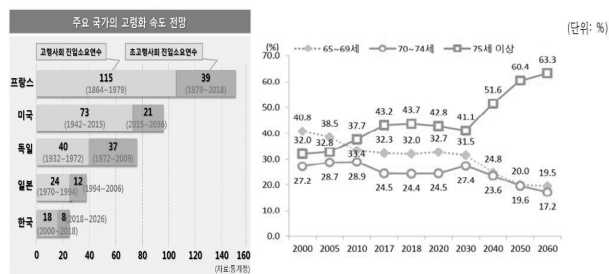
- Patient Selection
- Technical tips
- Basic Tactics

동원의료원
신 병 국

Population ageing of Korea



Population ageing of Korea



Prevalence of Carotid Stenosis

Table 3. Prevalence of asymptomatic >50% and >70% stenoses in the general population, stratified for gender and age.^a

Age	Stenosis	Males	Females
<50 years	>50%	0.2%	0.0%
	>70%	0.1%	0.0%
50–59 years	>50%	0.7%	0.5%
	>70%	0.2%	0.1%
60–69 years	>50%	2.3%	2.0%
	>70%	0.8%	0.2%
70–79 years	>50%	6.0%	3.6%
	>70%	2.1%	1.0%
≥80 years	>50%	7.5%	5.0%
	>70%	3.1%	0.9%

^a Based on analyses from de Weerd M, Greving JP, Hedblad B, Lorenz MW, Mathiesen EB, O'Leary DH. Prevalence of asymptomatic carotid artery stenosis in the general population: an individual participant data meta-analysis. Stroke 2010;41:1294–7.

Patients Selection for CAS

Journal of the American College of Cardiology
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ISSN 0735-1097/\$36.00
doi:10.1016/j.jacc.2010.11.006

PRACTICE GUIDELINES

2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/ SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease

A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, and the American Stroke Association, American Association of Neuroscience Nurses, American Association of Neurological Surgeons, American College of Radiology, American Society of Neuroradiology, Congress of Neurological Surgeons, Society of Atherosclerosis Imaging and Prevention, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of NeuroInterventional Surgery, Society for Vascular Medicine, and Society for Vascular Surgery

Developed in Collaboration With the American Academy of Neurology and Society of Cardiovascular Computed Tomography

7. Revascularization

7.1. Recommendations for Selection of Patients for Carotid Revascularization*

CLASS I

1. Patients at average or low surgical risk who experience nondisabling ischemic stroke² or transient cerebral ischemic symptoms, including hemispheric events or amaurosis fugax, within 6 months (symptomatic patients) should undergo CEA if the diameter of the lumen of the ipsilateral internal carotid artery is reduced more than 70%³ as documented by noninvasive imaging (20.83) (Level of Evidence: A) or more than 50% as documented by catheter angiography (20.70,83,359) (Level of Evidence: B) and the anticipated rate of perioperative stroke or mortality is less than 6%.
2. CAS is indicated as an alternative to CEA for symptomatic patients at average or low risk of complications associated with endovascular intervention when the diameter of the lumen of the internal carotid artery is reduced by more than 70% as documented by noninvasive imaging or more than 50% as documented by catheter angiography and the anticipated rate of periprocedural stroke or mortality is less than 6% (360). (Level of Evidence: B)
3. Selection of asymptomatic patients for carotid revascularization should be guided by an assessment of comorbid conditions, life expectancy, and other individual factors and should include a thorough discussion of the risks and benefits of the procedure with an understanding of patient preferences. (Level of Evidence: C)

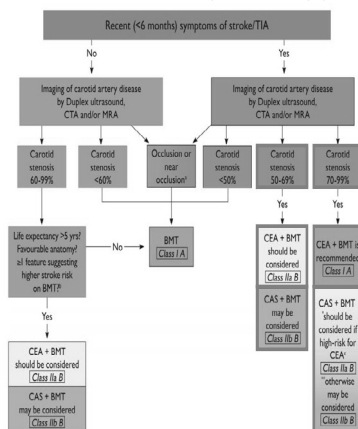
CLASS IIa

1. It is reasonable to perform CEA in asymptomatic patients who have more than 70% stenosis of the internal carotid artery if the risk of perioperative stroke, MI, and death is low (74,76,359,361-363). (Level of Evidence: A)
2. It is reasonable to choose CEA over CAS when revascularization is indicated in older patients, particularly when arterial pathoanatomy is unfavorable for endovascular intervention (360,364-368). (Level of Evidence: B)
3. It is reasonable to choose CAS over CEA when revascularization is indicated in patients with neck anatomy unfavorable for arterial surgery (369-373).³ (Level of Evidence: B)
4. When revascularization is indicated for patients with TIA or stroke and there are no contraindications to early revascularization, intervention within 2 weeks of the index event is reasonable rather than delaying surgery (374). (Level of Evidence: B)

CLASS IIb

1. Prophylactic CAS might be considered in highly selected patients with asymptomatic carotid stenosis (minimum 60% by angiography, 70% by validated Doppler ultrasound), but its effectiveness compared with medical therapy alone in this situation is not well established (360). (Level of Evidence: B)

Management of Atherosclerotic Carotid and Vertebral Artery Disease:
2017 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)



CEA VS CAS in symptomatic patients

Table 11. 30-day risks following CEA and CAS in trials that randomised >500 recently symptomatic patients into EVA-3S, SPACE, ICSS, and CREST.^{184,185,187,189}

30-day risks	EVA-3S ¹⁸⁴		SPACE ¹⁸⁵		ICSS ¹⁸⁷		CREST ¹⁸⁹	
	CEA n = 262	CAS n = 261	CEA n = 589	CAS n = 607	CEA n = 857	CAS n = 853	CEA n = 653	CAS n = 668
Death	1.2%	0.8%	0.9%	1.0%	0.8%	2.3%		
Any stroke	3.5%	9.2%	6.2%	7.2%	4.1%	7.7%	3.2%	5.5%
Ipsilateral stroke			5.1%	6.4%	3.5%	6.8%		
Disabling stroke	0.4%	2.7%	2.9%	4.1%	2.3%	7.0%	0.9%	1.2%
Death/any stroke	3.9%	9.6%	6.5%	7.4%	4.7%	8.5%	3.2%	6.0%
Disabling stroke/death	1.5%	3.4%	3.8%	5.1%	3.2%	4%		
Clinical MI	0.8%	0.4%			0.5%	0.4%		
Death/stroke/MI					5.2%	8.5%	5.4%	6.7%
Cranial nerve injury	7.7%	1.1%			5.3%	0.1%	5.1%	0.5%

CEA VS CAS in asymptomatic patients

Table 6. 30-day death/stroke in randomised trials comparing CEA and CAS in asymptomatic patients.

30-day outcomes	Lexington ¹⁵		CREST-1 ¹⁶		ACT-1 ¹⁷		SPACE-2 ²⁰		Mannheim ¹⁸	
	CEA	CAS	CEA	CAS	CEA	CAS	CEA	CAS	CEA	CAS
Death/stroke	0%	0%	1.4%	2.5%	1.7%	2.9%	2.0%	2.5%	1.5%	2.9%
Death/disabling stroke	0%	0%	0.3%	0.5%	0.6%	0.6%				
Death/stroke/MI	0%	0%	3.6%	3.5%	2.6%	3.3%			1.5%	2.9%

Study	CAS Events	CAS Total	CEA Events	CEA Total	Odds Ratio	OR	95%-CI	Wifflid
Brooks	0	43	0	42				0.0%
Mannheim	2	68	1	68				4.5%
CREST	15	594	8	587		2.03	[0.18; 22.93]	36.6%
ACT1	31	1072	6	348		1.70	[0.70; 4.10]	41.0%
SPACE2	5	197	4	203		1.30	[0.34; 4.90]	17.9%
Fixed effect model	1974	1248			1.71	[0.99; 2.94]		100%

Heterogeneity: I-squared=0%, tau-squared=0, p=0.726

0.1 0.5 1 2 10
favours CAS ← → favours CEA

경피적 두개강외 스텐트 삽입술 급여기준 (2019. 08)

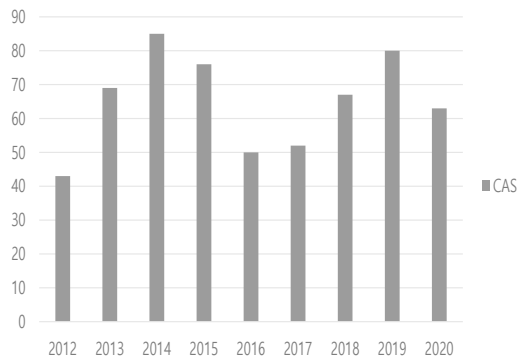
두개강외(경동맥)에 삽입하는 스텐트는 다음의 경우에 요양급여를 인정하며, 협착의 정도(%)는 NASCET measurement criteria에 따름.

- 다 음 -

두개강외 경동맥 (Extracranial carotid artery)

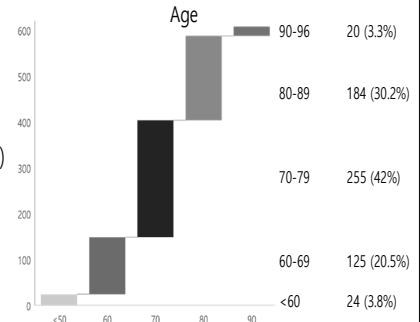
- 1) 유증상의 50% 이상 경동맥 협착
- 2) 무증상의 70% 이상 경동맥 협착
 - 단, 관류영상 검사 상 관류저하가 확인된 경우
- 3) 기타 (증상 또는 협착의 정도와 상관없이 가능한 경우)
 - 가) 반대측 경동맥의 폐색을 동반한 50% 이상의 경동맥 협착
 - 나) 가상동맥류(pseudoaneurysm)
 - 다) 동정맥루 치료를 위해 다른 방법이 가능하지 않은 경우
 - 라) 혈관박리로 인한 혈류 감소 또는 협착

Carotid Stenting In DEMC

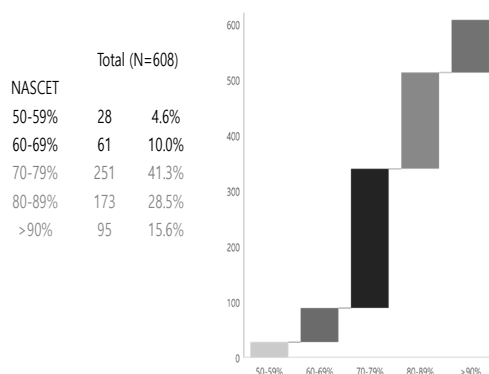


2012-2021 Carotid Stenting In DEMC

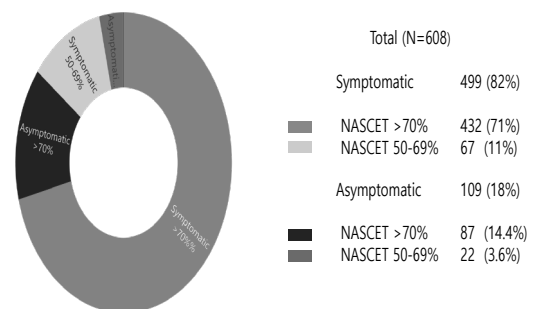
- N = 608
- M : F = 477 : 131
- Age : 77.3 y (39-96)



Severity of Carotid Stenosis



2012-2021 Carotid stenting In DEMC



2012-2021 Carotid stenting In DEMC

Total (N=608)		2011 AHA Guideline	2017 ESVS Guideline
Symptomatic	499 (82%)		
NASCET >70%	432 (71%)	Class I, Level B	Class IIa or IIb, Level B
NASCET 50-69%	67 (11%)	Class I, Level B	Class IIb, Level B
Asymptomatic	109 (18%)		
NASCET >70%	87 (14.4%)	Class IIa, Level B	Class IIb, Level B
NASCET 50-69%	22 (3.6%)	Class IIb, Level B	Class IIb, Level B

30-days Mortality/Stroke after CAS in DEMC

30 days Risks	N	(%)
Any Stroke	9	1.48%
Transient Neurological Deficit	6	0.98%
Disabling Stroke	1	0.16%
Death	2	0.33%
Death/Disabling Stroke	3	0.49%
Death/Any Stroke	11	1.8%

ASCENT 2021

Basic Tactics

- 3D imaging

Degree of Stenosis

Morphological Topography of atheroma and plaque

Working projection

Planning (EPD, Ballooning, Stenting)

Technical Tips

- Guiding Support
- Safe wire selection of Stenotic portion
- Delivery of EPD
- Balloon angioplasty
- Selection of stent and Precise Stent Placement
- Safe retrieval of EPD

Case Review & Discussion

Unresolved Carotid Issue

- Is it acceptable in Korea that the risk threshold of CAS is 6%(symptomatic) and 3%(asymptomatic) ?
- New DWI-MRI lesions after CAS, Do these contribute towards cognitive decline?

Thank you for your listening

Escape from complicated situation

김 영 우

가톨릭대학교 부천성모병원 신경외과

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery
Date : 2021.06.25(FRI) ~ 26(SAT)
Venue : 강릉 세인트존스호텔 그랜드볼룸

Basic endovascular training course

Escape from complicated situation

Department of Neurosurgery, Bucheon St. Mary's Hospital,
The Catholic University of Korea

Young Woo Kim

ASCENT 2021 (09:00~12:00, June 26th, 2021, 강릉 세인트존스호텔)

THE CATHOLIC UNIVERSITY OF KOREA
UIJEONGBU ST. MARY'S HOSPITAL

CAS outcome will improve with

CAS related complication: 0.9% ~ 9.3%¹

- Better patient selection
- Better devices
- Technical improvement
- Additional operator experience

¹ L. Bertog SC et al. J Cardiovasc Surg. 2013

Risk factors of CAS complications

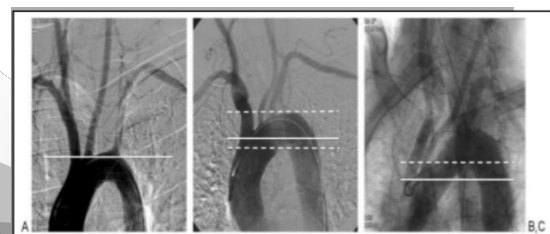
Table 2. Features Suggested to Increase the Risk of a Carotid Stent Procedure

Medical comorbidity	Anatomic criteria	Procedural factor
- Elderly (>75/80 years) - Symptom status - Hypercoagulable state - Bleeding risk - Chronic kidney disease - Decreased cerebral reserve	- Type III aortic arch - Vessel tortuosity - Heavy calcification - Lesion related thrombus - Echolucent plaque - Aortic arch atheroma	- Inexperienced operator/center - EPD not used - Lack of femoral access - Time delay from onset of symptoms - Open cell versus closed cell stent

White Cj et al. Cath & Card Vasc Int. 2013

Aortic Arch complexity

- Classified based on the origins of the great vessels
 - Type I – origins are level with upper convexity
 - Type II – origins are between the upper and lower convexity
 - Type III – origins are caudal to lower convexity



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Technique

- 1. DAPT (at least for 5-7 days)
- 2. Local anesthesia
- 3. Place guiding catheters in CCA: about 40% of the major complications¹
- 4. Cross the stenosis with microwire
- 5. Place PED
- 6. Pre-dilatation with small balloon
- 7. Place stent
- 8. Post-dilatation, if needed
- 9. Removal of PED and sheath

1. Verzini F et al. Vasc. Surg. 2006

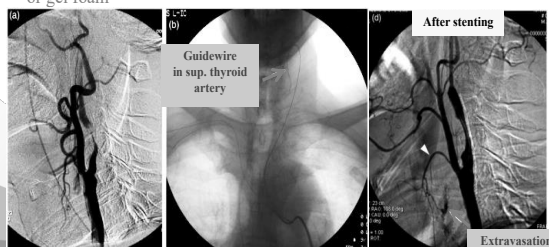
Possible Complications

- 1. ECA branch perforation
- 2. CCA dissection
- 3. Ophthalmic & Retinal artery embolization
- 4. ECA compromise
- 5. ICA occlusion (Flow arrest) !!
- 6. Embolic complication
- 7. Difficulty with filter removal
- 8. Carotid perforation
- 9. Access site complications
- 10. Other technical problems
- 11. Transient bradycardia and hypotension
- 12. Cerebral hyperperfusion
- 13. ICH
- 14. Contrast encephalopathy



1. ECA branch perforation

- < 0.3%¹
- Caused by positioning a stiff 0.035 inch wire into the ECA to provide support for guide sheath into the CCA
- **Rescue Tx.:** Prolonged balloon inflation or embolization using coils, glue, or gel foam

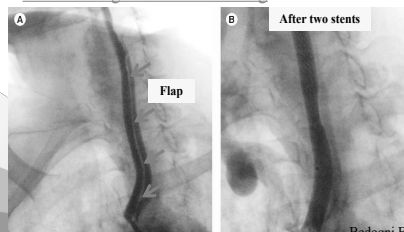


Nomura M, et al. Neuroradiol J. 2015

1. Ecker RD et al. J Invasive Cardiol 2005

2. CCA dissection

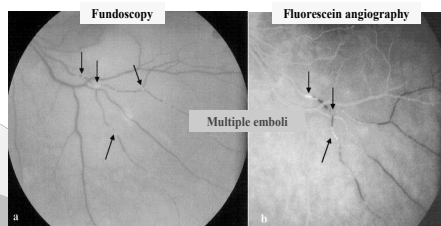
- Caused by aggressive manipulation of the guiding catheter against the arterial wall
- **Rescue Tx.**
 - Non-flow limiting: Observation
 - Flow limiting: Additional stenting



Bedogni F et al. Interv. Cardiol. 2009

3. Ophthalmic & Retinal artery embolization

- 4 ~ 15% (Symptomatic: 0.2~1.7%)^{1,2}
- Caused by embolus migration
 - via the ICA and ophthalmic a.
 - via orbital branch of MMA → recurrent br. of lacrimal a.



1. Wilentz JR et al. Catheter Cardiovasc Interv 2002

2. J.A Vos M.H. et al. Cardiovasc Intervent Radiol. 2010

Rescue Tx.

- No standard rescue Tx. → Consider IA thrombolysis (like Tx. for CRAO)
- IA thrombolysis
 - tPA¹ (10mg)
 - UK² (10,000 units/min → total of maximum 1 million units)
 - Glycoprotein IIb/IIIa inhibitors³
 - Eptifibatide (180 µg/kg bolus + 2µg/kg/min for 18 hours)
- IV thrombolysis
 - 0.4 µg/kg/min for 30 mins. + 0.10 µg/kg/min maintenance infusion⁴
- Conventional therapies (after procedure) → Ophthalmology consultation!
 - Ocular massage
 - Topical timolol (β-blocker), IV acetazolamide and mannitol
 - Ant. Chamber tap
 - Hyperbaric oxygen therapy

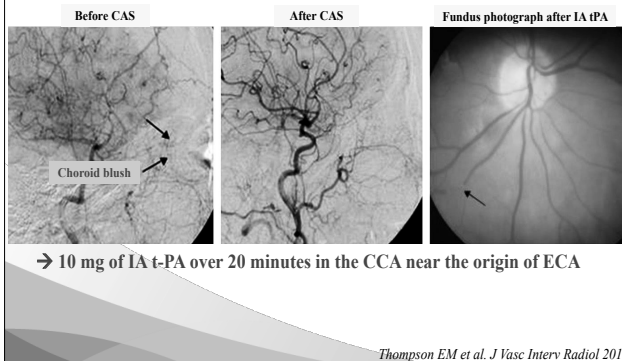
1. Thompson EM et al. J Vasc Interv Radiol 2011

2. Zhang X et al. neurol Res. 2009

3. Bertog SC et al. J Cardiovasc Surg. 2013

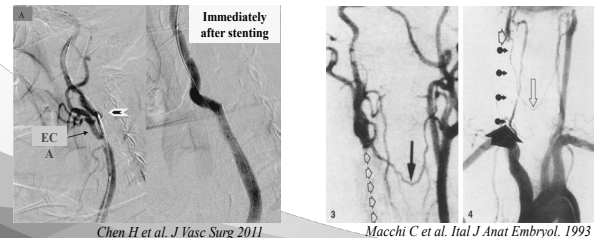
4. Luisa Perroo et al. Eur J Ophthalmol 2016

IA thrombolysis - tPA



4. ECA compromise

- Caused by plaque shifting after stenting
- Well tolerated d/t rich network of collaterals from the contralat. ECA & ipsilateral ICA
- Jaw claudication: ECA occlusion → maxillary a. occlusion (masseter and temporalis m.) → resolves spontaneously with time



5. ICA occlusion (Flow arrest) !!

- Usually the consequence of

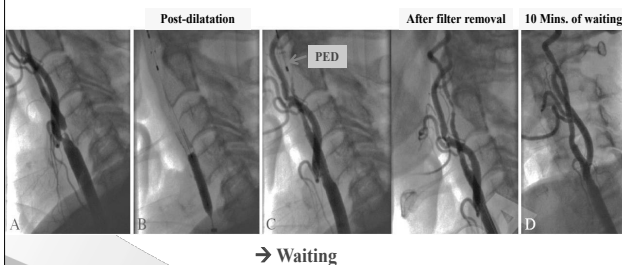
- 5-1. Vasospasm
- 5-2. Dissection
- 5-3 Acute thrombosis
- 5-4 Filter occlusion (m/c, 8~30%)^{1,2}

1. Bonaldi G et al. J Neurosurg. 2005
2. Kwon BJ et al. J Endovasc Ther. 2006

5-1. Vasospasm

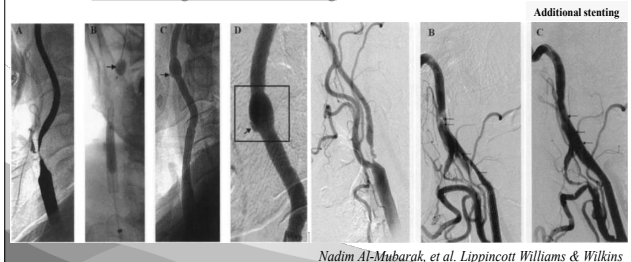
- Usually occurs related to the PED
- Rescue Tx.
 - Non-flow limiting
 - Procedure completion → filter removal → waiting a few minutes
 - Flow limiting
 - Wire should not be removed
 - Immediate vasodilator (IA nitroglycerine 100-400 µg / nicardipine 200-400 µg)
 - Stenting or balloon dilatation: strictly avoided

Flow-limiting Vasospasm after procedure completion



5-2. Dissection

- At the location of the distal PED, or distal or prox. stent edge
- Rescue Tx.
 - Non-flow limiting: Observation
 - Flow limiting: Additional stenting



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5-3. Acute stent thrombosis (AST)

➤ 0.5% ~ 2%

➤ Rescue Tx.

- Stent underexpansion → balloon angioplasty
- Protruding plaque or dissection
 - prolonged balloon inflation, if tolerable
 - stent-within-a-stent¹
- IA thrombolysis (UK, rtPA, GP IIb-IIIa inhibitor)
 - Abciximab²⁻⁴ or Tirofiban⁵
- Thromboaspiration through guiding or sheath
- Suction thrombectomy (Penumbra)^{6,7}
- Surgical management → stent removal & CEA⁸

1. Masuo O et al. *Nrrol Ned Chir*. 2006)

3. Steiner-Boker S et al. *AJNR*. 2004

5. Seo KD et al. *Yonsei Med J*. 2008

7. Munich S et al. *J Neurointerv Surg*. 2014)

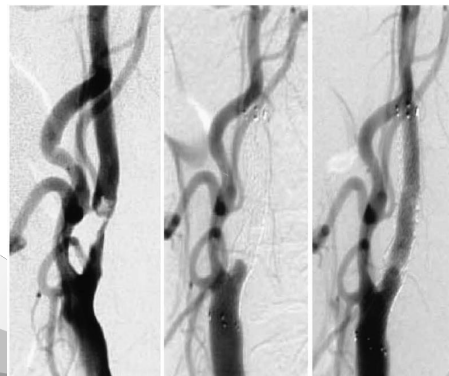
2. Bush RL et al. *J Endovasc Ther* 2003

4. Van den Berg JC. *Eur J Vasc Endovasc Surg* 2008

6. Kim YW et al. *Acta Neurochir*. 2013

8. Setacci C et al. *J Vasc Surg* 2005

Stent-within-a-stent



Masuo O et al. *Nrrol Ned Chir*, 2006

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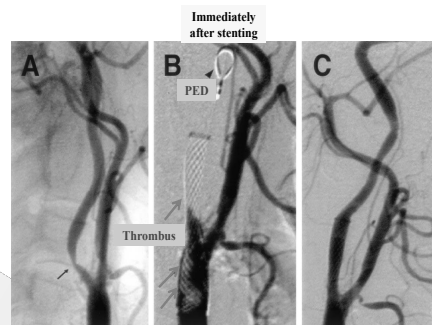
2. Bush RL et al. *J Endovasc Ther* 2003

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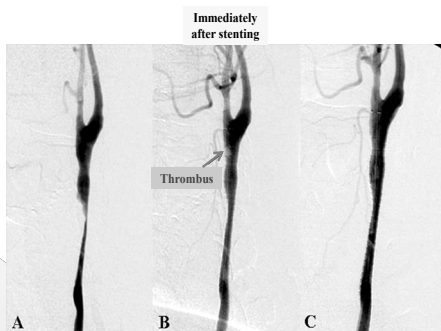
IA thrombolysis (1) – tPA + Abciximab



→ tPA (5mg via guiding + 5mg systemic) + IA abciximab 0.125 mg/kg

Steiner-Boker S et al. *AJNR*. 2004

IA thrombolysis (2)- Tirofiban



→ 0.4 µg/kg/min for 30 Mins. + 0.1 µg/kg/min for the next 26 hours

Seo KD et al. *Yonsei Med J*. 2008

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7. Munich S et al. *J Neurointerv Surg*. 2014)

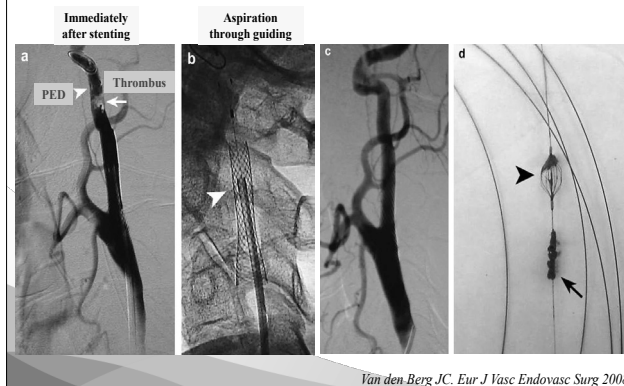
2. Bush RL et al. *J Endovasc Ther* 2003

4. Van den Berg JC. *Eur J Vasc Endovasc Surg* 2008

6. Kim YW et al. *Acta Neurochir*. 2013

8. Setacci C et al. *J Vasc Surg* 2005

Aspiration through guiding + Abciximab

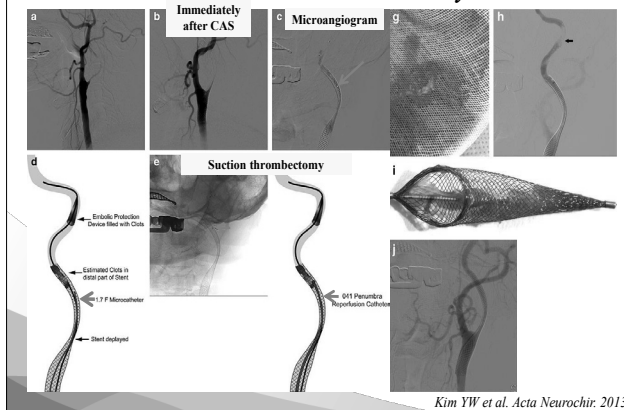


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2. Bush RL et al. J Endovasc Ther. 2003
3. Steiner-Boker S et al. AJNR. 2004
4. Van den Berg JC. Eur J Vasc Endovasc Surg 2008
5. Seo KD et al. Yonsei Med J. 2008
6. Kim YW et al. Acta Neurochir. 2013
7. Munich S et al. J Neurointerv Surg. 2014
8. Setacci C et al. J Vasc Surg 2005

Suction Thrombectomy

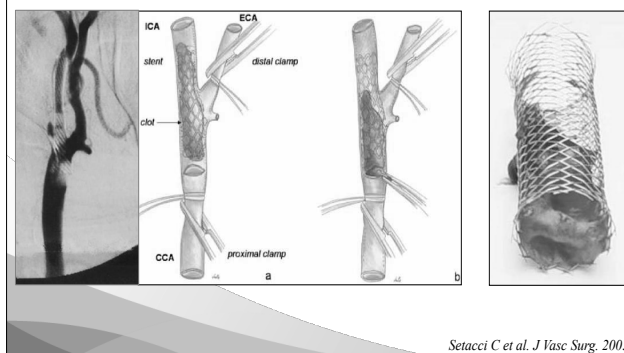


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6. Kim YW et al. Acta Neurochir. 2013
7. Munich S et al. J Neurointerv Surg. 2014
8. Setacci C et al. J Vasc Surg. 2005

Surgical management



5-4. Filter occlusion

- d/t large burden of embolic material in the filter obstructing flow
- Rescue Tx.
 1. Rule out other causes (dissection, spasm, or thrombus in the stent)
 2. Thromboaspiration through guiding (50-100 cc) of ICA blood
 3. Thromboaspiration with aspiration catheter as close to the filter
 4. Filter retrieval

6. Embolic complication

- Thromboembolism after CAS: 0.04~2%
- Rescue Tx. (Like Tx. for AIS)
 - Wire or microcatheter passage
 - Balloon angioplasty
 - IA tPA/UK and/or eptifibatide or abciximab
 - Under balloon guiding
 - Mechanical neuro-rescue - Aspiration or thrombus extraction

7. Difficulty with filter removal

- 7.7~10.2%¹
- 7-1. Difficulty with passing the retrieval sheath through the deployed stent
 - caused by
 - 1) the protruding struts of the stent (esp. due to its open cell type nature of the stent)
 - 2) the acute angle between stents and CCA
- 7-2. PED entrapment within the stent

Bertog SC et al. J Cardiovasc Surg. 2013

Rescue Tx.

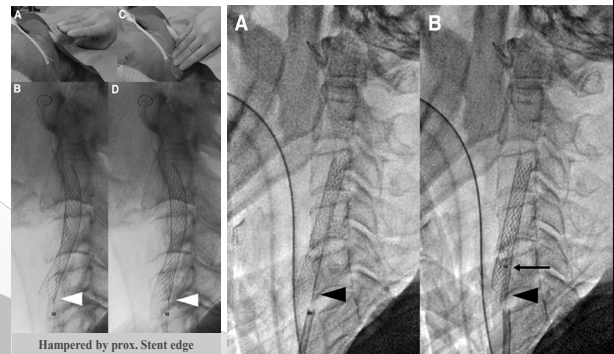
- 7-1. Difficulty with passing the retrieval sheath through the deployed stent
 - 1. Advance guiding catheter close to or into the stented segment
 - 2. Turning head, deep breath, & cough
 - 3. Manual carotid compression^{1,2} (lateral or vertical pressure)
 - straighten the angle between stent and the CCA
 - 4. Angled 5F catheter^{3,4}
 - The tip directed away from the impeding stent strut
 - If monorail system-EPD, creating a hole near
 - 5. Balloon advancement
 - 6. Post-dilatation
 - If the filter shears off the wire → retrieval with a snare

- 7-2 PED entrapment within the stent

- To-and-Pro motion → Surgical removal

1. Watanabe M, et al. J Vasc Interv Neurol 2013
2. Nil K et al. J Stroke Cerebrovasc Dis. 2015
3. Daugherty WP et al. AJNR, 2008
4. Ahn SH et al. Semin Intervent Radiol 2013)

Manual carotid compression



Nil K et al. J Stroke Cerebrovasc Dis. 2015

Rescue Tx.

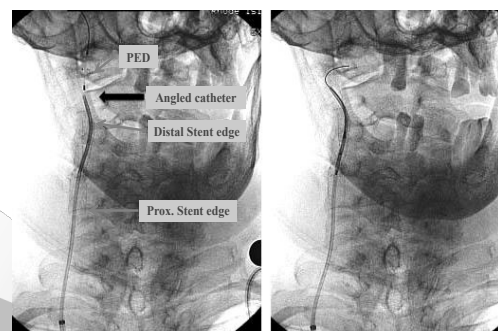
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3. Daugherty WP et al. AJNR, 2008
4. Ahn SH et al. Semin Intervent Radiol 2013)

Angled catheter (5F diagnostic catheter)



Ahn SH et al. Semin Intervent Radiol 2013

Rescue Tx.

➤ 7-1. Difficulty with passing the retrieval sheath through the deployed stent

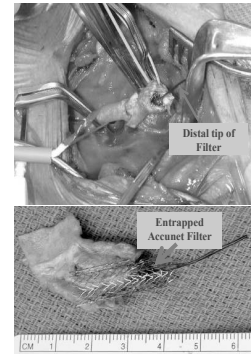
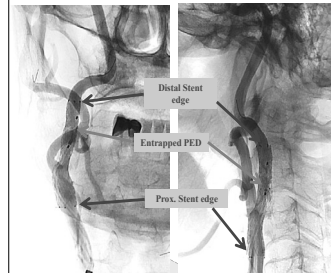
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➤ 7-2 PED entrapment within the stent

- To-and-Fro motion → Surgical removal

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2. Nil K et al. *J Stroke Cerebrovasc Dis.* 2015
3. Daugherty WP et al. *AJNR*, 2008
4. Ahn SH et al. *Semin Intervent Radiol*, 2013
5. Shilling K et al. *Vasc Endovascular Surg.* 2006

To-and-Fro motion → Surgical removal



Shilling K et al. *Vasc Endovascular Surg.* 2006

8. Carotid perforation

➤ < 0.1%

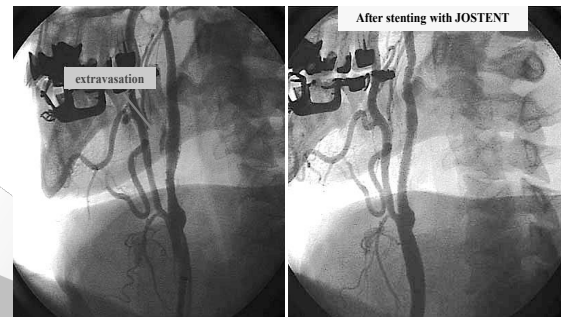
- Caused by aggressive pre- and postdilatation → Leakage of the contrast from the ICA

➤ Rescue Tx.

- Heparin reverse (protamine sulfate) + immediate and prolonged soft balloon inflation
- Covered stent implantation (concern for a higher thrombosis rate)

Dieter RS et al. *Catheter Cardiovasc Interv* 2006

Covered stent



Dieter RS et al. *Catheter Cardiovasc Interv* 2006

9. Access site complications

➤ 1~1.3%¹

- Utility of closure devices: controversial

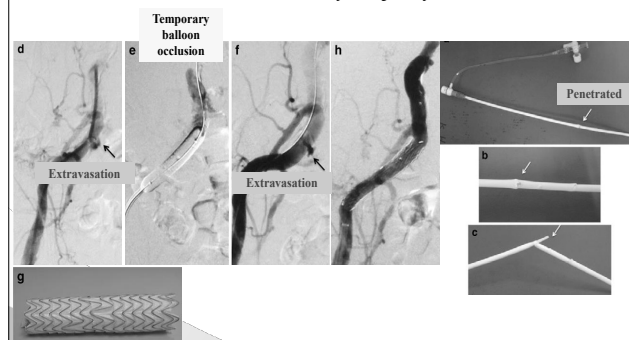
➤ Pseudoaneurysm²

- Risk factors: HTN, DM, CAD, BMI ↑, Catheter diameter ↑
- Rescue Tx.
 - <2cm: spontaneous resolution without treatment
 - Larger or symptomatic:
 - Thrombin injection or prolonged ultrasound guided compression
 - Surgical repair (4.7%)

- AVF: surgical closure or covered stent

1. Bertog SC et al. *J Cardiovasc Surg.* 2013
2. Ates M et al. *J. Vasc. Surg.* 2006

Iliac artery injury

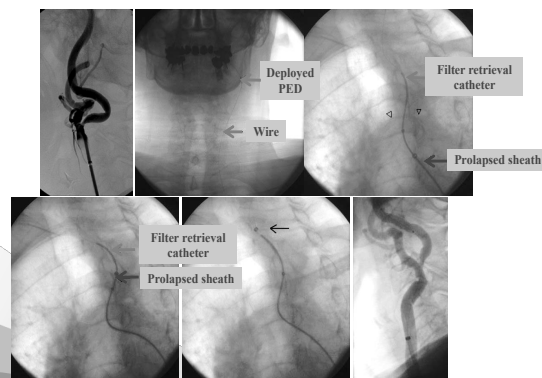


Hayashi K et al. *Acta Neurochir* 2014

10. Other technical problems

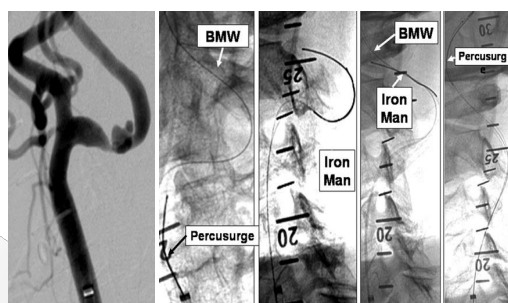
- 10-1. Guiding or Sheath Prolapse back into aortic arch
- 10-2. Difficulty with advancement of filter
- 10-3. Fused Monorail balloon and PED
- 10-4. FilterWire Ex membrane tear

10-1. Sheath Prolapse back into aortic arch



Chiam PT et al. Catheter Cardiovasc Interv. 2008

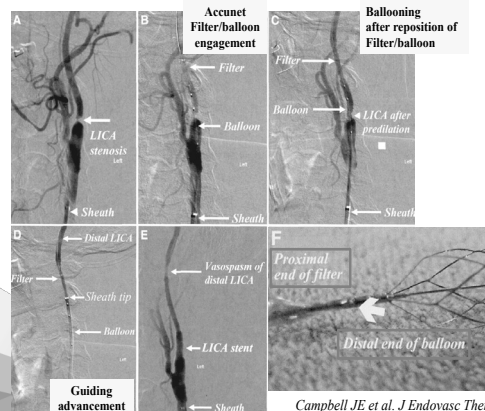
10-2. Difficulty with filter advancement



→ "buddy wire" technique

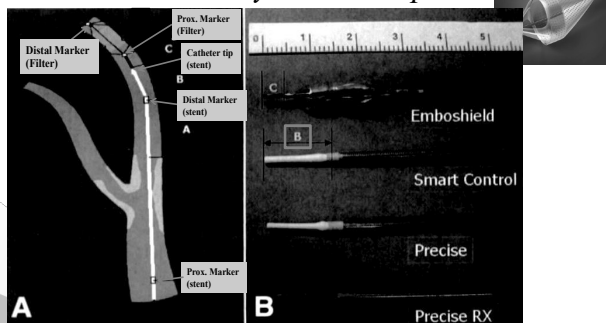
Malik RK et al. J Vasc Surg 2009

10-3. Fused Monorail balloon and PED



Campbell JE et al. J Endovasc Ther 2007

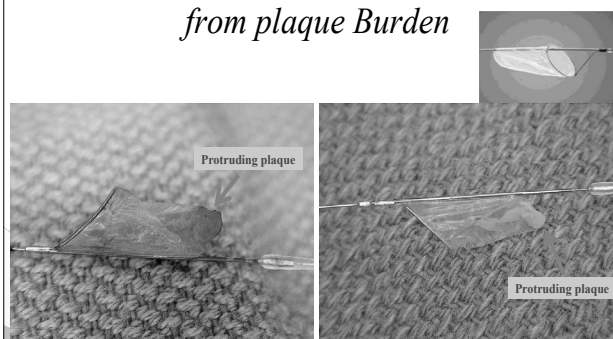
EmboShield filter wedging in the stent delivery catheter tip



Several to-and-fro movements of the stent delivery catheter along with the filter's guidewire

Kwon BJ et al. J Endovasc Ther 2006

10-4. FilterWire Ex membrane tear from plaque Burden



Inability of the retrieval sheath to encase large plaque burdens that exceed its lumen capacity.

Nguyen N et al. Catheter Cardiovasc Interv 2005

11. Transient bradycardia and hypotension

- 29~70% (vary depending on the definition)^{1,2}
- Caused by wall strain on the carotid sinus related to balloon inflation or stent implantation
- Prevention
 - temporary pacemaker prior to the stenting
 - pretreatment with 0.5 to 1 mg of IV atropine
 - caution in elderly: Large doses → confusion, blurry vision, urinary retention, dry mouth (10-20%)³
- Rescue Tx.
 - Awake consciousness by beating chest
 - Hydration and/or small dose of IV vasopressors
 - If Symptomatic hypotension → norepinephrine or dopamine (bradycardia)

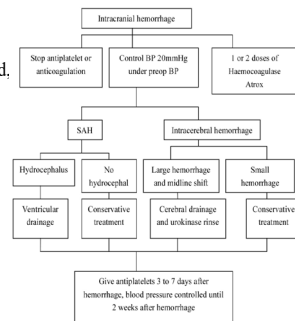
1. Yadav JS et al. Circulation. 1997
 2. Diehm N et al. J Vasc Interv Radiol. 2008
 3. Qureshi AI et al. Stroke-a journal of cerebral circulation. 1999

12. Cerebral hyperperfusion

- Following CEA and CAS: 0.3~2.7% and 1.1%, respectively
- Typically occurs in patients with
 - severe stenosis and poor collateral circulation,
 - particularly in those with complete occlusion of the contralateral ICA or patients with an underdeveloped circle of Willis.
- Related to long-standing hypoperfusion → impaired autoregulation
- Strict BP control

13. ICH

- approximately 0.3% (<1%)
- If a cerebral hemorrhage is suspected,
 - the procedure should be terminated
 - Heparin reverse & emergent op.



Xu Y et al. Interv Neuroradiol 2009

14. Contrast encephalopathy

- <0.1%
- Etiology: extravasation of contrast via a compromised BBB
- Neurologic deficit: cortical blindness and altered level of consciousness
- CT: contrast enhancement in the ipsilateral basal ganglia and cortex or sulcal enhancement
- Resolve without treatment usually within 24 hours

Take home message

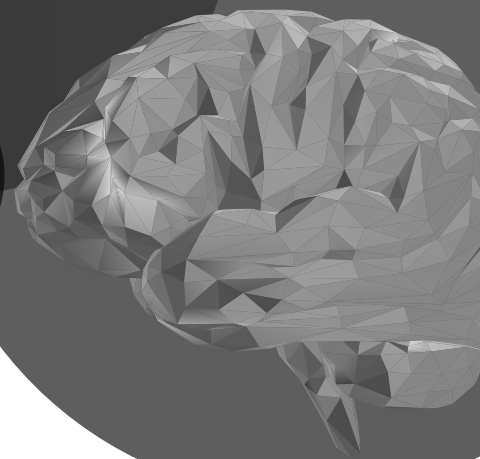
- CAS is not difficult, but, complication is the main issue.
- Prevention is the best way, but it is impossible to avoid complication. → “informed consent !”
- Recognize possible factors associated with an increased risk of complications.
- A cautious and tailored approach are mandatory.



The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/26(Sat.)

Luncheon seminar

좌장 : 이창영(계명대) / 김문철(에스포항병원)

1. Role of direct thrombin inhibitor for acute ischemic stroke
2. Safety and feasibility of using Argatroban

정진영(연세에스병원)

이동훈(가톨릭대)

Role of direct thrombin inhibitor for acute ischemic stroke

정진영

연세대학교병원 신경외과

YONSEI HOSPITAL
연세대학교병원

Role of direct thrombin inhibitor for acute ischemic stroke

연세대학교병원 신경외과
정진영

26 June, 2021 ASCENT

Treatment of Acute Ischemic Stroke

ISCHEMIC STROKE

Thrombectomy Thrombolysis

Antiplatelets Anticoagulants

Antihypertensives

What is the parenteral thrombolytic therapy for AIS?

TPA (Alteplase, Activase®) for Acute Ischemic Stroke Development Timeline

KNOW STROKE
KNOW THE SIGNS. ACT IN TIME.

1947: Swedish researchers describe enzyme that will become known as tissue plasminogen activator (tPA).

1977-1981: German researchers isolate tPA from a melanoma cell line in large quantities and show that it can dissolve blood clots in animal models.

1983: Small and then large-scale clinical trials test tPA in heart attack patients.

1985-1992: First clinical trials test tPA in stroke patients, including the first studies for developing organized stroke teams and protocols for treatment within 3 hours of symptom onset.

1987: FDA approves tPA for treatment of acute myocardial infarction, or heart attack.

1995: Several studies report the efficacy of tPA in animal models of stroke with improved outcomes and low risk of hemorrhage when treatment is initiated early.

1996: Focal Phase III trial demonstrates the safety and efficacy of tPA for acute ischemic stroke.

1998-2001: FDA approves tPA for the treatment of acute ischemic stroke.

2015: Out clinical trials are shown to be more effective than tPA alone for strokes involving clots in large arteries.

Reconstructing studies show benefits of tPA treatment in certain, high hospital settings where rapid treatment protocols are followed.

Academic and industry researchers assess recombinant tPA, enabling purification in amounts sufficient for commercial sale.

Ref: https://www.ninds.nih.gov/studies/tfau/tfau/tfpa_design_508.pdf

Which agent is FDA approved for thrombolytic therapy of acute ischemic stroke (AIS)?

Updated: Dec 26, 2017 | Author: Wanda L. Rivera-Bou, MD, FAAGM, FACEP; Chief Editor: Erik D. Schraga, MD, more...

Which agent is FDA approved for thrombolytic therapy of acute ischemic stroke (AIS)?

The US Food and Drug Administration (FDA) approved the use of IV tissue plasminogen activator (tPA) in 1996, partly on the basis of the results of the National Institute of Neurological Disorders and Stroke (NINDS) trial of IV recombinant tPA (rTPA). Favorable outcomes were achieved in 31-50% of patients treated with rTPA and 20-38% of patients given placebo; the major risk of treatment was symptomatic intracranial hemorrhage (sICH), which occurred in 6.4% of patients treated with rTPA and in 0.6% of patients given placebo.

The New England Journal of Medicine

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Volume 333 DECEMBER 14, 1995 Number 24

TISSUE PLASMINOGEN ACTIVATOR FOR ACUTE ISCHEMIC STROKE

Abstract Background. Thrombolytic therapy for acute ischemic stroke has been approached cautiously because there were high rates of intracerebral hemorrhage in early clinical trials. We performed a randomized, double-blind trial of intravenous recombinant tissue plasminogen activator (tPA) for ischemic stroke after recent plausibly suggested that tPA was beneficial when treatment was begun within three hours of the onset of stroke.

Methods. The trial had two parts. Part 1 (in which 291 patients were enrolled) tested whether tPA had clinical activity, as indicated by an improvement of 4 points over base-line values in the scores of the National Institute of Health stroke scale (NIHSS) or the resolution of the neurologic deficit within 24 hours of the onset of stroke. Part 2 (in which 333 patients were enrolled) used a global test statistic to assess clinical outcome at three months, according to scores on the Barthel index, modified Rankin scale, Glasgow outcome scale, and NIHSS.

Results. In part 1, there was no significant difference between the group given tPA and that given placebo in the percentage of patients with neurologic improvement at 24 hours, although a benefit was observed for the tPA group at three months for all four outcome measures. In part 2, the long-term clinical benefit of tPA predicted by the results of part 1 was confirmed (global odds ratio for a favorable outcome, 1.7; 95 percent confidence interval, 1.2 to 2.5). As compared with patients given placebo, patients treated with tPA were at least 30 percent more likely to have minimal or no disability at three months on the assessment scales. Symptomatic intracerebral hemorrhage within 36 hours after the onset of stroke occurred in 6.4 percent of patients given tPA and only 0.6 percent in patients given placebo ($P < 0.001$). Mortality at three months was 17 percent in the tPA group and 21 percent in the placebo group ($P = 0.30$).

Conclusions. Despite an increased incidence of symptomatic intracerebral hemorrhage, treatment with intravenous tPA within three hours of the onset of ischemic stroke improved clinical outcome at three months. (N Engl J Med 1995;333:1055-7).

Ref: <https://www.nejm.org/doi/full/10.1056/NEJM199512143332401>
the New England Journal of Medicine: volume 333 December 14, 1995 number 24

ASCENT 2021

AHA/ASA Guideline 2018

AHA/ASA Guideline

2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Reviewed for evidence

3.9. Antiplatelet Treatment

Endorsed by	COR	LOE	New, Revised, or Unchanged
1. Administration of aspirin is recommended in patients with AIS within 24 to 48 hours after onset. For those treated with IV alteplase, aspirin administration is generally delayed until 24 hours later but might be considered in the presence of concomitant conditions for which such treatment given in the absence of IV alteplase is known to provide substantial benefit or withholding such treatment is known to cause substantial risk.	I	A	Recommendation revised from 2013 AIS Guidelines.
5. In patients presenting with minor stroke, treatment for 21 days with dual antiplatelet therapy (aspirin and clopidogrel) begun within 24 hours can be beneficial for early secondary stroke prevention for a period of up to 90 days from symptom onset.	IIIa	B-R	New recommendation.

Ref Stroke, 49 (3), e46-e110

AHA/ASA Guideline 2019 Update

AHA/ASA GUIDELINES

Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke

A guideline for healthcare professionals from the American Heart Association/American Stroke Association

3.9. Antiplatelet Treatment

Endorsed by	COR	LOE	New, Revised, or Unchanged
1. Administration of aspirin is recommended in patients with AIS within 24 to 48 hours after onset. For those treated with IV alteplase, aspirin administration is generally delayed until 24 hours later but might be considered in the presence of concomitant conditions for which such treatment given in the absence of IV alteplase is known to provide substantial benefit or withholding such treatment is known to cause substantial risk.	I	A	Recommendation revised from 2013 AIS Guidelines.
2. In patients presenting with minor noncardioembolic ischemic stroke (NIHSS score ≤3) who did not receive IV alteplase, treatment with dual antiplatelet therapy (aspirin and clopidogrel) started within 24 hours after symptom onset and continued for 21 days is effective in reducing recurrent ischemic stroke for a period of up to 90 days from symptom onset.	I	A	New recommendation.

Ref Stroke December 2019

AHA/ASA Guideline 2019 Update

AHA/ASA GUIDELINES

Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke

A guideline for healthcare professionals from the American Heart Association/American Stroke Association

3.9. Antiplatelet Treatment

Endorsed by	COR	LOE	New, Revised, or Unchanged
3. The efficacy of the IV glycoprotein IIb/IIIa inhibitors tirofiban and eptifibatide in the treatment of AIS is not well established.	IIIb	B-R	Recommendation revised from 2013 AIS Guidelines.
4. Ticagrelor is not recommended over aspirin for treatment of patients with minor acute stroke.	III: No Benefit	B-R	New recommendation.
5. The administration of the IV glycoprotein IIb/IIIa inhibitor abciximab as medical treatment for AIS is potentially harmful and should not be performed.	III: Harm	B-R	Recommendation revised from 2013 AIS Guidelines.
6. Aspirin is not recommended as a substitute for acute stroke treatment in patients who are otherwise eligible for IV alteplase or mechanical thrombectomy.	III: Harm	B-R	Recommendation revised from 2013 AIS Guidelines.

Ref Stroke December 2019

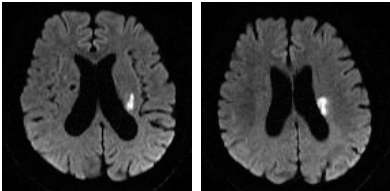
Real world stroke treatment

AIS patients who are not eligible for tPA or IAT

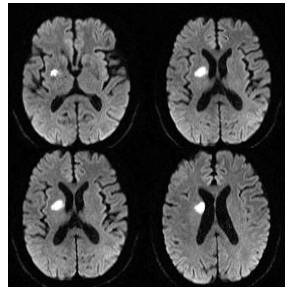
Early neurological deterioration(END) following AIS

Adjunctive Option of Intra-arterial Thrombectomy

M/63 right hemiparesis, beyond 4.5hrs NIHSS 5




M/74 left hemiparesis, beyond 4.5hrs NIHSS 3




AHA/ASA Guideline 2019 Update

AHA/ASA GUIDELINES

Guidelines for the Early Management of Patients with Acute Ischemic Stroke: Update to the 2018 Guidelines for the Management of Acute Ischemic Stroke

A guideline for healthcare professionals from the American Heart Association/American Stroke Association

CLASS IIb (WEAK)

Suggested phrases for writing recommendations:

- May/might be reasonable
- May/might be considered
- Usefulness/effectiveness is unknown/unclear/uncertain or not well established

LEVEL B-R

3.10. Anticoagulants

3. At present, the usefulness of argatroban, dabigatran, or other thrombin inhibitors for the treatment of patients with AIS is not well established.	IIb	B-R
---	-----	-----

Several observational studies have demonstrated the safety and feasibility of treating AIS with thrombin inhibitors as either a single or adjunct therapy to alteplase. The oral direct thrombin inhibitor dabigatran was studied in 53 patients with TIA or minor stroke (NIHSS score ≤ 3) with no occurrences of sICH up to 30 days.²⁴ ARTESAR Argatroban With Recombinant Tissue Plasminogen Activator for Acute Stroke²⁵ was an open-label, pilot safety study of argatroban infusion plus IV alteplase in 65 patients with complete or partially occluded thrombi diagnosed by transcranial Doppler²⁶ in the ARTIST-2 phase I study. Patients with AIS treated with alteplase (n=50) were randomized to receive placebo or argatroban (100-mg/kg bolus), followed by infusion of either 1 (low dose) or 3 (high dose) mg/kg per minute for 48 hours. Rates of AICH were similar among the control, low-dose, and high-dose arms: 3 of 29 (10%), 4 of 30 (13%), and 2 of 31 (6%), respectively.²⁶ Further trials are necessary to clarify the safety and efficacy of this intervention.

Ref Stroke December 2015

See Tables XLIX and L in online Data Supplement 1.

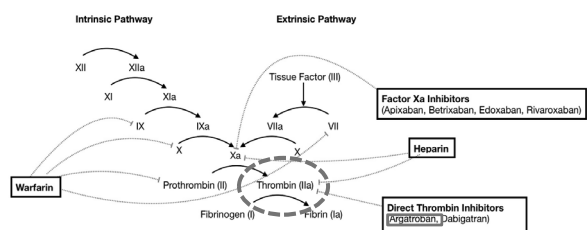
Argatroban Profiles: Direct thrombin inhibitor

Structure	Synthetic low-molecular weight, heterocyclic of derivative of L-arginine (molecular mass 508.7 Da).
Mechanism of Action	Competitive, direct thrombin inhibitor that reversibly binds to thrombin active site
Distribution	Protein bound: 54% Vd: 174 mL/kg
Metabolism	Liver
Elimination	Half-life: 39-51 min Total body clearance: 5.1 mL/kg/min Excretion: Feces (65%); urine (22%)

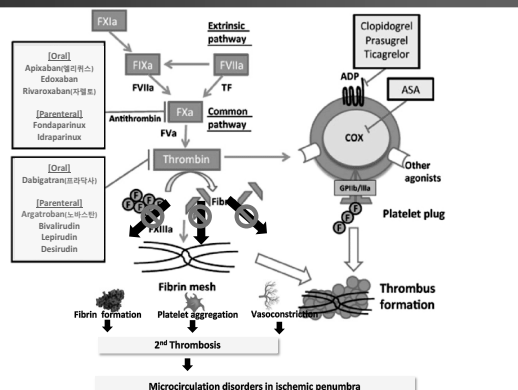


개요 정보	노티피케이션을 위한 NotificationService 인터페이스에 대한 NotificationService		
선언 / 실행	Application	여기서 호출되는 NotificationService	클래스 다이어그램
참고 사항	변경되어야 하는 주 프로그램은 수신되는 메시지를		
전달 / 반환	전달	반환 / 결과	반환
개조 / 주입성	개조 (개조기) (비동기) (고정)에 의해	반환성	
개방	주요성	무엇으로	주요성
선언	주요성 (선언) (개조기) (비동기) (고정)에 의해		
주요성	주요성 (선언) (개조기) (비동기) (고정)에 의해		

Argatroban exhibits anticoagulant action by inhibiting fibrin formation, platelet aggregation and vasoconstriction caused by thrombin action

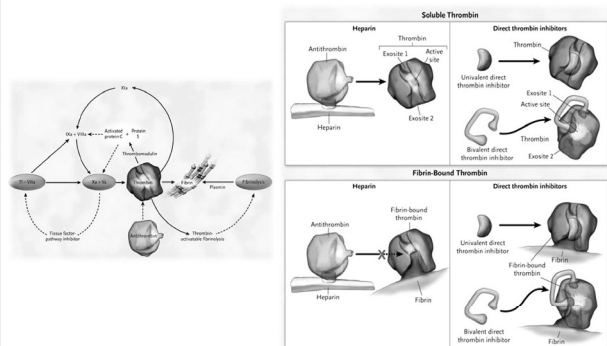


Argatroban exhibits anticoagulant action by inhibiting fibrin formation, platelet aggregation and vasoconstriction caused by thrombin action



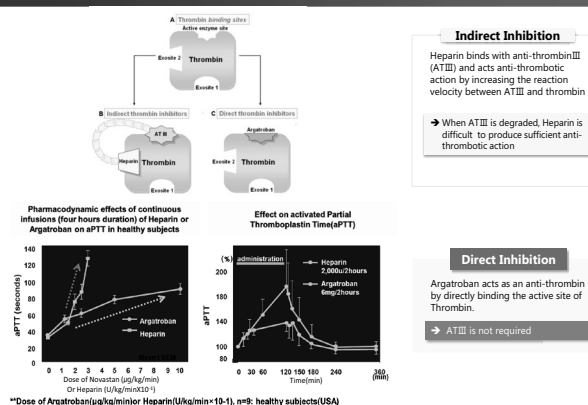
Manuscript Exit Row: 2012 Nov 19 (C) 2012, 8:12

Difference between Heparin vs. Argatroban



Ref. N Engl J Med 2005; 353:1028-1040

Difference between Heparin vs. Argatroban



1. Journal of Materials Science: Materials in Medicine (2018) 29:66.
2. SEMINARS IN THROMBOSIS AND HEMOSTASIS—VOL. 23, NO. 6, 1

Anticoagulants Systematic search (2017)

ORIGINAL ARTICLE

Anticoagulation in acute ischemic stroke: A systematic search

NAYARA L. FROST¹, RICHARD MURDOCH MONTGOMERY¹, ELIAS DAVID-NETO¹, NAN APRAHAMAN¹*¹Department of Internal Medicine, Faculdade de Medicina de Jundiaí, Jundiaí, SP (Brazil)

Results: Fourteen clinical trials were selected based on inclusion criteria. No evidence was found supporting the early use of heparin, heparinoids or low-molecular-weight heparin (LMWH) early after stroke. No consistent evidence for the use of warfarin and the newer oral anticoagulants were found. **Argatroban was the only anticoagulant with significant positive results early after large-artery ischemic stroke.**

Conclusion: The ideal time for initiating anticoagulation remains undefined, requiring further investigation. Early anticoagulation for ischemic stroke is not recommended, with few exceptions, such as that of argatroban.

Study design:

Computerized search for clinical trials and randomized controlled clinical trials was done to the present date at Medline, Scielo, Embase, PsycInfo, and Cochrane Library using MeSH terms and the keywords stroke, ischemic stroke, anticoagulation, anticoagulants, heparin, low-molecular-weight heparin, warfarin, dabigatran, rivaroxaban, apixiban. The PRISMA statement was used to evaluate clinical trials.

Rev Assoc Med Bras 2017; 63(3):50-56

Anticoagulants Systematic search (2017)

TABLE 1. Brief description and results of IST, TOAST, HAEST, TAST, FISS-III, and ARGIS-1 trials comparing anticoagulation versus aspirin or placebo in the acute management of ischemic stroke (up to 14 days after the event).

Drug used	FISS	IST	TOAST	HAEST	TAST	TOPAS	FISS-III	ARGIS-1
	Naftropidil 4,100 IU (4h), SC, 2x/daily; nadroparin 4,100 IU, once daily, or placebo	UFH 5,000 or 12,500 IU, SC, 2x/daily; or without aspirin 300 mg	Dabigatran 150 mg, daily, vs. aspirin 100 mg, daily; or 150 mg, daily vs. placebo	Aspirin 100 mg, daily, vs. aspirin 100 mg, daily; or 100 mg, daily vs. placebo	Ticlopidine 150 mg, daily, vs. aspirin 100 mg, daily; or 150 mg, daily vs. placebo	Ticlopidine 150 mg, daily, vs. aspirin 100 mg, daily; or 150 mg, daily vs. placebo	Naftropidil 4,100 IU (4h), SC, 2x/daily; nadroparin 4,100 IU, once daily, or placebo	Aspirin 100 mg, daily, vs. aspirin 100 mg, daily; or 100 mg, daily vs. placebo
Duration of anticoagulation	10 days*	14 days*	14 days	14 days	10 days*	12-18 days	10 days*	3 days
Time between onset and treatment	Within 48 hours	Within 48 hours	Within 24 hours	Within 10 hours	Within 48 hours	Within 12 hours	Within 48 hours	Within 12 hours

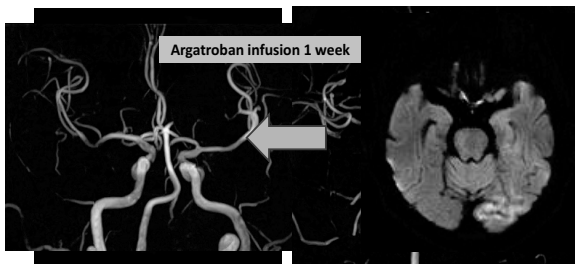
The main reason to avoid the use of anticoagulants was increase to the risk of bleeding.

However, bleeding rates did not differ between the therapeutic and placebo groups of the ARGIS-1 trial using argatroban

	Bleeding rates among the groups at 10 days	↑ Hemorrhagic stroke and extracranial bleeding at 14 days	favorable outcomes among patients at 14 days	hemorrhagic stroke at 14 days	particularly at 24 hours	groups. Clinical improvement in all groups within 14 days; lower bleeding rates in the aspirin group	and adverse events were not different among the groups	no major bleeding events were not different among the groups
Long term outcomes	Significant dose-dependent reduction in risk of death or dependency at 6 months with LMWH	Heparin showed no benefit for disability or death at 6 months	More favorable outcomes among large-artery atherosclerosis patients at 3 months	No differences between groups for independence or death at 6 months	No differences between groups with respect to favorable functional outcome at 90 days	Treatment groups were not different with respect to favorable functional outcome at 90 days	Patients with higher baseline scores had a higher rate of improvement at 90 days	Neurological scores did not differ among the groups at 90 days

IST: International Stroke Trial; TOAST: Trial of Org 10171 in Acute Stroke Treatment; HAEST: Heparin in Acute Ischemic Stroke Trial; TAST: Ticlopidine in Acute Ischemic Stroke Trial; TOPAS: Ticlopidine in Acute Ischemic Stroke Trial; FISS-III: Fibrinolytic Stroke Study; ARGIS-1: Argatroban in Ischemic Stroke Study. *Significant difference between groups.

Rev Assoc Med Bras 2017; 63(3):50-56

F/86 A-fib, old PCA infarction, deteriorated mentality
NIHSS 20, unclear onset, beyond 24hrs

Early neurological deterioration(END) following AIS

REVIEW

Incidence, causes and predictors of neurological deterioration occurring within 24 h following acute ischaemic stroke: a systematic review with pathophysiological implications

Pierre Seners,¹ Guillaume Turc,¹ Catherine Oppenheim,² Jean-Claude Baron¹

Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/jnnp-2014-028577).

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Received 16 April 2014

Revised 6 June 2014

Accepted 7 June 2014

ABSTRACT Early neurological deterioration (END) following ischaemic stroke is a serious event with manageable causes in only a fraction of patients. The incidence, causes and predictors of END occurring within 24 h of acute ischaemic stroke (END₂₄) have not been systematically reviewed. We systematically reviewed Medline and Embase from January 1990 to April 2013 for all studies on END₂₄ following acute ischaemic stroke (AIS) (within 24 h from onset). We recorded the incidence and presumed causes of and factors associated with END₂₄. Thirty-six studies were included. Depending on the definition used, the incidence of END₂₄ markedly varied among studies. Using the most widely used change in National Institutes of Health Stroke Scale ≥2 definition, the pooled incidence was 13.8% following thrombolysis, 10.8% following thrombolysis and malignant oedema each in ~20% of these. As other mechanisms were rarely reported, in the majority no clear cause was identified. Few data on END₂₄ occurring in non-thrombolysed patients were available. Across thrombolysed and non-thrombolysed samples, the strongest and most consistent admission predictors were hyperfibrinolysis, no prior aspirin use, prior transient

receptor or even deteriorations, so-called early neurological deterioration (END). Current estimates of incidence of END after AIS vary widely, from 5% to 40%, depending on the definition used (i.e. type of stroke scales and time frame used for the definition), but regardless of the definition used END is consistently associated with poor 3-month clinical outcome. Major causes of END include symptomatic intracranial haemorrhage (ICH) and malignant vasogenic oedema. Therefore, preventing END and, if it occurs, treating its underlying mechanism, is an important challenge towards improving stroke outcome.

Apart from ICH, malignant oedema and some additional unusual causes leading to specific management according to published—though not always standardised—guidelines, around a half of all ENDs may have no clear mechanism and are often referred to as ‘stroke progression’. Accordingly, no specific management is recommended in this situation, and no clear action is usually taken to try and reverse the deficit and hence prevent poor outcomes. Despite the rapidly growing literature on END in general, with the

Ref. 1 J Neurol Neurosurg Psychiatry, 86 (1), 87-94, 2 Postgrad Med J 2008;84:412-417

Early neurological deterioration(END) following AIS

Journal of Neurology 2019; 266(3): 609-615
https://doi.org/10.1007/s00415-019-08173-0

ORIGINAL COMMUNICATION

Incidence and mechanism of early neurological deterioration after endovascular thrombectomy

Jeong Min Kim¹, Jae Man Bae¹, Kirang-Yeol Park¹, Woong Jae Lee², Jun Soo Byun³, Suk Won Ahn⁴, Hae-Won Shin⁵, Su-Hyun Han⁶, Il-Han Yoo⁷Received: 31 October 2018 / Revised: 24 December 2018 / Accepted: 20 December 2018 / Published online: 10 January 2019
© Springer-Verlag GmbH Germany, part of Springer Nature 2019

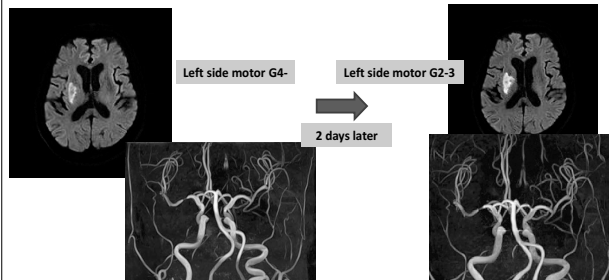
Abstract

Background We investigated the prevalence and mechanisms of neurological deterioration after endovascular thrombectomy. **Methods** Between January 2011 and October 2017, acute ischemic stroke patients treated by endovascular thrombectomy at a tertiary university hospital were included. Early neurological deterioration (END) was defined as an increase in National Institutes of Health Stroke Scale (NIHSS) compared to the best neurological status after stroke. **Results** A total of 125 acute ischemic stroke patients received endovascular thrombectomy. Neurological deterioration was detected in 44 patients, and 24 cases (66.4% of END) occurred within 72 h. The END mechanism included 20 ischemia progression, 16 brain edema and 8 hemorrhagic transformation cases. Multivariable logistic regression analysis revealed that the patients who experienced END were more likely to have poor functional outcome defined as modified Rankin scale 3–6 at 90 days than neurologically stable patients (odds ratio (OR)=4.06, confidence interval (CI)=1.29–12.5). The risk factor of END due to ischemia progression was stroke subtype of large artery atherosclerosis (OR=6.28, CI=1.79–22.0). Successful recanalization (OR=0.11, CI=0.03–0.39) and NIHSS after endovascular thrombectomy (OR=1.13 per one-point increase, CI=1.06–1.24) were significantly associated with END due to hemorrhage or brain edema. **Conclusion** Neurological deterioration frequently occurs after endovascular thrombectomy, and the risk factors of END differ according to the mechanism of END.

Keywords Stroke · Mechanical thrombectomy · Prognosis

Ref. J Neurol. 2019 Mar;266(3):609–615.

F/77 left hemiparesis, onset 1hr, tPA infusion



Argatroban Anticoagulation in Patients With Acute Ischemic Stroke (ARGIS-1)

Stroke

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Stroke Association

A Division of American Heart Association

Argatroban Anticoagulation in Patients With Acute Ischemic Stroke (ARGIS-1): A Randomized, Placebo-Controlled Safety Study
Marian P. LaMonte, Marshall L. Nash, David Z. Wang, Andrew R. Woolfenden, John Schultz, Marcie J. Hursting and Philip M. Brown

Purpose

Direct thrombin inhibitors, including argatroban, represent an anticoagulant class distinct from heparins. This study investigated the safety of 2 levels of argatroban anticoagulation in acute ischemic stroke.

Method

multicenter, randomized, double-blinded, placebo-controlled study included 171 patients with acute (12 hours from onset) stroke and National Institutes of Health Stroke Scale (NIHSS) scores of 5 to 22.

Intervention

Patients received continuous intravenous argatroban (100 µg/kg bolus) at 3 µg/kg per minute (n=59) or 1 µg/kg per minute (n=58), respectively, adjusted to target activated partial thromboplastin times (aPTTs) 2.25X and 1.75X baseline or placebo (n=54) for 5 days.

Ref. Stroke. 2004 Jul;35(7):1677-1682

Argatroban Anticoagulation in Patients With Acute Ischemic Stroke (ARGIS-1) : argatroban provides safe anticoagulation in acute ischemic stroke

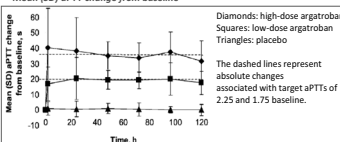
Result

Safety Outcomes

Event	n (%)		P vs Placebo	
	High-Dose Argatroban (N=59)	Low-Dose Argatroban (N=58) / Placebo (N=54)	Active	High-Dose / Low-Dose
Symptomatic intracranial hemorrhage	3 (5.1)	2 (3.4)	0.65	0.24
Paraneuronal hemorrhage	1 (1.7)	0 (0)	0.65	1.0
Hemorrhagic infarction	1 (1.7)	0 (0)	0.65	1.0
Hemorrhagic transformation	1 (1.7)	2 (3.4)	0.65	1.0
Major systemic hemorrhage	0 (0)	0 (0)	NA	NA
Asymptomatic intracranial hemorrhage	1 (1.7)	4 (6.9)	2 (3.7)	1.0
Minor systemic hemorrhage	16 (27.1)	11 (19.0)	0.11	0.05
Death	2 (3.4)	4 (7.0)	1 (1.8)	NA
Within 7 days	2 (3.4)	4 (7.0)	1 (1.8)	NA
Within 90 days	7 (11.9)	11 (19.0)	5 (8.3)	NA
Survival estimate (95% CI)	0.881	0.802	0.907	0.26

NA indicates not applicable/available.

Mean (SD) aPTT change from baseline



1. Symptomatic ICH was not significantly different between groups (high-dose argatroban, 5.1%; low-dose argatroban, 3.4%; placebo, 0%; P=0.18) with 3 events during argatroban infusion and 2 events 7 days after stopping infusion.
2. No significant between-group differences occurred in asymptomatic ICH (7 events), major systemic hemorrhage (no event), or 90-day mortality (13.4% overall).

Argatroban at each dose evaluated significantly prolonged aPTTs without increasing ICH or major bleeding.

Ref. Stroke. 2004 Jul;35(7):1677-1682

The Argatroban and Tissue-Type Plasminogen Activator Stroke Study : ARTSS I

Stroke

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Stroke Association

A Division of American Heart Association

The Argatroban and Tissue-Type Plasminogen Activator Stroke Study : Final Results of a Pilot Safety Study
Andrew D. Barreto, Andrei V. Alexandrov, Pat Lyden, Jessica Lee, Sheryl Martin-Schild, Loren Shen, Tzu-Ching Wu, April Sisson, Ranganayaki Pandurengan, Zhongxue Chen, Mohammad H. Rahbar, Clotilde Balcani, Kristian Barlim, Rebecca M. Sugg, Zoltan Gombos, Georgios Tsivgoulis, Nicole P. Gonzalez, Sean I. Savitz, Robert Mikulik, Andrew M. Demchuk and James C. Grotta

Purpose

This Argatroban tPA Stroke Study was an open-label, pilot safety study of tPA plus Argatroban in patients with ischemic stroke due to proximal intracranial occlusion.

Method

Prospective multicenter, single-arm, open-label, uncontrolled study. Sixty-five patients were enrolled (2003-2010)

Intervention

During standard-dose intravenous tPA, a 100-µg/kg bolus of Argatroban and infusion for 48 hours was adjusted to a target partial thromboplastin time of 1.75 baseline.

(Concomitant anticoagulants or antiplatelet agents were not permitted during Argatroban.)

Barreto AD, et al. Stroke 2012; 43:770-775

The Argatroban and Tissue-Type Plasminogen Activator Stroke Study : ARTSS I : The combination of Argatroban and intravenous tPA produce more complete recanalization than tPA alone.

Result

1. Safety and Bleeding Results

Significant intracranial hemorrhage, no. (% 95 CI)	
Total	4 (6.2, 1.7-15)
Symptomatic ICH	3 (4.6, 0.9-12.9)
Paraneuronal hematoma Type 2*	2 (3.1, 0.4-10.7)

*One patient had a paraneuronal hematoma Type 2 that was also symptomatic.

2. Clinical and Recanalization Outcome

Any recanalization within 2h (n=47) No. (%)	
Total	29 (61)
Partial	10 (21)
Complete	19 (40)
Sustained recanalization within 2h No. (%)	
Total	26 (55)
Partial	12 (25)
Complete	14 (30)
24h (n=60) No. (%)	
Total	47 (78)
Partial recanalization	9 (15)
Complete recanalization	38 (63)

Significant ICH occurred in 4 (6.2%) of 65 patients (95% CI, 1.7-15). These rates of bleeding are of the same order of magnitude seen with intravenous recombinant tPA alone.

Within the 2-hour monitoring period, transcranial Doppler recanalization (n=47) occurred in 29 (61%) patients, Sixty patients had vessel imaging at 24 hours demonstrating complete recanalization in 63% (n=38) and partial in 15% (n=9); total 78% any recanalization.

Although an overall effective treatment for ischemic stroke, intravenous tPA is less efficacious for larger, more proximal occlusions. Only 4.4% of distal internal carotid artery and 30% to 32% of MCA distal branches recanalized.

Stroke. 2007;38: 948-954.

MCA: middle cerebral artery

Barreto AD, et al. Stroke 2012; 43:770-775

Randomized, Multicenter Trial of ARTSS-2 (Argatroban With Recombinant Tissue Plasminogen Activator for Acute Stroke)

Stroke

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Stroke Association

Randomized, Multicenter Trial of ARTSS-2 (Argatroban With Recombinant Tissue Plasminogen Activator for Acute Stroke)
Andrew D. Barreto, Gary A. Ford, Loren Shen, Claudia Pedrosa, Jon Tyson, Chunyan Cai, Mohammad H. Rahbar, James C. Grotta and on behalf of the ARTSS-2 Investigators

Purpose

Conducted a randomized exploratory study to assess safety and the probability of a favorable outcome with adjunctive argatroban, a direct thrombin-inhibitor, administered to r-tPA treated ischemic stroke patients.

Method

3-arm, multicenter, randomized, blinded-outcome evaluation, exploratory study, 90 Patients enrolled who treated with standard-dose r-tPA, not receiving endovascular therapy

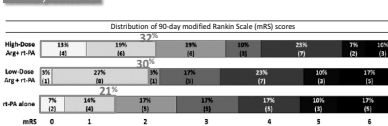


1. Safety: incidence of symptomatic intracerebral hemorrhage
2. Probability of Clinical benefit: mRS

Barreto AD, et al. Stroke 2017 Jun;48(6):1608-1616

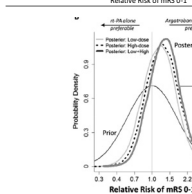
Randomized, Multicenter Trial of ARTSS-2 (Argatroban With Recombinant Tissue Plasminogen Activator for Acute Stroke)

Primary outcome



At 90 days, 6 (21%) r-tPA alone, 9 (30%) low-dose, and 10 (32%) high-dose patients were with modified Rankin Scale score 0 to 1.

Relative Risk of mRS 0-1



The probability that adjunctive argatroban was superior to r-tPA alone was 67%, 74%, and 79% for low, high, and low or high dose, respectively.

RR (95% CI), probability RR>1.0

Low±High-Dose Argatroban+r-tPA (N=61)	1.34 (0.68-2.76), 0.79
High-Dose Argatroban+r-tPA (N=31)	1.27 (0.63-2.53), 0.74
Low-Dose Argatroban+r-tPA (N=30)	1.17 (0.57-2.37), 0.67

Graphical depiction of Bayesian results. The neutral prior is centered at relative risk (RR) =1.0, indicating a 50:50 chance of argatroban+r-tPA superiority or inferiority. The area under the curve located on the right-hand side of RR=1.0 for each posterior represents the probability that combination is superior (ie, RR>1.0) to r-tPA alone (67%, low; 74%, high; and 79%, low-high dose). Note: the x axis is set to logarithmic scale.

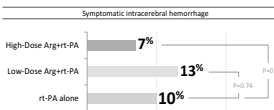
Barreto AD, et al. Stroke 2017 Jun;48(6):1608-1616

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Randomized, Multicenter Trial of ARTSS-2

Adjunctive argatroban was not associated with increased risk of symptomatic intracerebral hemorrhage and provides evidence that a definitive effectiveness trial is indicated.

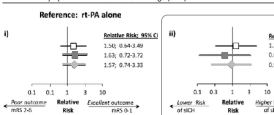
Secondary outcomes



Rates of symptomatic intracerebral hemorrhage were similar among control, low-dose, and high-dose arms: 3/29 (10%), 4/30 (13%), and 2/31 (7%), respectively. (and no major systemic bleeding adjudicated as argatroban related occurred)

Summary

Forest plots of 90-day excellent clinical outcome and symptomatic intracerebral hemorrhage (sICH) within 48-hour of rt-PA



Overall rates of sICH were lower and nearly identical across arms. Substituting a neutral prior (identical to the primary outcome analysis) for the conservative, the probability that adjunctive argatroban increased sICH risk was 63%, 34%, and 48% for low, high, and low or high dose, respectively.

Barreto AD, et al. Stroke 2017 Jan;48(1):3058-3066

Safety and Feasibility of Argatroban, rtPA and IAT in Stroke(ARTSS-IA Study)

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Safety and Feasibility of Argatroban, Recombinant Tissue Plasminogen Activator, and Intra-Arterial Therapy in Stroke (ARTSS-IA Study)

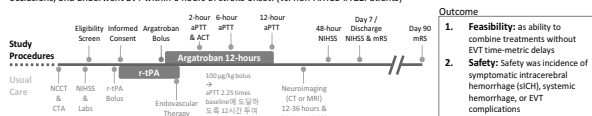
Ketevan Berekashvili, MD,^{1,2} Jazba Soomro, MD,^{1,2} Loren Shen, MD,³ Vivek Misra, MD,¹ Peng R. Chen, MD,¹ Spiros Blackburn, MD,¹ Mark Dannenbaum, MD,¹ James C. Grotta, MD,¹ and Andrew D. Barreto, MD, MD¹

Purpose

This study intended to study feasibility and safety of concurrent rt-PA and Argatroban in patients undergoing EVT.

Method

Conducted a single-arm, feasibility, and safety study of 10 patients that received standard-dose rt-PA, had intracranial large vessel occlusions, and underwent EVT within 6 hours of stroke onset. (vs. non-ARTSS-IA 22 patients)



Stroke Cardiovasc Dis. 2018 Dec; 27(12):3647-3651

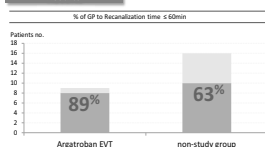
Safety and Feasibility of Argatroban, rtPA and IAT in Stroke(ARTSS-IA Study)

In patients treated with rt-PA and EVT, concomitant Argatroban is feasible, does not delay EVT provision, produces high rates of recanalization, is probably safe

All pre-planned 10 patients were enrolled.

Arterial occlusions were middle cerebral artery (n = 8), internal carotid artery (n = 1), and posterior cerebral artery (n = 1). All received Argatroban before EVT and completed infusions.

Results



- Time interval from GP to recanalization was 56 minutes in 89% (8 of 9) patients versus 63% (10 of 16) of non study patients.
- Nine patients achieved excellent angiographic reperfusion (Thrombolysis in Cerebral Ischemia [TICI] ≥ 2b); with 7 complete (TICI=3).

- There were no sICH, systemic hemorrhage, or EVT complications.
- At 90 days, 6 (60%) patients had a modified Rankin Scale of 0-2 and none died.

The authors hypothesized that combination therapy of Argatroban with rtPA is likely to be safe, and the higher dose arm had demonstrated the most promise (no increase in bleeding with better clinical outcomes), hence its choice for the present study (from ARTSS I, ARTSSII study).

Stroke Cardiovasc Dis. 2018 Dec; 27(12):3647-3651

On-going study(ARTSS III) Multi-arm Optimization of Stroke Thrombolysis (MOST)

NIH U.S. National Library of Medicine

ClinicalTrials.gov

Multi-arm Optimization of Stroke Thrombolysis (MOST)

Method Study: 2019 Oct-2024 Apr. Randomized, Parallel Assignment study



Result

- Improved 90-day modified Rankin scores (mRS) as compared with placebo in acute ischemic stroke (AIS) patients treated with 0.9mg/kg IV rt-PA within three hours of symptom onset. Patients may also receive endovascular thrombectomy (ET).

- Primary Outcome Measures:** 90-day modified Rankin scores (mRS) [Time Frame: 90 days after randomization]
- Secondary Outcome Measures:** 1) proportion of participants with 90-day mRS 0-1 (or return to their historical mRS) [Time Frame: 90 days after randomization] 2) proportion of participants with 90-day mRS 0-2 (or return to their historical mRS) [Time Frame: 90 days after randomization] 3) 90-day ordinal analysis of the mRS [Time Frame: 90 days after randomization]

[Korean Study 2010] Effectiveness of Intravenous Direct Thrombin Inhibitor, Argatroban

www.kns.or.kr 10.3340/kns.2010.47.4.258 Print ISSN 2092-5770 On-line ISSN 1586-7675 J Korean Neurosurg Soc 47: 258-264, 2010 Copyright © 2010 The Korean Neurosurgical Society

Treatment for Patients with Acute Ischemic Stroke Presenting beyond Six Hours of Ischemic Symptom Onset : Effectiveness of Intravenous Direct Thrombin Inhibitor, Argatroban

Jung Soe Park, M.D., Seung Soe Park, M.D., Eun Jeong Kih, M.D., Ph.D., Jong Pil Eun, M.D., Ph.D., He Young Choi, M.D., Ph.D. Department of Neurosurgery, Research Institute of Clinical Medicine, Chonbuk National University Medical School and Hospital, Jeonju, Korea

Purpose

The objectives of this study were to analyze the outcome and hemorrhagic risk of intravenous (IV) argatroban in patients with acute ischemic stroke presenting beyond six hours of ischemic symptom onset.

Method

Eighty patients with acute ischemic stroke who were admitted to the hospital beyond six hours from ischemic symptom onset were retrospectively analyzed.

- Could not perform IV thrombolysis or intra-arterial thrombolysis because of limited time window.
- IV argatroban was performed to prevent recurrent thrombosis and progression of infarcted area. The argatroban was injected at a loading dose of 60mg/day by continuous intravenous infusion for the first two days, followed by intravenous infusion of 20 mg/day in two divided doses over three hours for subsequent five days.

J Korean Neurosurg Soc 47:258-264,2010

[Korean Study 2010] Effectiveness of Intravenous Direct Thrombin Inhibitor, Argatroban

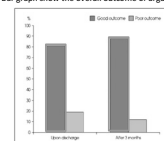
Results

Outcome and hemorrhagic risk evaluation

Table 2. Outcome and hemorrhagic risk	At admission	Upon discharge	After 3 months
Median NIHSS	8.0	4.1	3.3
Outcome			
Good (%)	65 (81%)	71 (88%)	
Poor (%)	15 (19%)	9 (12%)	
Hemorrhage			
Symptomatic (%)	2 (0%)		
Asymptomatic (%)	6 (8%)		

NIHSS: National Institute of Health Stroke Scale

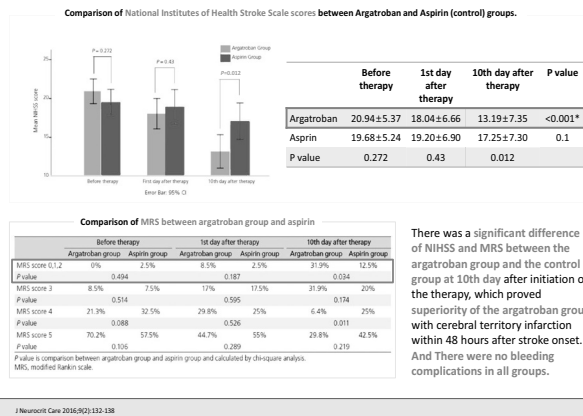
*Bar graph show the overall outcome of argatroban



- The median NIHSS was 8.0 at admission, 4.1 upon discharge, and 3.3 after three months.
- A good outcome* was achieved in 81% of patients upon discharge and 88% after three months. (A good outcome was defined as a decreased NIHSS score above 4 point of the initial score at admission, or the score equal to 0 or 1 upon discharge or after three months).
- Symptomatic hemorrhage occurred in only two patients (3%).
- IV argatroban was effective regardless of initial stroke severity, subtype, and location.
- IV argatroban may be an effective and safe treatment modality for acute ischemic stroke presenting beyond six hours of ischemic symptom onset.

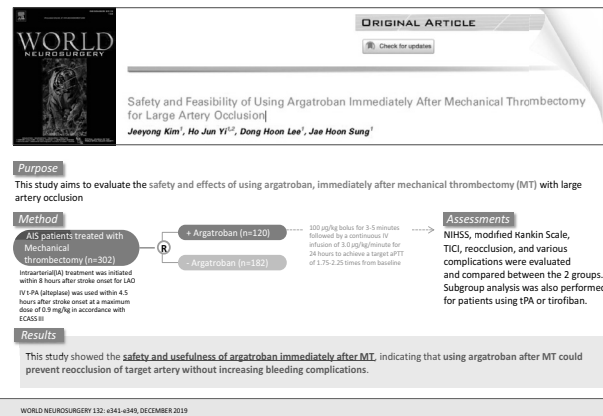
J Korean Neurosurg Soc 47:258-264,2010

[Korean Study 2016] Therapeutic Effect and Safety of Argatroban in Cerebral Territory Infarction : argatroban has added benefit in early neurological outcomes after acute cerebral territory infarction

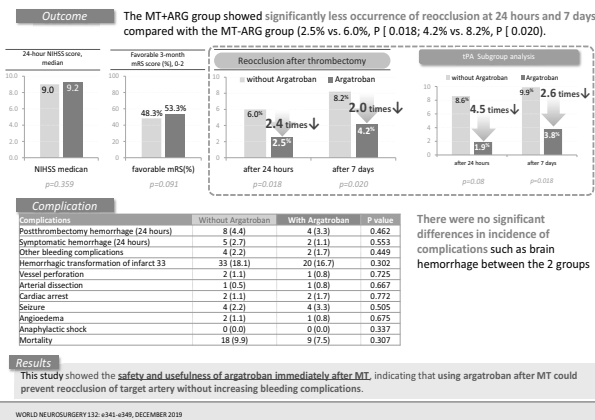


J Neurosurg 2016;122:132-138

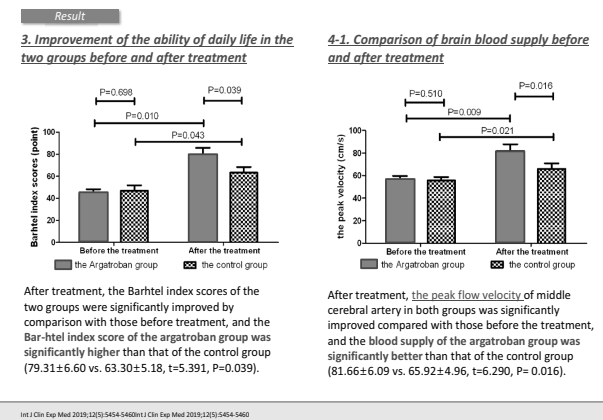
[A new Korean study : 2019] Safety and Feasibility of Using Argatroban Immediately After Mechanical Thrombectomy for Large Artery Occlusion



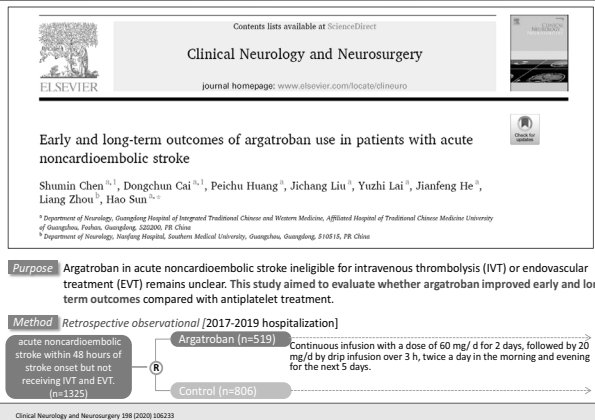
[A new Korean study : 2019] Safety and Feasibility of Using Argatroban Immediately After Mechanical Thrombectomy for Large Artery Occlusion



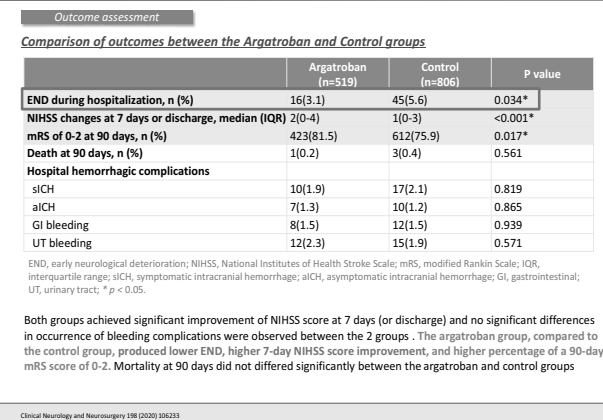
[A new study : 2019] Efficacy of argatroban in the treatment of acute cerebral infarction



[A new study : 2020] Early and long-term outcomes of argatroban use in patients with acute noncardioembolic stroke



[A new study : 2020] Early and long-term outcomes of argatroban use in patients with acute noncardioembolic stroke



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[A new study : 2020]
Early and long-term outcomes of argatroban use in patients with acute noncardioembolic stroke

Outcome assessment

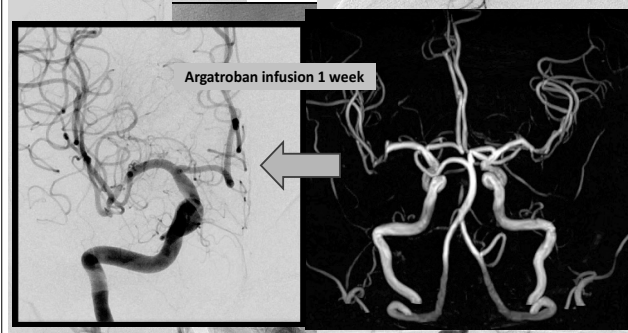
Subgroup analysis with mild, moderate and severe stroke

	Mild stroke (NIHSS 0-4)			Moderate stroke (NIHSS 5-15)			Severe stroke (NIHSS 16-42)		
	Argatroban (n = 207)	Control (n = 332)	P value	Argatroban (n = 255)	Control (n = 427)	P value	Argatroban (n = 27)	Control (n = 47)	P value
Age, y, median (IQR)	62.7 ± 11.4	63.2 ± 10.8	0.609	63.0 ± 9.9	64.5 ± 8.4	0.311	66.5 ± 12.1	63.3 ± 11.5	0.262
Gender, male, n (%)	139 (67.1)	222 (66.9)	0.946	200 (78.2)	201 (65.8)	0.223	14 (51.9)	32 (68.1)	0.166
Baseline NIHSS, median (IQR)	3 (2-4)	3 (3-4)	0.703	8 (7-10)	7 (6-8)	0.054	17 (16-18)	17 (16-19)	0.594
Baseline mRS, median (IQR)	2 (1-2)	2 (1-2)	0.571	3 (3-4)	3 (3-3)	0.440	5 (4-5)	5 (4-5)	0.839
END during hospitalization, n (%)	4 (1.9)	15 (4.4)	0.346 [†]	5 (2.0)	20 (4.6)	0.344 [†]	4 (14.3)	1 (2.1)	0.206 [†]
NIHSS changes at 7 days or discharge, median (IQR)	0 (0-1)	0 (0-1)	0.350	3 (2-1)	2 (0-3)	0.900 [†]	4 (2-5)	4 (3-4)	0.293
mRS at 90 days or 0-1 (for the mild stroke) or 0-2 (for the moderate and severe stroke) at 90 days, n (%)	107 (51.3)	200 (60.3)	0.046 [†]	206 (80.8)	268 (62.8)	0.000 [†]	10 (37.0)	12 (25.5)	0.297
Death at 90 days, n (%)	0 (0.0)	0 (0.0)	-	0 (0.0)	1 (0.2)	0.414	1 (3.7)	2 (4.3)	0.900
Haemorrhagic complications, n (%)	0 (0.0)	0 (0.0)	-	7 (2.7)	12 (2.8)	0.774	3 (11.1)	5 (10.6)	0.950
sICH	0 (0.0)	0 (0.0)	-	3 (1.2)	8 (1.9)	0.907	2 (7.4)	2 (4.3)	0.564
GI bleeding	0 (0.0)	0 (0.0)	-	7 (2.7)	10 (2.3)	0.922	1 (3.7)	2 (4.3)	0.900
UTI bleeding	3 (1.4)	5 (1.5)	0.958	9 (3.5)	10 (2.3)	0.508	0 (0.0)	0 (0.0)	-

IQR, interquartile range; NIHSS, National Institutes of Health Stroke Scale; mRS, modified Rankin Scale; END, early neurological deterioration; sICH, symptomatic intracranial hemorrhage; aICH, asymptomatic intracranial hemorrhage; GI, gastrointestinal; UTI, urinary tract; [†]p < 0.05.

Clinical Neurology and Neurosurgery 188 (2020) 106233

F/54 A-fib, left hemiparesis NIHSS 6 -> NIHSS 0 (discharge)



Conclusion

IV Argatroban may be an effective and safe treatment modality for acute ischemic

AIS patients who are not eligible for tPA or IAT

for prevention of Early neurological deterioration(END)

Adjunctive Option of Intra-arterial Thrombectomy

Safety and feasibility of using Argatroban

Dong Hoon Lee¹, Jae Hoon Sung¹, Ho Jun Yi², Seung Yoon Song¹, Dong Sub Kim¹

¹Department of Neurosurgery, St. Vincent's Hospital, The Catholic University of Korea

²Department of Neurosurgery, Soonchunhyang University Bucheon Hospital, Bucheon, Korea

Background: This study aims to evaluate the safety and effects of using argatroban, immediately after mechanical thrombectomy (MT) with large artery occlusion.

Methods: A total of 302 patients were divided into 2 groups: the MT with post argatroban (MT+ARG) group and the MT without post argatroban (MT-ARG) group. Baseline characteristics, time interval categories, and results of MT were reviewed. Outcome assessment with the National Institutes of Health Stroke Scale, modified Rankin Scale, TICI, reocclusion, and various complications were evaluated and compared between the 2 groups. Subgroup analysis was also performed for patients using tissue plasminogen activator or tirofiban.

Results: Baseline characteristics and time intervals were similar for the 2 groups. The MT+ARG group showed significantly less occurrence of reocclusion at 24 hours and 7 days compared with the MT-ARG group (2.5% vs. 6.0%, $P = 0.018$; 4.2% vs. 8.2%, $P = 0.020$). However, there were no significant differences in incidence of complications such as brain hemorrhage between the 2 groups. In subgroup analysis with tissue plasminogen activator, the MT+ARG group showed less occurrence of reocclusion at 24 hours and 7 days compared with the MT-ARG group ($P = 0.008$ and $P = 0.018$, respectively). In subgroup analysis with tirofiban, reocclusion at 7 days occurred less in the MT+ARG group ($P = 0.040$).

Conclusions: This study showed the safety and usefulness of argatroban immediately after MT, indicating that using argatroban after MT could prevent reocclusion of target artery without increasing bleeding complications.

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery

6/26(Sat.)

Free paper III : Early experiences by young gun in EVT

좌장 : 성재훈(가톨릭대) / 신승훈(차의과학대)

- | | | |
|-------|---|------------------------|
| FP3-1 | Complications and solutions in treating cerebral arteriovenous malformation with liquid-embolic materials; Beginner's personal experience | 조동영
(이화여자대학교 서울병원) |
| FP3-2 | Contrast neurotoxicity after coil embolization for cerebral unruptured aneurysm mimicking subarachnoid hemorrhage | 김학성
(중앙보훈병원) |
| FP3-3 | Intractable seizure after endovascular coil embolization of unruptured paraclinoid aneurysm | 윤별희
(의정부 을지대학교병원) |
| FP3-4 | Framing coil total prolapse due to stretched coil stuck in a microcatheter | 정동환
(한림대학교 동탄성심병원) |
| FP3-5 | First voyage as a neurosurgery vascular surgeon | 박재원
(천안충무병원) |
| FP3-6 | The use of contralateral angioplasty to improve collateral flow in case of difficulty in initial EVT position | 최연주
(에스포항병원) |
| FP3-7 | Early-visit patients with poor clinical outcomes after successful recanalization with multiple retrieval attempts | 김승환
(성균관대학교 삼성창원병원) |
| FP3-8 | Safety and efficacy of mechanical thrombectomy using balloon-expandable stent deployment as a rescue therapy after failed stent retriever thrombectomy — young gun in EVT (Case report) | 김상영
(에스포항병원) |

Complications and solutions in treating cerebral arteriovenous malformation with liquid-embolic materials; Beginner's personal experience

Dong Young Cho, Jung Jae Kim, Eu Kyo Seo

Department of Neurosurgery, Ewha Womans University Seoul Hospital

Objective: Cerebral arteriovenous malformations (AVM) are usually treated with endovascular treatment using liquid-embolic material. Herein, we would introduce two cases which were successfully treated after periprocedural complications.

Methods: First case was 40-year-old male presenting AVM involving Rt. frontal lobe with 12mm sized nidus and 2 arterial feeders from ACA, and single draining to superior sagittal sinus. During endovascular treatment with onyx embolization, onyx material was refluxed to proximal feeder, and Rt. ACA was occluded. Second case was 41-year-old male with AVM involving Lt. temporal lobe. The nidus size was 38mm, with 2 feeders from Lt. MCA and 1 feeder from Lt. PCA, and draining veins to sigmoid sinus and Lt. cavernous sinus. The patient was planned to be treated with 2 stage method, partial occlusion of nidus with onyx embolization and surgical resection on next day. During the procedure, leakage of onyx material was observed, and postoperative CT scan showed intracranial hemorrhage with subarachnoid hemorrhage. The patient showed global aphasia postoperatively.

Result: First case with ACA occlusion was treated with mechanical embolectomy with thrombectomy device. After 2 trials of embolectomy, Onyx fragment was removed, and ACA flow was successfully recanalized. The patient was neurologically free after the procedure. In second case, we underwent emergency craniotomy and nidus removal. After the surgery, patient's neurologic symptoms were fully recovered after few days and discharged without neurologic deficit.

Conclusion: Appropriated solution after periprocedural complications in treating AVM with liquid-embolic materials is important, which might result in minimizing of mortality and morbidity of the patient.

Contrast neurotoxicity after coil embolization for cerebral unruptured aneurysm mimicking subarachnoid hemorrhage

Hak Sung Kim, In Ho Oh, Ji Hye Lee, Moon Hee Han

Department of Neurosurgery, Veterans Hospital Service Medical Center

Objective: To report our case with non-ionic contrast neurotoxicity after coil embolization for cerebral unruptured aneurysm that was recovered spontaneously.

Methods: A 69-years old female was admitted to our hospital for coil embolization of left supraclinoid internal carotid artery(ICA) unruptured aneurysm. Coil embolization was performed under general anesthesia and the procedure was successfully completed. However, 3 hours after surgery, mental deterioration, weakness in right extremities and right facial palsy was noted. In addition, high fever with unknown origin and seizure attack occurred.

Result: Emergent non-contrast brain CT and diffusion-weighted image(DWI) MRI were performed. On DWI, no evidence of abnormal bright signal intensity in the brain parenchyma, but on brain CT, faint and diffuse enhancement of left cerebral hemisphere with increased density of left cortical subarachnoid spaces was identified. Fortunately, the patient fully regained consciousness, orientation and muscular strength after 2 days. In parallel, as observed with repeat CT scans, sulcal hyperdensities completely faded out.

Conclusion: Contrast induced neurotoxicity is rare complication after endovascular treatment. Probably, the cause of these complications is the disruption of the blood-brain barrier and contrast extravasation. In most cases, these neurological symptoms are considered to resolve spontaneously.

Intractable seizure after endovascular coil embolization of unruptured paraclinoid aneurysm

Byul Hee Yoon, Young Ki Park, Duk Ryung Kim, Byung Gwan Moon

Department of Neurosurgery, Uijeongbu Eulji Medical Center

Objective: Unruptured paraclinoid aneurysms have been treated to endovascular coil embolization and the most common complication of endovascular coil embolization is an ischemic event, and other complications are so rare that they are often overlooked. This case study corresponds to the consideration of this overlooking.

Methods: The patient is a 68-year-old female patient with hypertension, diabetes, and previous allergic skin rash for contrast, who underwent coil embolization for incidental unruptured aneurysm. Coil embolization was completed successfully and no events during procedure. Six hours after embolization, she showed aphasia and hemiparesis. Some embolic events were identified in magnetic resonance diffusion, but there was no clinical correlation with symptoms. Computed tomography angiogram showed no vascular abnormalities, but she got progressively worse and showed global aphasia and hemiplegia. And, there were no singularities in diffusion and electroencephalogram followed up over time. On the second day, clinical seizure was showed 3 times and loading of antiepileptic drugs were administered. Three hours after the last clinical seizure, all previous symptom was recovered dramatically except for mild sensory aphasia and she recovered completely when she was discharged.

Result: The pathophysiology of seizure after coil embolization in unruptured aneurysms has not been elucidated. In this case study, there were many risk factors that were considered, such as old age, two or more comorbid diseases, and a kind of neurotoxicity associated with contrast media. Despite successful coil embolization of unruptured aneurysm, these risk factors may have contributed to seizures.

Conclusion: It should always be kept in mind about seizures and Todd's paralysis during or after coil embolization in relation to the patient's neurologic symptoms as well as ischemic events. For patients with many comorbid disease or previous allergic skin rash for contrast, preoperative AED may be considered. And continuous EEG can be helpful for diagnosis when neurologic symptom occurred.

Framing coil total prolapse due to stretched coil stuck in a microcatheter

Donghwan Jeong

Department of Neurosurgery, Hallym University Dongtan Sacred Heart Hospital

Objective: Coil stretching is not uncommon mechanical complication of coil embolization. Here, the author presented a case report of a patient with framing coil total prolapse due to stretched coil stuck in the microcatheter.

Methods: A patient with an unruptured paraclinoid aneurysm was undergoing an elective coil embolization. Double catheter method was planned. When the frame coil was almost made, the coil was stretched and stuck in the microcatheter. The stretched coil was detached unintentionally while push wire manipulation. Small helical coil was used for pushing the coil but failed to push out the stretched coil. A careful microcatheter withdrawal was performed but stretched coil was not movable in the microcatheter. The frame coil was prolapsed totally from the aneurysm stuck in the microcatheter. Subarachnoid hemorrhage was not detected by cone beam computed tomography. The escaped coil was withdrawn with a guiding catheter at sheath level. We retrieved the coil with a snare kit safely. Afterward, double catheter coil embolization was performed successfully. After 2 days, the patient was released from hospital without neurologic deficit.

Result: Successful coil embolization without complication was confirmed with post procedural magnetic resonance imaging.

Conclusion: We should observe 1) integrity of coil and 2) gap between coil and push wire marker carefully for detecting coil stretching. And also we should be fully aware of salvage techniques.

First voyage as a neurosurgery vascular surgeon

Jaewon Park

Department of Neurosurgery, Cheonan Chungmu Hospital

Objective: Independently as a neurosurgeon and vascular specialist, I started my first steps at Cheonan Chungmu Hospital. For the first time, I would like to report the trial and error and experiences I experienced in deciding and performing endovascular surgery independently under my own responsibility to my teachers and share it with my juniors.

Methods: I will present two coil cases for ruptured aneurysm and one onyx embolization case for ruptured AVM. Case 1. A 27-year-old female, a Korean in Kazakhstan, who entered the country as a Korean in self-quarantine, had mental deterioration after a sudden burst headache during self-quarantine. After brain CT, she was diagnosed with cerebral hemorrhage. She was in GCS E3V4M6 13 drowsy state and she did not speak Korean, so communication was difficult. In the initial CT performed, IVH of the 4th ventricle and both lateral ventricles and ICH of the corpus callosum were observed. An AVM with a diameter of 2.7 cm was observed at the splenium of left corpus callosum in CTA. She underwent onyx embolization for AVM 2 days after both EVD in relation to IVH. Afterwards, the patient was discharged without any sequelae other than short term memory impairment. Case 2. A 67-year-old woman with sudden burst headache was diagnosed with SAH and transferred to a local medical center after brain CT. After CTA, she had mental deterioration. As an emergency, she underwent catheter assisted coil embolization for Ruptured MCAB aneurysm, Lt., and ICH aspiration under XperCT guiding in a hybrid room. Her mental status was restored from GCS E1V2M4 7 Stupor to GCS E4V5M6 15 Alert. Case 3. A 39-year-old male Chinese illegal immigrant who endured a burst headache for 1 week and then visited the emergency room due to mental deterioration. SAH, inf frontal lobe ICH, and IVH were observed on initial CT, and AcoA large aneurysm and Rt. AVM of P-O was observed. He performed coil embolization for EVD and large AcoA An. and was discharged with mRS 0.

Result: The cases and routines repeated countless times as a fellow and clinical assistant professor helped me. Fortunately, I did not tremble or make a mistake while performing my first endovascular surgery myself.

Conclusion: I think it's time to prove the value of the hard times I've spent, and I will devote myself to it in the future.

The use of contralateral angioplasty to improve collateral flow in case of difficulty in initial EVT position

Yeon-Ju Choi

Department of Neurosurgery, Pohang Stroke and Spine Hospital

Objective: A 72-year-old female was admitted in a stuporous state with left hemiplegia on June 30, 2020. The patient had not only a history of hypertension and diabetes but also had experienced cerebral infarction in 2017. Initial National Institute of Health Stroke Scale (NIHSS) score was 6. TFCA and MRI revealed very severe stenosis of the right ICA ophthalmic segment and occlusion of the ipsilateral MCA M2 segment. Stroke MRI confirmed multi-focal HSI of both MCA territories on DWI. PWI revealed extended periods of delayed time to peak in both hemispheres.

Methods: Cerebral angioplasty was performed while the patient was under general anesthesia. At first, severe stenosis of the left CCA was resolved using a PRECISE 8*40(stent). Then, balloon angioplasty was done to treat severe stenosis of the right ICA ophthalmic segment with Ryurei PTA balloon 3*20. Immediate neurological assessment was performed, which showed slight improvement of mentality and motor functions compared with the patient's state at admission.

Result: In the case direct EVT is difficult for acute ischemic stroke, other ways can be utilized to improve collateral flow to the delayed perfusion area. If the second treatment option is easier than the first, the second treatment option can prove helpful for both the operating surgeon and the patient.

Conclusion: Contralateral angioplasty for improving collateral flow may help to improve the patient's state when contralateral angioplasty is easier than direct EVT.

Early-visit patients with poor clinical outcomes after successful recanalization with multiple retrieval attempts

Seung Hwan Kim

Department of Neurosurgery, Samsung Changwon Hospital, Sungkyunkwan University School of Medicine

Objective: Rapid reperfusion has been considered the most powerful predictor of outcomes in patients with acute ischemic stroke. However, rapid reperfusion does not always make good clinical outcomes after endovascular thrombectomy. Here, we reported a case of early-visit patient with poor clinical outcomes after successful recanalization with multiple retrieval attempts.

Methods: A 66-year-old man visited our hospital with left hemiplegia within 30 minutes of symptom onset. The NIHSS score on admission was 16, and atrial fibrillation was checked by electrocardiogram. The right ICA was not observed on CT angiography, and MR perfusion imaging showed more than 50% mismatch between cerebral blood flow and cerebral blood volume in the right MCA territory.

Result: Intravenous thrombolysis was administered within 60 minutes of hospital arrival, and endovascular thrombectomy began within 90 minutes of hospital arrival. Due to the fragmentation and migration of the thrombus, endovascular thrombectomy using a combination technique of catheter aspiration and stent retriever was performed three times for the occlusion of the petrous segment, the communicating segment, and the ICA bifurcation. In addition, a stent retriever was performed for the occlusion of the M2 superior trunk. Successful recanalization was achieved with a total of four attempts within three hours of symptom onset. Post-procedural CT showed decreased density and edematous changes in the right MCA territory. Re-occlusion was not observed on the brain MRA one day after the procedure. He developed deep drowsiness on two days after the procedure, and severe brain edema with midline shifting was observed on the brain CT. Decompressive hemicraniectomy was performed, and hemorrhagic transformation was observed on the postoperative CT. He survived with severe disabilities and needed constant nursing care (mRS 5).

Conclusion: In our case, successful recanalization with multiple retrieval attempts did not achieve good clinical outcomes in patient with early visit and rapid reperfusion. Our study suggests that it is important for young neurovascular surgeons to learn to make a successful recanalization as few attempts as possible to achieve better clinical outcomes.

Safety and efficacy of mechanical thrombectomy using balloon-expandable stent deployment as a rescue therapy after failed stent retriever thrombectomy — young gun in EVT (Case report)

Sang Young Kim

Department of Neurosurgery, Pohang Stroke and Spine Hospital

Objective: To show through our case study that balloon-expandable stent deployment is safe and effective in patients with immediate re-occlusion due to underlying atherosclerotic stenosis after unsuccessful intracranial stenting as a rescue therapy (a self-expandable stent : Solitaire AB stent).

Methods: A 58-year-old man developed sudden right hemiparesis and dysarthria while he was sleeping. He had a baseline National Institutes of Health Stroke Scale (NIHSS) score of at least 11. Cerebral angiography was performed with conscious sedation, confirming an occlusion of the middle trunk (M1) of the left middle cerebral artery (MCA). Using stent-retriever technique, a Solitaire platinum stent thrombectomy device was deployed across the clot. Post-thrombectomy control angiography demonstrated non-revascularization of the left MCA. Consequently, intracranial stenting(a self-expandable stent : Solitaire AB stent) was performed as the second-line therapy. Post-intracranial stent deployment control angiography demonstrated non-revascularization of the left MCA. Finally, the patient was treated with balloon-expandable stent deployment (PRO-kinetic Energy stent). Immediate neurological assessment was performed, which showed motor improvement. An immediate post-intervention CT scan confirmed non-hemorrhage and contrast in the basal ganglia.

Result: The patient was treated with unsuccessful stent - retriever thrombectomy as first - line therapy, intracranial stenting (a self-expandable stent(SES) : Solitaire AB stent) as second-line therapy. Finally, he was treated with balloon-expandable stent(BES) deployment. BES deployment control angiography demonstrated partial incomplete revascularization (mTICI: 2B). Immediate neurological assessment was performed, which showed motor improvement. An immediate post-intervention CT scan confirmed non-hemorrhage and contrast in the basal ganglia. The patient was moved from ICU to general wards on five days after operation with an NIHSS score of 6. At one-month follow-up in general wards, his NIHSS was 3 and modified Rankin Scale score was 2. There was significant improvement in the patient's NIHSS (11 vs. 3), dysarthria (sever vs. mild) and right side weakness (Gr. 2/2 vs. 4+/4+).

Conclusion: Balloon-expandable stent deployment can be used as an efficient and safe rescue device after the failure of both stent - retriever thrombectomy as first - line therapy and intracranial stenting as a rescue therapy (a self-expandable stent : Solitaire AB stent) as second-line therapy in acute stroke with intracranial large artery vessel occlusion of the anterior circulation.

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

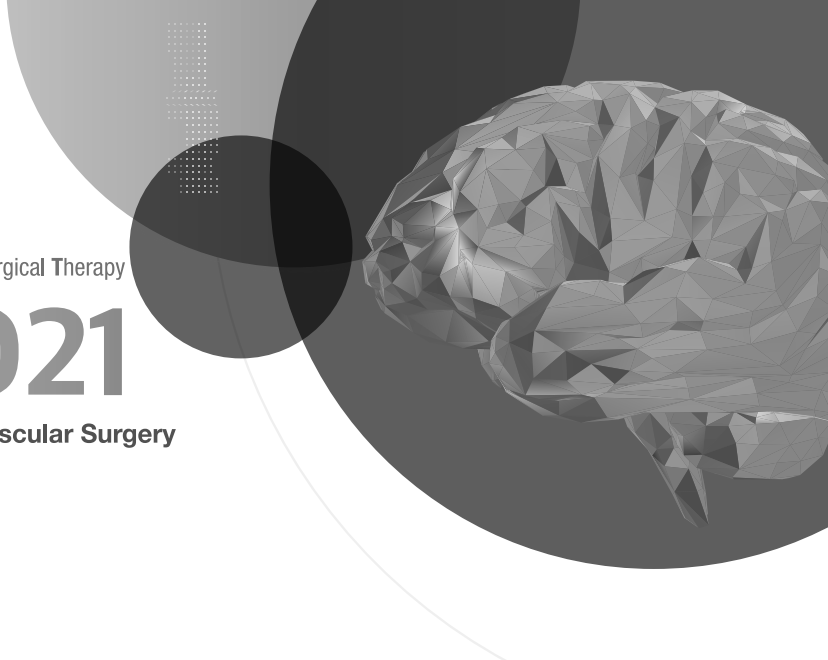
ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery

6/26(Sat.)

Introduction of new endovascular devices by company

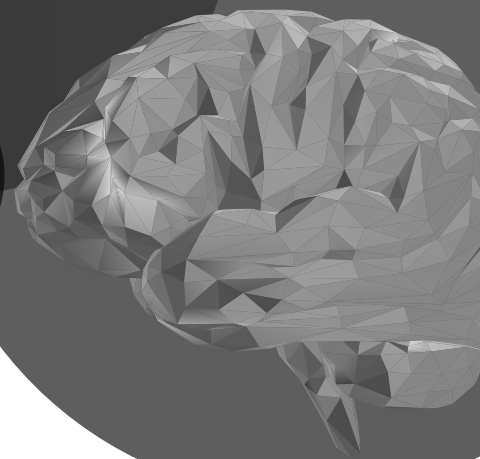
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The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



6/26(Sat.)

Symposium II : Bifurcation aneurysm from clipping/ coiling to flow modulation

좌장 : 신용삼(가톨릭대) / 권순찬(울산대)

1. Why clipping for bifurcation aneurysm
2. Why coiling for bifurcation aneurysm
3. Benefit of flow disruptor on bifurcation aneurysm
4. Update and review for flow disruptor on bifurcation aneurysm

하성곤(고려대)

박정현(한림대)

신용삼(가톨릭대)

Jacques Moret (NEURI center,
Bicêtre University Hospital, France)

Why clipping for bifurcation aneurysm

하성곤

고려대학교 안산병원 신경외과

ASCENT 2021

Why Clipping for bifurcation Aneurysm

Department of Neurosurgery, Korea University Medical Center
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Sung-Kon Ha, M.D., Ph.D.



고려대학교안산병원
KOREA UNIVERSITY ANSAN HOSPITAL



Clipping은 전투기 조종사와 같은 운명일까?

그래도 Clipping이 유리한 경우

- IICP c hematoma mass effect
- **Easier** clipping than endovascular Tx
 - Pts vs Doctors vs Facilities

Clip vs Coil for MCA bif. An

• 환자 vs 의사 vs 설비

- 불변 조건이면 조건에 맞추어 시행
- 가변 조건 특히 의사 요인
 - Clip only, Coil only, Hybrid

Clipping for MCA bif. An 연자로서 고민

- Coil only
 - 어쩌면 마음 편하게 Clipping에 맡기도록 할까?
- Hybrid
 - 어쩌면 Coiling 보다는 Clipping을 택하게 할까?
- 환자
 - Clipping의 장점을 어떻게 설명할 것인가?
- * 학문적 근거와 기술적 측면

Clip-first policy versus coil-first policy for the exclusion of middle cerebral artery aneurysms

CLINICAL ARTICLE
J Neurosurg 133:1124–1131, 2020

- the results of two centers using opposing policies in the management of MCA aneurysms:
 - one clip-first policy, the other coil-first policy
 - limited the selection bias and ensured a good comparison of these two treatment modalities
- between January 2012 and December 2015
- retrospectively reviewed
- All MCA An (not bifurcation An only)

TABLE 1. Baseline characteristics and clinical outcomes of patients with a ruptured MCA aneurysm treated with clipping or coiling

Variable	Coiling	Clipping	p Value
No. of aneurysms	48	42	
WFNS grade, no. (%)			0.003
I	28 (58.3%)	19 (42.9%)	
II	1 (2.1%)	8 (19.0%)	
III	7 (14.6%)	0 (0%)	
IV	6 (12.5%)	6 (14.3%)	
V	6 (12.5%)	10 (23.8%)	
Clinical outcomes, no. (%)			8.89E-02
Additional surgery	21 (43.8%)	3 (7.1%)	
DCI	1 (2.1%)	3 (7.1%)	0.336
VP shunting	2 (4.2%)	5 (11.9%)	0.245
Death	6 (12.5%)	2 (4.8%)	0.276
6-mo mRS score			0.565
0–3	36 (85.7%)	32 (80%)	
4–5	6 (14.3%)	8 (20%)	
Return to previous state at 6 mos	12 (25%)	13 (31%)	0.639
Return to work at 6 mos			0.776
Yes	8/38 (21.1%)	7/29 (24.1%)	
NA	10	13	
Discomfort related to temporal muscle atrophy			0.052
No	42 (100%)	36 (90%)	
Moderate	0 (0%)	4 (10%)	
Severe	0 (0%)	0 (0%)	

TABLE 2. Baseline characteristics and clinical outcomes of patients with an unruptured MCA aneurysm treated with clipping or coiling

Variable	Coiling	Clipping	p Value
No. of aneurysms	40	57	
Clinical outcomes, no. (%)			
Death	0 (0%)	2 (3.5%)	0.51
6-mo mRS score			0.064
0–1	30 (78.9%)	51 (92.7%)	
2–5	8 (21.1%)	4 (7.3%)	
Return to previous state at 6 mos	31/38 (81.6%)	48 (84.2%)	0.784
Return to work at 6 mos			0.416
Yes	10/14 (71.4%)	22/26 (84.6%)	
NA	24	31	
Discomfort related to temporal muscle atrophy			0.002
No	38 (100%)	44 (80%)	
Moderate	0 (0%)	11 (20%)	
Severe	0 (0%)	0 (0%)	

TABLE 3. Baseline radiological characteristics and radiological outcomes of ruptured and unruptured aneurysms treated with clipping or coiling

Variable	Coiling	Clipping	p Value
No. of aneurysms	88	99	
Missing pretreatment data, no.	2	2	
Aneurysm location, no. (%)			0.848
M ₁	11 (12.5%)	14 (14.1%)	
Bifurcation	71 (80.7%)	80 (80.8%)	
Distal (M ₂ , M ₃ , M ₄)	6 (6.8%)	5 (5.1%)	
Outcomes, no. (%)			
Posttreatment Raymond-Roy grade			
I	27 (31)†	80 (84.2)§	7.94E-13
II	32 (36.8)‡	8 (8.4)§	
III	28 (32.2)‡	7 (7.4)§	
Early aneurysm retreatment at 1 mo	2 (2.3)‡	1 (1.1)§	0.607
Raymond-Roy grade at 6–12 mos			
I	20 (27)¶	69 (86.3)**	9.57E-14
II	30 (40.5)¶	7 (8.8)**	
III	24 (32.4)¶	4 (5)**	
Late aneurysm retreatment at 24 mos	4 (4.5)	0 (0)	0.04

Conclusion

- Clipping and coiling for MCA aneurysm treatment provide the **same clinical outcome** for ruptured and unruptured aneurysms.
- **clipping provides higher short- and long-term rates of complete exclusion, which in turn decreases the risk of aneurysm retreatment.**

Surgical or Endovascular Management of Middle Cerebral Artery Aneurysms: A Randomized Comparison

WORLD NEUROSURGERY ■ 14:1-14, 2021

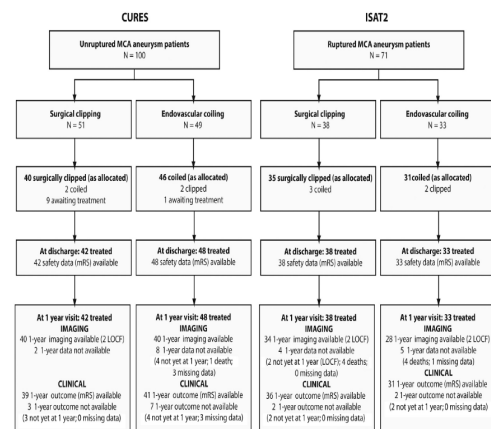
- Analyzed results from patients with MCA aneurysms (randomized trials)
 - CURES (Collaborative UnRuptured Endovascular vs. Surgery)
 - ISAT-2 (International Subarachnoid Aneurysm Trial II)
- The primary outcome (Treatment failure)
 - CURES
 - 1) failure to treat the aneurysm
 - 2) intracranial hemorrhage during follow-up
 - 3) residual aneurysm at 1 year
 - ISAT-2
 - death or dependency (modified Rankin Scale score >2) at 1 year.
 - One-year angiographic outcomes
- CURES in September 2010 to July 2020
ISAT-2 in November 2012 to July 2020
- All MCA An (not bifurcation An only)

International subarachnoid aneurysm trial – ISAT Part II: Study protocol for a randomized controlled trial

- **Patients excluded from ISAT**
 - More than 9,559 aneurysms were screened, but only 2,143 patients were enrolled in the original ISAT study.
 - The applicability of the study results to the type of patients that were screened but excluded remains in doubt.
 - Subgroup analyses show that a variety of aneurysms and clinical situations were under-represented in the original ISAT study
 - MCA bifurcation aneurysms are readily accessible by surgery, while their anatomy may sometimes be less favorable for simple coiling, at least during the years that ISAT was conducted. **MCA aneurysms were likely excluded because they were preferentially clipped.**
 - Due perhaps to perceived difficulties with surgical access, an insufficient number of posterior circulation aneurysm (only 2.7% of the total number) were included in ISAT.
 - Posterior circulation aneurysms, and especially basilar bifurcation aneurysms, were likely preferentially coiled [31].
 - As a result, a substantial number of clinicians remain unsure about the best management of MCA and of non-basilar, posterior circulation aneurysms.

International subarachnoid aneurysm trial – ISAT Part II: Study protocol for a randomized controlled trial

- Aneurysm location: middle cerebral artery bifurcation and posterior circulation
- Posterior circulation aneurysms have been associated with worse prognosis for both clipping and coiling [5]. For this reason, lesions in the different circulations will be minimized to ensure balanced groups, although we expect posterior circulation aneurysms will represent a minority of patients.
- Middle cerebral artery (MCA) aneurysms are common, but they were under-represented in ISAT. **While they are increasingly treated with coiling, the best option remains unknown.** We will monitor clinical results of treatments of MCA aneurysms separately, but this location will not be a minimization criterion.



ASCENT 2021

Table 2. Primary End Points Reached in CURES and ISAT-2 for Patients with Middle Cerebral Artery Aneurysms

Treatment Failure	Surgery	Endovascular	P
Intent-to-treat analysis of primary trial end point			
CURES: unruptured MCA aneurysms			
Failure of modality to treat aneurysm	0	4*	
Hemorrhage during follow-up	0	0	
Residual aneurysm at 1 year	3	9	
Total	3/42 (7%) (95% CI, 0.02–0.19)	13/48 (27%) (95% CI, 0.17–0.41)	0.025
ISAT-2: ruptured MCA aneurysms			
mRS score >2 at 1 year	7/38 (18%) (95% CI, 0.09–0.33)	8/33 (24%) (95% CI, 0.13–0.41)	—
As-treated analysis of primary trial end point			
CURES: unruptured MCA aneurysms			
Failure of modality to treat aneurysm	0	4*	
Hemorrhage during follow-up	0	0	
Residual aneurysm at 1 year	2	10	
Total	2/43 (5%) (95% CI, 0.01–0.15)	14/47 (30%) (95% CI, 0.19–0.44)	0.002
ISAT-2: Ruptured MCA aneurysms			
mRS score >2 at 1 year	7/37 (19%) (95% CI, 0.09–0.34)	8/34 (24%) (95% CI, 0.12–0.40)	—

MCA, middle cerebral artery; CI, confidence interval; mRS, modified Rankin Scale.

*3 untreated (fully patent) aneurysms after procedure, 1 intraprocedural death.

Table 3. Continued

	CURES		ISAT2	
Angiographic Outcomes, 1 year, Intent-to-Treat	Surgical (n = 40)	Endovascular (n = 40)	Surgical (n = 34)	Endovascular (n = 28)
Complete occlusion	30 (75)	14 (35)	24 (71)	15 (54)
Residual neck	7 (18)	14 (35)	6 (18)	8 (29)
Residual aneurysm	3 (8)	9 + 3† (30)	4 (12)	5 (18)
Total	40	40	34	28
Angiographic Outcomes, 1 year, As-Treated	Surgical (n = 41)	Endovascular (n = 39)	Surgical (n = 34)	Endovascular (n = 28)
Complete occlusion	30 (73)	14 (36)	26 (76)	13 (46)
Residual neck	9 (22)	12 (31)	5 (15)	9 (32)
Residual aneurysm	2 (5)	10 + 3† (33)	3 (9)	6 (21)
Total	41	39	34	28

mRS, modified Rankin Scale.

†Crossed over from clipping to coiling (patient choice).

‡Patient aneurysms after attempted coiling.

CONCLUSIONS: Randomized data from 2 trials show that better efficacy may be obtained with surgical management of patients with MCA aneurysms.

Microsurgical Clipping versus Advanced Endovascular Treatment of Unruptured Middle Cerebral Artery Bifurcation Aneurysms After a "Coil-First" Policy

WORLD NEUROSURGERY ■ 11:E9 ■ 2021

- Retrospective review
- The authors' institution
 - the University Hospital of Cologne
 - a tertiary care neurovascular center
 - UIA or RA 140/year cases (100 coil/40 clip)
 - coil-first policy (70%) treated by endovascular means)
- November 2010 and December 2019
- 148 patients with 160 unruptured MCA bifurcation An
- 120 (75%) clipping and 40 (25%) endovascularly.

Patient presents with an unruptured MCA bifurcation aneurysm

- › Department of Neurosurgery
- › Department of Neurology
- › Department of Neuroradiology

Interdisciplinary case discussion within a neurovascular conference

- › Vascular neurosurgeons
- › Interventional neuroradiologists
- › Neurologists
- › Vascular surgeons

Conservative treatment (Watch and Wait)

- Small aneurysm size
- Non-complex morphology
- High patient age
- Single aneurysm
- No hypertension/smoking

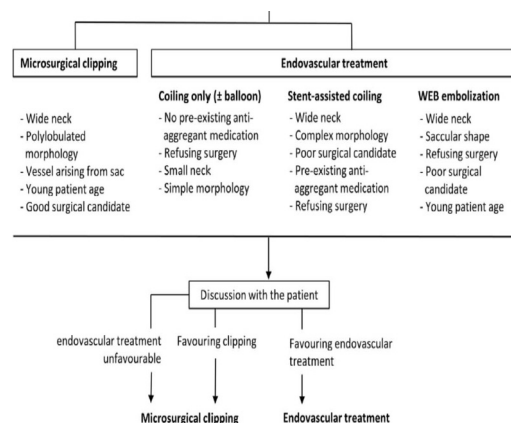


Figure 2. Decision-making algorithm for treatment of unruptured middle cerebral artery bifurcation aneurysms.

Results

- Immediate technical success rates
 - clipping (100%) vs endovascular (92.5%, $P = 0.015$)
- In the endovascular group
 - Conventional coiling : 8 (20.0%)
 - SAC : 16 (40.0%) , 2 staged procedures
 - BAC : 3 (7.5%)
 - WEB device : 13 (32.5%), 1 case additional Y stenting
 - 3 Treatment failures
 - 1 case rupture during BAC
 - 1 case coil & WEB embolization failure -> clipping
 - 1 case rupture during WEB detachment -> SAC c sacrificing parent A.

Table 1. Baseline Patient Demographics and Aneurysm Characteristics

	Clipping (n = 120)	Endovascular (n = 40)	P
Patient age (years)	54.1 ± 10.8	59.3 ± 10.0	0.008
Female sex	90 (75.0%)	34 (85.0%)	0.392
mRS at baseline			<0.001
0	105 (87.5%)	24 (60.0%)	
1	11 (9.2%)	6 (15.0%)	
2	3 (2.5%)	5 (12.5%)	
3	0 (0%)	1 (2.5%)	
4	1 (0.8%)	4 (10.0%)	
Aneurysm size (mm)	7.0 ± 3.6	6.6 ± 3.3	0.574
Neck width (mm)	4.0 ± 1.6	3.8 ± 1.3	0.452
Dome-to-neck ratio	1.7 ± 1.1	1.6 ± 0.4	0.766
Aspect ratio	1.7 ± 1.3	1.6 ± 0.6	0.598
Morphology			0.278
Regular	24 (20.0%)	13 (32.5%)	
Irregular	55 (45.8%)	19 (47.5%)	
Daughter sac	18 (15.0%)	2 (5.0%)	
Lobulated	23 (19.2%)	6 (15.0%)	

Table 2. Complication Types

	Clipping (n = 120)	Endovascular (n = 40)	P
Overall adverse events	20 (16.7%)	8 (20.0%)	0.631
Neurologic deficits			
Overall	17 (14.2%)	5 (12.5%)	0.791
Persistent	7 (5.8%)	2 (5.0%)	1.000
Ischemic stroke			
Overall	7 (5.8%)	5 (12.5%)	0.166
Major	5 (4.2%)	3 (7.5%)	0.414
Subarachnoid or intraparenchymal hemorrhage	3 (2.5%)	1 (2.5%)	1.0
Seizure	8 (6.7%)	0 (0%)	0.202
Access-related complications			
Chronic subdural hematoma	6 (5.0%)	0 (0%)	0.338
Wound infection and wound-healing disorder	2 (1.7%)	0 (0%)	1.0
Femoral artery pseudoaneurysm	0 (0%)	0 (0%)	1.0
Intestinal diseases	4 (3.3%)	1 (2.5%)	1.0

Table 3. Clinical Outcome

	Clipping (n = 120)	Endovascular (n = 40)	P
mRS after treatment			0.009
0	95 (79.2%)	22 (55.0%)	
1	12 (10.0%)	4 (10.0%)	
2	8 (6.7%)	7 (17.5%)	
3	0 (0%)	1 (2.5%)	
4	2 (1.7%)	4 (10.0%)	
5	2 (1.7%)	1 (2.5%)	
6	0 (0%)	1 (2.5%)	
mRS at 6 months			0.012
0	93 (77.5%)	25 (62.5%)	
1	16 (13.3%)	7 (17.5%)	
2	8 (6.7%)	7 (17.5%)	
3	2 (1.7%)	2 (5.0%)	
4	1 (0.8%)	3 (7.5%)	
5	0 (0%)	0 (0%)	
6	0 (0%)	1 (2.5%)	
Morbidity	11 (9.2%)	5 (12.5%)	0.543
Unfavorable outcome			
Discharge	3 (2.5%)	2 (5.0%)	0.386
Smooth follow-up	1 (0.8%)	2 (5.0%)	0.154

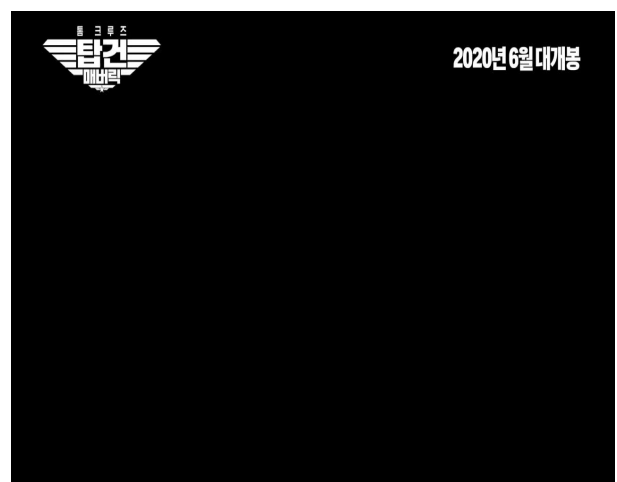
mRS, modified Rankin Scale.

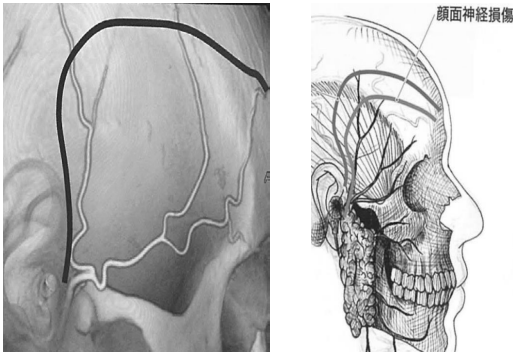
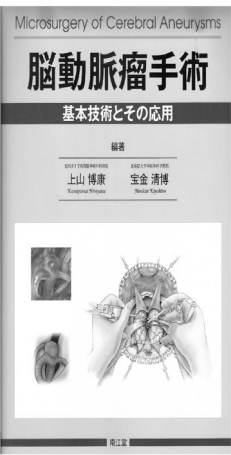
Table 4. Six-Month Angiographic Results

	Clipping (n = 83)	Endovascular (n = 29)
Complete occlusion	74 (89.2%)	22 (75.9%)
Neck remnant	6 (7.2%)	3 (10.3%)
Aneurysm remnant	3 (3.6%)	4 (13.8%)

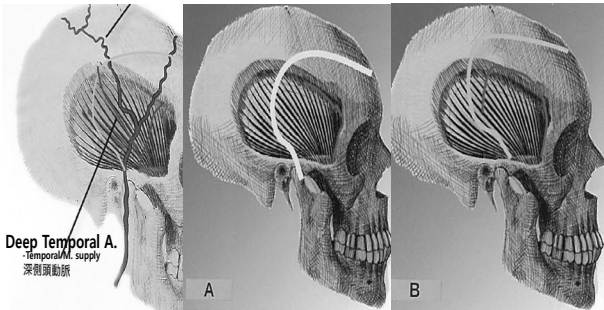
Conclusions

- **Microsurgical clipping** compared to endovascular Tx
 - higher technical success rate
 - slightly higher complete occlusion
 - no additional morbidity
 - similar clinical outcome
- Microsurgical clipping **may still be the gold standard** treatment option for *unruptured MCA bifurcation aneurysms*, even though developments in endovascular treatment may change this in the future.



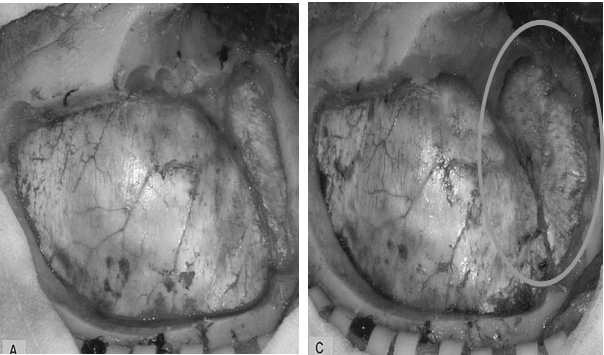
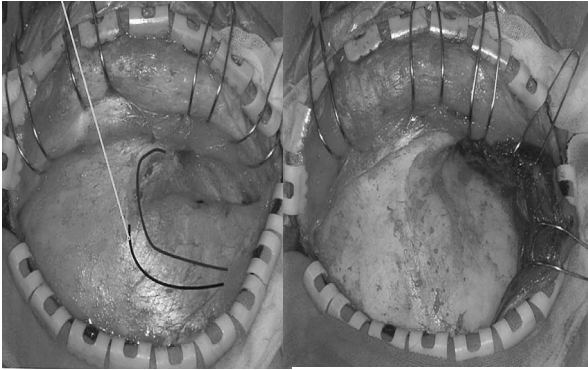


*Incision이 tragus에서 더 상방, 후방에서 시작함



Deep Temporal A.
-TemporalM. supply
深部頭動脈

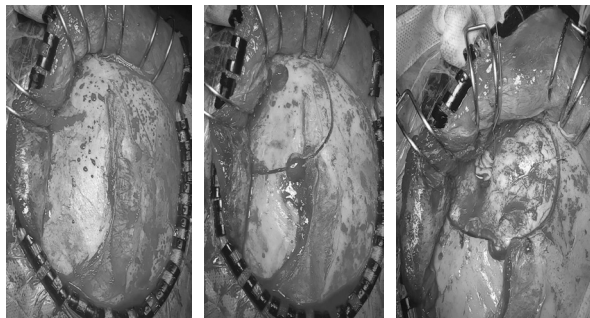
Red line - Muscle incision
Yellow & orange line - Skin incision
* Orange line - more posterior (my case)



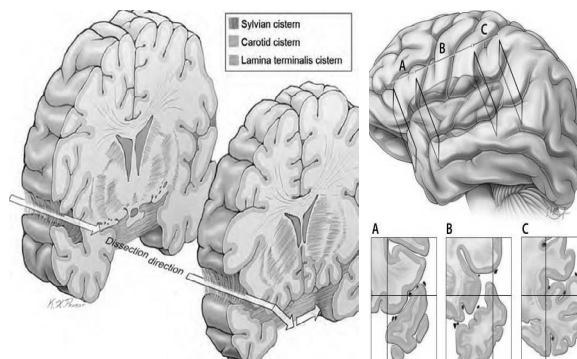
My case



My case



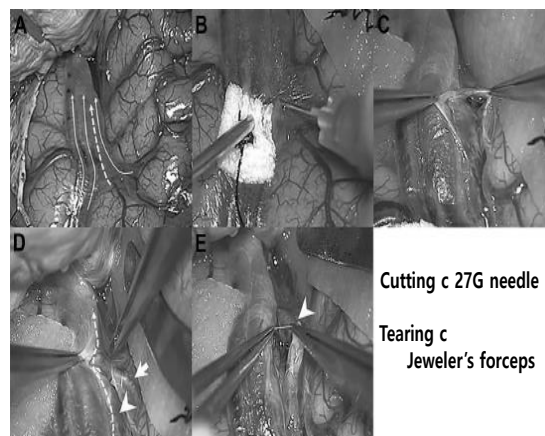
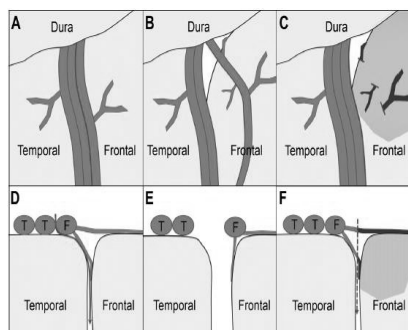
Sylvian Dissection



Venous-Preserving Sylvian Dissection

Hidetsugu Maekawa and Hiromu Hadeishi

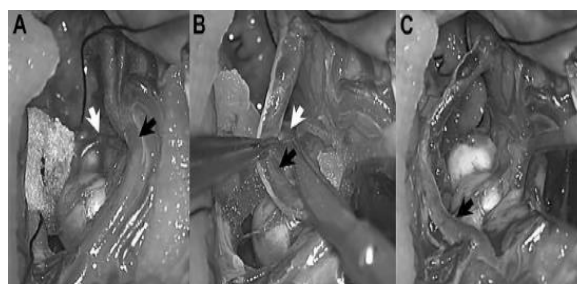
Department of Neurosurgery, Kaneda Medical Center, Kanagawa, Chiba, Japan
 To whom correspondence should be addressed: Hiromu Hadeishi, MD, Ph.D.
 (E-mail: hadeishi@kaneda.jp)
 Citation: World Neurosurg. (2015) 84, 82043-2052.
<http://dx.doi.org/10.1016/j.wneu.2015.07.050>
 Journal homepage: www.WORLDNEUROSURGERY.org



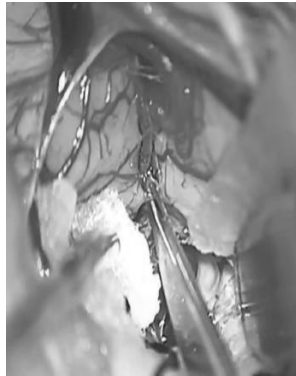
Cutting c 27G needle

Tearing c
 Jeweler's forceps

My Case Video



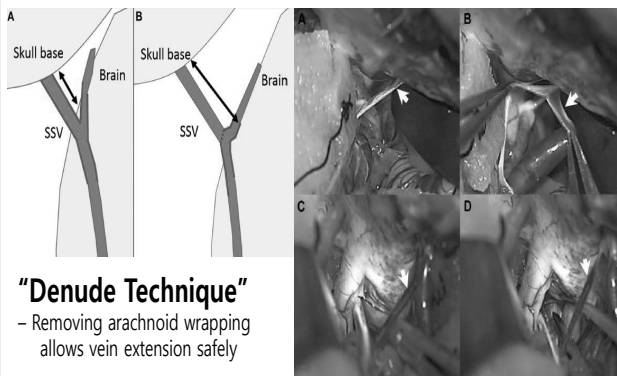
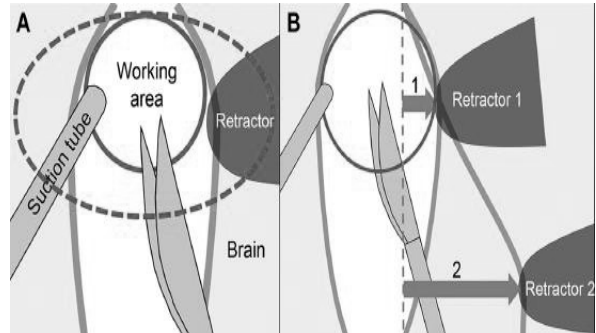
ASCENT 2021



"Paper knife Technique" (=letter opener)

After entering of deep SF,
- Deep to superficial,
Distal to proximal dissection

Retractor tip & Suction tube
- close to working area



"Denude Technique"

- Removing arachnoid wrapping
allows vein extension safely

Sylvian dissection

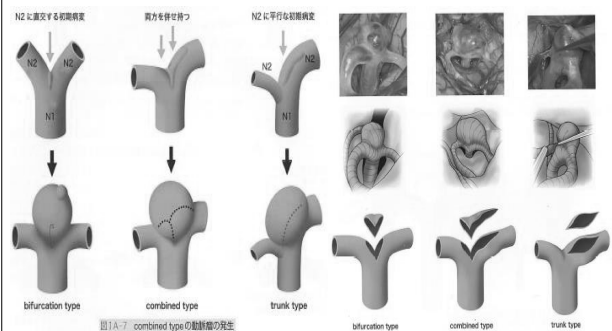
- Aneurysmal SAH, blunt D. may be safer and faster
- d/t blood clot
- Sharp D. more easily & safely handle bridging Vein
- Focused blunt D. is faster than sharp D.
- Focused opening - blunt D. c bipolar
- Wide opening - Sharp D. c microscissors

Aneurysm clipping -closure line



脳動脈瘤手術

Aneurysm clipping -closure line



脳動脈瘤手術

MCA An clipping이 쉬운 가장 큰 이유(나의 의견)
- complete flow arrest 후 수술이 가능하다

Thank you for your attention

Why coiling for bifurcation aneurysm

박 정 현

한림대학교 동탄성심병원 신경외과

Advances in the endovascular treatment of intracranial aneurysms since the advent of detachable coil embolization continue to expand the spectrum of lesions amenable to minimally invasive therapy. The feasibility of treating a given cerebral aneurysm by a given open or endovascular modality does not necessarily make such an approach the optimal choice. Rather, any given cerebral aneurysm and patient should be carefully analyzed on a multitude of parameters which are based on available adjunctive technology, aneurysm morphology and characteristics, endovascular vs. microsurgical accessibility, and long-term angiographic outcome. In addition to patient age, co-morbid conditions, lesion size and attendant risk, one must also consider patient preference with respect to length of hospital stay, recovery duration and required follow-up and radiographic assessments. The relentless improvements in minimally invasive embolization therapies ranging from coiling with adjunctive balloon and stent support to the emerging role of flow-diversion must be balanced against the lower cost and complexity associated with longitudinal clinical and radiographic follow-up requirements of microsurgical clipping. In this rapidly evolving field, the quest for maximizing protection from aneurysm rupture at the lowest neurological cost dictates that a balance be maintained between technical virtuosity and procedural safety of either microsurgical clipping or endovascular repair to ensure that the advantages of the selected modality not be negated by its associated shortcomings.

Benefit of flow disruptor on bifurcation aneurysm

신 용 삼

가톨릭대학교 서울성모병원 신경외과

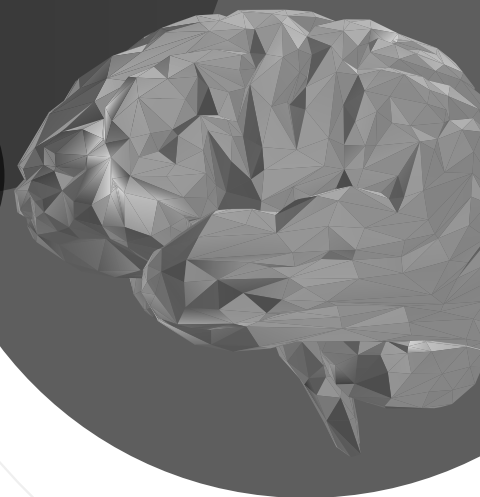
NEURI center, Bicêtre University Hospital, France

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

The 15th Annual Summer Conference on Endovascular Neurosurgical Therapy

ASCENT 2021

Theme: Exploring What is Next in Neuroendovascular Surgery



Poster Session

- | | |
|--|----------------------------------|
| P-01 Preoperative proton density MRI-based intradural versus extradural localization of paraclinoid aneurysms | 이아름, 김범태
(순천향대학교 부천병원) |
| P-02 Initial experiences of flow redirection endoluminal device (FRED) for complex cerebral aneurysms | 강범모
(순천향대학교 천안병원) |
| P-03 Clinical and angiographic outcomes of thrombectomy with novel stent-type clot-retrieval Embotrap II device in acute major arterial occlusion | 김창현
(계명대학교 동산병원) |
| P-04 Hemodynamic instability induced by carotid artery stenting; A single-center retrospective study | 이무하
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| P-05 Possibility of variant form of artery of 'Davidoff and Schechter' (ADS) | 심환석
(강동경희대학교병원) |
| P-06 A left vertebral artery originating from an left internal carotid artery discovered incidentally during treatment for a cerebral aneurysm: A case report | 오형석
(부평세림병원) |
| P-07 Clinical characteristics and neuroimaging findings of isolated anterior cerebral artery territory infarction: A report of 8 cases | 김미경
(분당제생병원) |
| P-08 Deep seated Moyamoya-related intracranial aneurysm which was indirectly treated by reducing the hemodynamic burden on the parent artery: A case report | 김장훈
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(가톨릭대학교 인천성모병원) |
| P-11 Large thrombus formation during coil embolization | 기희종
(가톨릭대학교 대전성모병원) |
| P-12 Hemorrhage after balloon angioplasty for proximal ICA severe stenosis | 방창환
(서울대학교병원) |
| P-13 A case of secondary Parkinsonism Induced by hydrocephalus after aneurysmal subarachnoid hemorrhage | 권순영
(메리놀병원) |
| P-14 Severe carotid bulb stenosis should be ruled out in spontaneous convexity subarachnoid hemorrhage | 박현욱
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| P-15 Pseudoaneurysm formation caused by stenting for intracranial atherosclerotic stenosis: A case report | 김영수
(에스포항병원) |

Preoperative proton density MRI-based intradural versus extradural localization of paraclinoid aneurysms

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순천향대학교 부천병원 영상의학과¹, 신경외과²

Objective: Exact preoperative confirmation of the distal dural ring and intradural location of a paraclinoid aneurysms has been an age old dilemma.

Methods: The equipment and techniques associated with magnetic resonance imaging (MRI) have rapidly evolved. High-resolution MRI (HRMRI) can yield excellent visualization of both the arterial wall and lumen, thus facilitating the exact localization of unruptured paraclinoid aneurysms.

Result: In the present study, we describe the usefulness of proton density magnetic resonance (PD MR) imaging for localization of unruptured paraclinoid aneurysms which was planned and whether we do endovascular approaches in our cases.

Conclusion: Proton density MRI showed sufficient contrast difference to distinguish intradural location from surrounding dural structures.

Initial experiences of flow redirection endoluminal device (FRED) for complex cerebral aneurysms

Bum-Mo Kang, Sung-Ho Lee, Jae-Sang Oh, Seok-Mann Yoon

Department of Neurosurgery, Soonchunhyang university Cheonan Hospital

Objective: Coil embolization for large to giant aneurysms and fusiform aneurysms is challenging. Flow diverter is an alternative treatment modality for these aneurysms. The authors report initial experiences of FRED for complex aneurysm treatment.

Methods: Six FRED were successfully deployed in 5 patients.

Result: Three ICA large to giant aneurysms and three vertebrobasilar fusiform aneurysms were treated with FRED without difficulty. One intraprocedural thrombus was identified and resolved with intraarterial Tirofiban infusion. Postoperatively all patient was neurologically normal except one case of thalamic infarction, who was treated with FRED Jr for PCA fusiform aneurysm. Complete or near-complete occlusion of all aneurysms was achieved during follow-up.

Conclusion: Flow diverter implantation is a safe and effective treatment modality for complex cerebral aneurysms.

Clinical and angiographic outcomes of thrombectomy with novel stent-type clot-retrieval Embotrap II device in acute major arterial occlusion

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Hyung-Jong Park², and Chang-Young Lee¹

¹Department of Neurosurgery and ²Neurology, Keimyung University, Dong-San Medical Center

Objective: The aim of this study is to investigate angiographic, clinical results, and first pass recanalization (FPR) effect on clinical outcomes of mechanical thrombectomy (MT) with novel stent-type clot-retrieval Embotrap II device in acute stroke.

Methods: All 28 consecutive patients with acute major arterial occlusion underwent MT with first-use Embotrap II stent-retriever in our institute. Successful recanalization (SR) was defined as modified TICI grade 2b or 3. Clinical outcome was determined using modified Rankin Scale (mRS) score at discharge or 3 months (good: 0-2, poor: 3-6). Clinical and angiographic data were collected. Also, we classified into two groups: first-pass recanalization (FPR) and non-FPR group. We analyzed the effect on clinical outcome of FPR using the statistical analysis.

Result: Mean age and initial NIHSS score was 73.5 ± 11.3 years and 13.5 ± 5.8 , respectively. The location of occluded vessel was as follows; 20 MCA (17 M1 and 3 M2 segment) and 8 ICA (5 distal ICA and 3 proximal ICA), respectively. Overall SR was achieved in all 28 (100%) patients. The SR of MT with first-use Embotrap II was performed in 20 (71.4%) in 28 patients. Also, the first-pass recanalization (FPR) was achieved in 18 (64.3%) patients. Additional intra-arterial tirofiban and rescue stenting was achieved in 4 (14.3%) and 3 (10.7%) patients, respectively. Mean time of puncture to final recanalization was 45.6 ± 30.2 (range 16-120) min. Good mRS score at discharge or 3-month was 16 of 28 patients (57.1%). Fortunately, no procedure-related complication occurred in any patients. Symptomatic hemorrhage developed in 3 (10.7%) patients. Overall mortality was one (3.6%) patient with symptomatic hemorrhage. Also, the FPR groups (66.7%) had a higher tendency of good outcome (mRS score 0-2) than the non-FPR groups (40.0%).

Conclusion: We suggest that mechanical thrombectomy with novel stent-type clot-retrieval Embotrap II is safe and effective treatment method in acute major arterial occlusion.

Hemodynamic instability induced by carotid artery stenting: A single-center retrospective study

MuHa Lee, Sukh Que Park, Hye Ran Park, Hyung-Ki Park, Jae-Chil Chang, Sung-Jin Cho

Department of Neurosurgery, Soonchunhyang University Seoul Hospital

Objective: Post-treatment hypotension and bradycardia are important complications of carotid artery stenting (CAS) and these are called hemodynamic instability (HI). The incidence and impact of HI on patients' short-term outcomes have been widely discussed and have been of large debate in the literature. Also, the duration of HI is not yet well known. Attempts are being made to identify the expected risk factors for HI occurrence and duration. We investigate the assessment of patient HI incidence, duration, possible predictors and factors affecting HI.

Methods: This study was performed with a retrospective design in a single institution. A total of 89 patients with carotid artery stenosis received carotid artery stenting between 2012 and 2020. HI is defined as systolic blood pressure lower than 90mmHg or a heart rate lower than 50. And continuous EKG monitoring and BP monitoring were conducted before and after the procedure and continued until recovery.

Result: The mean age of the patients was 72.43 ± 8.53 years old (range 49 to 87). Of 89 patients, 25 patients (28%) developed HI after CAS. The median duration of HI was 11.33 ± 44.57 hours (range 0.08 to 224). The difference in the diameter before and after the procedure (3.29 ± 12.43 mm)(p-value 0.026), the presence of symptoms (p-value 0.027) and the presence of coronary artery disease (p-value 0.047) were found to have a significant relationship with incidence of HI. Other factors (sex, plaque ulceration, plaque calcification, distance from bifurcation to maximum stenotic lesion) were not significantly related to incidence of HI. Most patients with HI were recovered within 3 hours, but some of them (20%) lasted more than 3 hours. All of the factors were not significantly related to HI lasting more than 3 hours. However, the closer the distance from the carotid bifurcation to stenotic lesion and the greater the diameter before and after the procedure, the more likely the HI lasted for more than 3 hours.

Conclusion: Hemodynamic instability is a common complication that occurs after carotid artery stenting. And most of them resolved in a few hours. The difference in the diameter before and after the procedure, the presence of symptoms and the presence of coronary artery disease can be used to predict HI after CAS.

Possibility of variant form of Artery of 'Davidoff and Schechter' (ADS)

Hwanseok Shim

Department of Neurosurgery, Kyung Hee University Hospital at Gangdong

Objective: The Artery of Davidoff and Schechter (ADS) is a dural branch of the posterior cerebral artery that can supply the meninges close to the falcotentorial junction. It is usually not identified on angiography except when enlarged in the setting of a dural AVF or meningioma. Our recent case of dural arteriovenous fistula occurred in the posterior fossa was caused by artery of Davidoff and Schechter and ipsilateral Occipital artery. And we treated the dAVFs by Onxy embolization of those arteries successfully. But its running route of the artery of Davidoff and Schechter was some what different from previously printed articles. So we want to introduce this well known but uncommon case of dAVF from ADS to ASCENT 2021, as a possibility of variant form of artery of Davidoff and Schechter.

Methods: Review of literature and compare with our case of angiographic findings.

Result: Our institutional case of ADS which made dural AVF was started from inferior direction of PCA P1-2 junction, and palisade lateral to ipsilateral SCA , P4 calcarine artery and parieto-occipital artery. And finally into falco-tentorial junction. Before reach the faco-tentorial junction, this vessel made dural AVF. This finding is somewhat different from previously known route of ADS.

Conclusion: The artery of our case which made dural AVF in posterior fossa may indicates possibility of variant form of ADS.

A left vertebral artery originating from an internal carotid artery discovered incidentally during treatment for a cerebral aneurysm: A case report

Hyungsug Oh, Hyosang Lee, Munsul Yang

Department of neurosurgery, Serim General Hospital

Objectives: To report the left vertebral artery originating from an internal carotid artery discovered incidentally during treatment for a cerebral aneurysm.

Summary of background data: Anomalous origin of vertebral arteries is a rare vascular anomaly and mostly discovered as incidental findings during computed tomography angiogram, magnetic resonance angiography or digital subtracted angiogram of the aortic arch and cerebral vessels.

Case presentation: A 54-year-old male patient visited the neurologist with symptoms of headache and head tremors. In the neurology department, brain MRI and MRA were taken. A cerebral aneurysm of the anterior communicating artery was found on MRA, and neurosurgery was recommended. A preoperative head and neck CT angiography was performed, and as a result of the examination, a vertebral artery originating from the left internal carotid artery was found along with a 4 mm cerebral aneurysm of the anterior communicating artery. The vertebral arteries originating from both subclavian arteries were in severe hypoplasia. The coil embolization was successfully performed for cerebral aneurysm of the anterior communicating artery, and the anomaly of the vertebral artery was confirmed in detail during intervention.

Discussion: Anomalous origin of left VA is more frequently involved than the right. Origin of left VA directly from aortic arch (about 3-8% of cases), represents the commonest variation in the origins of VAs and second commonest aortic arch anomaly. However, anomalous origin of VA directly from carotid arteries is very rare. VA originating from common carotid artery and from ECA have been reported in the literature. Trifurcation of common carotid artery is well known and trifurcation with occipital artery and facial artery have been reported. However, anomalous origin of VA directly from internal carotid artery is very rare. Normally, both VAs arise from subclavian artery, except for C7 transverse foramen, they pass through C6 to C1 transverse foramina and enter foramen magnum with its intracranial course. Importantly, in our case, abnormal course of left VA occurred after originating from internal carotid artery.

Conclusions: The anomalous origin of the left vertebral artery from the left internal carotid artery is rare. Vertebral artery anomalies are usually incidentally discovered during angiographic imaging of the head and neck, however, it is importance for preoperative planning of neuro-endovascular intervention to avoid inadvertent arterial injury.

Clinical characteristics and neuroimaging findings of isolated anterior cerebral artery territory infarction: A report of 8 cases

Mi Kyung Kim, Hyun Gon Kim, Gyo Jun Hwang

Department of Neurosurgery, Bundang Jesaeng Hospital

Objective: Isolated brain infarction in the anterior cerebral artery (ACA) territory is rare, and its etiology has not yet been fully elucidated. This study aimed to investigate the clinical and radiologic characteristics of patients with isolated ACA territory infarction.

Methods: We retrospectively reviewed 119 consecutive patients diagnosed and treated with acute cerebral infarction confirmed by diffusion-weighted MRI and digital subtraction angiography (DSA) between January 2019 and December 2020 in our institute. Of these patients, 8 patients (6.7%, 6 men, 45-84 years old) suffered isolated ACA territory infarction. We categorized the infarction pattern into three groups: scattered, territorial and scattered-territorial.

Result: Five (62.5%) patients were overweight and the mean body mass index was 26.1 (23.1–29.8) kg/m². The initial morphology of vascular lesions identified by magnetic resonance angiography (MRA) or computed tomography angiography (CTA) showed the following distribution: occlusion of the ACA (n=4, 50.0%), luminal irregularity/stenosis (n=2, 25.0%), and no steno-occlusion (n=2, 25.0%). One patient with occlusion, 2 patients with luminal irregularity/stenosis, and 1 patient with no steno-occlusion in MRA or CTA were confirmed arterial dissections by DSA. The stroke subtypes of the 8 patients with isolated ACA territory infarction were arterial dissection, atherothrombotic infarction, and cardioembolic infarction in 4 patients (50.0%), 3 patients (37.5%), and 1 patient (1.3%), respectively. Of 4 patients with arterial dissection, 2 underwent endovascular treatment. The scattered-territorial infarction pattern was observed in 2 (50%) patients with arterial dissection and 3 (100%) patients with atherothrombotic infarction. The vascular lesion was most commonly located on the A2 segment of the ACA in 4 (50.0%) patients and the right side in 5 (62.5%) patients. The National Institutes of Health Stroke Scale upon admission and favorable clinical outcome (modified Rankin Scale score, 0-2) at discharge had no relation with stroke subtype or the infarction pattern.

Conclusion: Arterial dissection was common vascular lesion underlying an isolated ACA territory infarction. Therefore, a thorough assessment of isolated ACA territory infarction and proper treatment strategies might be considered according to stroke subtypes.

Deep seated moyamoya-related intracranial aneurysm which was indirectly treated by reducing the hemodynamic burden on the parent artery: A case report

Gi Yeop Lee, Jang Hun Kim, Seung-Pil Ban, Byung-gyu Cho

Department of Neurosurgery, Seoul National University Bundang Hospital

Objective: The prevalence of aneurysm formation in cases of adult Moyamoya disease (MMD) is approximately 14% and represents a major potential hemorrhagic risk. Here, we introduce a patient who showed MMD-related aneurysm on the left anterior choroidal artery (AChA) and was treated by the decrease the hemodynamic burden on his AChA after indirect bypass surgery.

Methods: A 22-year-old male soldier was transferred to the emergency room of Armed Forces Capital Hospital after showing sudden headache and few minutes of loss of consciousness. On arrival, he was alert and presented with no neurologic deficits. Initial brain computed tomography (CT) revealed a small amount of subarachnoid hemorrhage on the left quadrigeminal cistern. In his left internal carotid angiogram, 2.42 mm-sized saccular aneurysm was identified on his plexal segment of left AChA. Initially, the MMD-related aneurysm was observed because the embolization of plexal segment of AChA might have higher risk of complications comparing to the chance for rupture. Indirect bypass surgery of encephalo-duro-arterio-synangiosis (EDAS) was performed three weeks later from the first onset.

Result: Postoperatively, his clinical course got worsened and the serial CT revealed the delayed postoperative hematoma on the epidural and subdural spaces occurred. The left hemisphere was shrunken; therefore, 2~3 L of normal saline & 0.5~1 L of starch a day were hydrated for his brain expansion. In the left common carotid angiogram, the known aneurysm was enlarged that the maximal diameter was 5.33 mm. Aneurysm was again observed because of several reasons: (1) If coil embolization of aneurysm failed, trapping of the plexal segment of AChA was inevitable and it might lead to the progressive infarctions. (2) Since the redundant collateral flows were originated from the proximal and distal AChA, procedures may confer the decrease of deep cerebral perfusions. Fortunately, after three weeks from EDAS surgery, the patient was restored, and his weakness got improved. Hydration was gradually ceased, and the following angiogram (1 month after EDAS) revealed a dramatic size reduction of the aneurysm.

Conclusion: The treatment of MMD-related aneurysm can be challenging and should be tailored according to the hemodynamic status of the patient. When the aneurysm is deeply seated be treated and is highly suspected as accompanying the complications, surgical bypass for decreasing hemodynamic burden of the parent artery can be a good optional treatment.

A case of anomaly with the left vertebral artery originated from aortic arch

Sung-Kyun Hwang

Department of Neurosurgery, Ewha Womans University of College of Medicine, Mokdong Hospital

Objective: We report a case of an anomalous origin of the left vertebral artery originated from aortic arch presented by non-aneurysmal spontaneous subarachnoid hemorrhage (SAH).

Methods: A 33-year-old man presented with sudden severe headache and followed by sensory change in right hand. At the time of admission, brain computed tomography angiography revealed small amount of acute SAH in the left introitus of the left sylvian cistern. Cerebral angiography showed no definite intracranial vascular lesion (aneurysm) but, anomalous origin of the left vertebral artery originated from aortic arch in aortography.

Result: The patient was treated by medication and followed by one week using computed tomography subtraction angiography. He made a steady recovery without neurological sequela including sensory change in right hand.

Conclusion: Further investigations are needed to reveal risk factors, vascular anatomy, and causative mechanisms of this cerebral vascular anomaly.

Y-stent-assisted-coil embolization of a wide-necked anterior communicating aneurysm involving a subcallosal artery: A case report

Minhyeong Moon, Dong-Kyu Jang, Byung-Rae Cho

Department of Neurosurgery, Incheon St. Mary's Hospital and College of Medicine, The Catholic University of Korea

Objective: A wide-necked anterior communicating aneurysm (ACoMAn) involving a subcallosal artery around aneurysm neck is rare and very challenging to treat because of potential basal forebrain infarction and cognitive dysfunction. Here, we report this complex aneurysm treated successfully with Y-stent-assisted coil embolization.

Methods: A 61-year-old woman was diagnosed with multiple unruptured aneurysms including ACoMAn (7.7x7.07x5.67mm (DNH)), left A1 aneurysm (1.93x2.82x2.09mm (DNH)), and Lt anterior choroidal aneurysm (1.99x1.59x2.15mm (DNH)), and bilateral MCA occlusion with basal moyamoya-like vessels without transdural anastomosis. ACoMAn was initially planned to treat because of potential higher rupture risk due to size and bleb.

Result: Bifemoral access was adopted and main guiding catheter was positioned up to left petrous ICA and diagnostic catheter was positioned into right ICA. Initially, the first microcatheter was inserted into ACoMAn. The second microcatheter was positioned up to left A2 and Neuroform atlas 4x21mm was deployed from left A2 to A1 during coil mass protection of herniation of stent into aneurysm sac. Subsequently the second microcatheter was reloaded into deployed stent and passed through the stent struts up to subcallosal artery. Neuroform atlas 3x21mm was deployed from subcallosal artery to left A1 with the configuration of Y. The second microcatheter was retrieved and coil embolization through the first microcatheter was conducted. Raymond class I with packing density of 40.9% measured with AngioCalc tool was achieved. The patient was discharged without any complications.

Conclusion: Y-stent-assisted coil embolization may be a feasible treatment option for a complex anterior communicating aneurysm involving a subcallosal artery.

Large thrombus formation during coil embolization

Heejong Ki

Department of Neurosurgery, Daejeon St Mary's Hospital, The Catholic University of Korea

Objective: This was not only my first endovascular treatment case but also the complication case which the large thrombus was formed in the distal internal carotid artery (ICA) during stent assisted coil embolization (SAC).

Methods: A 64-year old woman visited the emergency room complaining of headache and fever. Initial computed tomography angiography (CTA) showed diffuse subarachnoid hemorrhage with a saccular aneurysm involving anterior communicating artery (AcomA). SAC was decided after performing diagnostic angiography. A large thrombus located in the left distal ICA was detected during deployment of coils. Consecutively, mechanical thrombectomy was performed for the large thrombus migrated into the left MCA.

Result: SAC was performed for the ruptured aneurysm involving AcomA with 9 coils. Mechanical thrombectomy was performed with modified treatment in cerebral ischemia (mTICI) 3 score.

Conclusion: The lesson from this case was the importance of flushing the system continuously and checking all the angiography carefully.

Hemorrhage after balloon angioplasty for proximal ICA severe stenosis

방창환^{1,2}, 유동현¹, 김강민¹, 조영대¹, 강현승¹

서울대학교병원 신경외과¹, 분당서울대학교병원 신경외과²

Objective: Carotid artery stenting (CAS) is good treatment option for symptomatic hemodynamically unstable proximal ICA severe stenosis. But it has potential serious complication such as cerebral hyperperfusion syndrome (CHS). Staged carotid artery may be considered to prevent serious complication of CHS. Here we present ICH after staged CAS.

Methods: A 74-year-old male patient complained of decreased visual acuity in both eyes, especially in the right eye for 2 years, even after multiple attempts to ophthalmologic treatment. MRA was performed on suspicious of ocular ischemic syndrome and right proximal ICA steno-occlusion was suspected. On TFCA, severe stenosis of right proximal ICA was confirmed, and both basal perfusion and vascular reserve capacity on right MCA territory were decreased on perfusion MRI. For symptomatic hemodynamically unstable right proximal ICA severe stenosis, we planned staged CAS. First, balloon angioplasty using SLEEK 3*40 at a pressure of 12 atm was done. (Nominal pressure 8 atm, bursting pressure 16 atm). Preoperative SBP range was 120 to 165 and postoperative SBP range was 100 to 145.

Result: He discharged one day after balloon angioplasty, and readmitted for carotid artery stenting one week later. Perfusion MRI performed before CAS showed improvement in perfusion, but basal ganglia ICH was confirmed. It was revealed that the patient arbitrarily took dual antiplatelet agents at double the dose. He had no symptoms, and after stopping the antiplatelet and controlling the BP in normotensive range, the hemorrhage was stable and he was discharged without performing CAS. Since there was no recoil on the CTA performed one months later, and there was no worsening of symptoms, the patient was observed on at outpatient basis.

Conclusion: This case is the first of ICH since staged CAS was performed at our institution for a patient with symptomatic, hemodynamically unstable severe ICA stenosis. However, unlike other patients, there was breach of our treatment protocol regarding the dose of dual antiplatelet agents. Since cerebral hyperperfusion syndrome is possible serious complication, even if staged CAS is performed, the patient should be managed with attention to medications and strict blood pressure control.

A case of secondary Parkinsonism induced by hydrocephalus after aneurysmal subarachnoid hemorrhage

Soon Young Kwon

Department of Neurosurgery, Maryknoll Medical Center

Objective: Secondary parkinsonism by hydrocephalus after aneurysmal rupture is a rare complication. Hydrocephalus can induce secondary parkinsonism caused by increased ventricular pressure near the upper midbrain and basal ganglia. These mechanisms are thought to cause mechanical disruption of the dopaminergic system. Dopamine replacement is essential in secondary parkinsonism.

Methods: We report a case of secondary Parkinsonism due to hydrocephalus after aneurysmal subarachnoid hemorrhage.

Result: A 50-year-old woman presented with subarachnoid hemorrhage with PICA aneurysmal rupture. Coil embolization and extraventricular drainage(EVD) were performed, and the patient's consciousness improved on the 1st day after surgery. The patient was tolerable with the EVD clamping test and removed 7 days after surgery. After removal of the EVD catheter, the patient's consciousness gradually deteriorated and the ventricle size slightly increased in the brain computed tomography. She underwent a ventriculoperitoneal(VP) shunt operation, and the patient's consciousness improved slightly. However, new symptoms of sialorrhea, bradykinesia, dysphagia and rigidity were developed. Suspected of secondary Parkinsonism, levodopa/carbidopa was administered and the patient showed significant improvement in above symptoms.

Conclusion: Secondary parkinsonism can rarely be caused by hydrocephalus after aneurysmal subarachnoid hemorrhage. Dopaminergic agents should be considered if symptoms do not improve after VP shunt, or if symptoms such as rigidity, bradykinesia, or tremor are present.

Severe carotid bulb stenosis should be ruled out in spontaneous convexity subarachnoid hemorrhage

Hyun Wook Park

Department of Neurosurgery, Busan Bumin Hospital

Objective: There are several causes of non-traumatic cortical subarachnoid hemorrhage(SAH), including pial AVM, dural AVF, artery dissection, severe artery stenosis, cortical vein thrombosis, vasculitis, reversible cerebral vasoconstriction syndrome, posterior reversible encephalopathy syndrome, and coagulopathy. We report our experience with spontaneous cortical SAH associated with severe carotid bulb stenosis.

Methods: A 48-year-old male presented with headache and visual disturbance without head trauma. As standard workup, brain CT, MRI, and MRA was done which demonstrated Rt. Parieto-occipital cortical SAH, and Rt. Carotid bulb severe stenosis. Perfusion MRI was performed for Rt. Carotid bulb severe stenosis. Perfusion MRI showed Rt. MCA territory perfusion delay, especially MCA-PCA watershed zone. Rt. Carotid bulb stenosis was diagnosed in NASCET 85% by TFCA. The cause of parieto-occipital cortical SAH seen on brain CT in the absence of trauma was unknown, so a literature review was conducted. It was confirmed that severe carotid bulb stenosis can cause cortical SAH, and it was confirmed that it is an indication for early carotid bulb stenting. We decided to treat Rt. Carotid bulb severe stenosis with a stent. Procedures were performed using Protege stent and there were no procedure related complication. He was discharged 7 days later without neurologic deficit.

Result: If carotid bulb stenosis is severe, Posterior cerebral artery(PCA)-Middle cerebral artery(MCA) leptomeningeal compensation flow is supplied through PCA. Spontaneous cortical SAH can occur when the fragile pial PCA-MCA leptomeningeal artery is ruptured due to hemodynamic stress. Spontaneous cortical SAH due to carotid bulb stenosis should be considered a risk factor for ischemic stroke. When spontaneous cortical SAH occurs in the setting of carotid bulb stenosis, Carotid bulb stenting should be considered.

Conclusion: If a patient with non-traumatic cortical SAH comes to the hospital with headache and there is no apparent cause in the intra-cranial artery, Carotid bulb evaluation is considered necessary.

Pseudoaneurysm formation caused by stenting for intracranial atherosclerotic stenosis: A case report

Youngsoo Kim, Sangyoung Kim, Haemin Kim, Yeon-Ju Choi, Suntak Jin, Dongwoo lee, Daeyoung Hong, Mun-Chul Kim

Department of Neurosurgery, Pohang Stroke and Spine Hospital

Objective: This is a report of pseudoaneurysm formation after stenting Intracranial atherosclerotic stenosis (ICAS).

Methods: A 72-year old patient presented with dysarthria and right hemiparesis. Brain diffusion-weighted image(DWI) revealed acute ischemic lesions in the internal watershed area of the left cerebral hemisphere. Secondary prevention therapy was started according to guidelines for ischemic stroke treatment with aspirin, clopidogrel, and rosuvastatin. After 14 days of admission, the patient had a nearly full clinical recovery, with residual slight motor deficit of the distal right upper limb. Conventional angiography and sequential CT angiography revealed aggravation of severe stenosis (about 75%) at left distal ICA and proximal M2. Also, perfusion-weighted image(PWI) showed increased the time to peak(TTP) and size of the lesion.

Result: After 30 days of the attack, the patient underwent endovascular treatment for ICAS. Under general anesthesia, a Wingspan stent(3.5×15 mm) was deployed. a 3.0×20 mm-sized Reurei balloon was used with step-wise inflation (4 atm 7 atm for 30 seconds each). Then Post-operative angiography showed good patency of the MCA, but severe stenosis of distal ICA. An Energy balloon mounts stent (4.0×15 mm) was deployed with 9 atm inflation pressure. After stent placement, an abnormal pseudo sac appeared at the distal ICA. Pseudosac embolization was done with 3 detachable coils and additional Neuroform ATLAS stent immediately (Occluder-like way). Postop CT showed no bleeding or acute complication. However, the patient had drowsy consciousness and right hemiparesis of grade 4 on the postoperative day. After another a month later, the newly developed infarction was well resolved. The patient had minimal motor weakness on hand grasping at 3 month clinical follow-up.

Conclusion: This is report shows the pseudoaneurysm formation after stenting ICAS lesion which was successfully treated occluder-like way coil embolization.

MEMO

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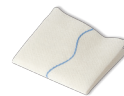
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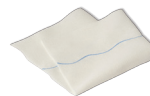
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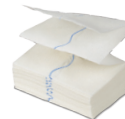
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[References] 1. Ryu KH, et al. Ginkgo biloba extract enhances antiplatelet and antithrombotic effects of cilostazol without prolongation of bleeding time. *Thrombo Res.* 2009;124:328-334 2. Kwak PA, et al. Supra-Additive Neuroprotection by Renexin, a Mixed Compound of Ginkgo Biloba Extract and cilostazol, Against Apoptotic White Matter Changes in Rat after Chronic Cerebral Hypoperfusion. *J Clin Neurol.* 2012 Dec; 8(4): 284-292 3. Bae JP, et al. Adherence and dosing frequency of common medications for cardiovascular patients. *Am J Manag Care.* 2012 Mar;18(3):139-46 4. SID142 임상3상, Data on file, SK케미칼. [Updated 2019.04.09]

리넥신서방정 제품요약정보

전문의약품

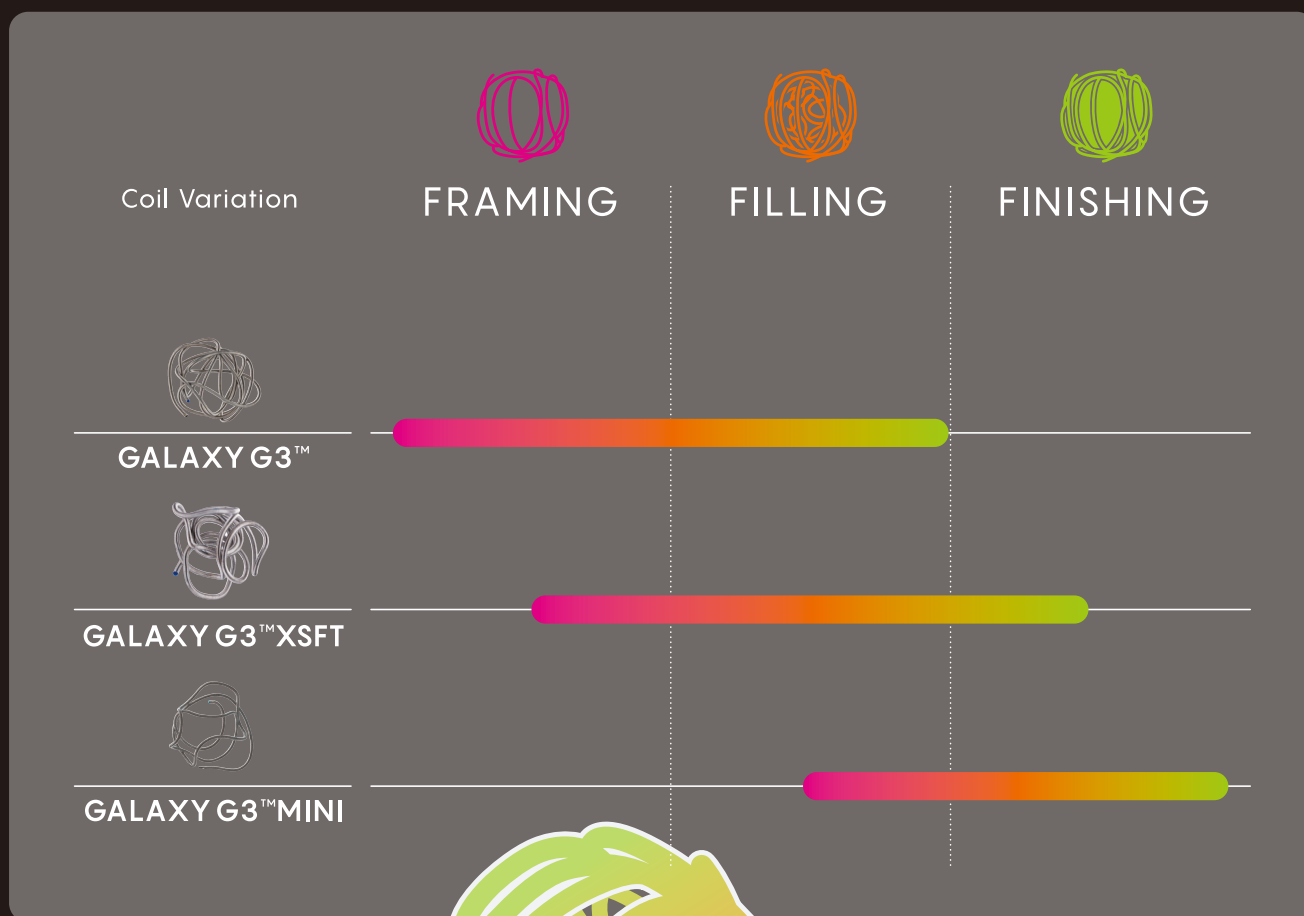
【제품명】 · 리넥신서방정 **【원료약품 및 그 분량】** 이 약 1정 중 유효성분 : 실로스타졸(JP)···200 mg, 은행엽건조엑스(생규)···160 mg **【성상】** 연두색의 타원형 서방성 필름코팅정 **【효능·효과】** 다음 질환에 대하여 실로스타졸 단독요법으로 효과가 불충분한 경우, 실로스타졸과 은행엽건조엑스 제제의 병용요법에 대한 대체요법 1. 만성동맥폐색증(버거씨병, 폐색성 동맥경화증, 당뇨병성 말초혈관병증 등)에 따른 괴양, 동통 및 냉감 등 허혈성 증상상의 개선 2. 뇌경색(심인성 뇌색전증 제외) 발증 후 재발억제 **【용법·용량】** 이 약은 서방정 정제이므로 분쇄하거나 분할 또는 씹지 않고 전체를 복용하며, 식사를 피하여 공복 상태에서 복용한다. 이 약은 1회 용량으로 실로스타졸 100밀리그램과 은행엽건조엑스 80밀리그램을 1일2회 병용투여시 효과가 충분한 성인 환자에 대하여 대체요법으로 투여한다. 통상 성인에 대하여 1일1회, 1회 1정을 경구 투여한다. **【사용상의주의사항】** 1. 경고, 이 약은 실로스타졸 투여로 인해 맥박수가 증가하여 협심증이 발현될 수 있으므로 협심증의 증상(가슴통증 등)에 대한 문진을 주의깊게 실시한다(뇌경색 재발 억제효과를 검토하는 시험에서, 장기간에 걸쳐 PRP(pressure rate product)를 의미있게 상승시키는 작용이 인정되었다. 또한, 실로스타졸 투여군에서 협심증이 발현된 증례가 나타났다). 2. 다음 환자에는 투여하지 말 것. 1) 출혈(혈우병, 모세혈관 취약증, 두개내출혈, 상부소화관출혈, 요로출혈, 객혈, 초저출혈 등) 또는 그러한 소인(활동성 소화궤양, 최근 6개월 이내에 출혈성뇌졸중, 3개월 이내에 외과수술, 증식당뇨망막병증, 조절되지 않는 고혈압)이 있는 환자(출혈을 조장할 우려가 있다) 2) 출혈성심부전 환자(증상을 악화시킬 우려가 있다) 3) 이 약 및 이 약의 구성성분에 과민반응의 병력이 있는 환자 4) 임부 또는 임신하고 있을 가능성이 있는 여성 및 수유부 3. 다음 환자에는 신중히 투여할 것. 1) 항응고제(와파린 등), 항혈소판제(아스피린, 티클로피딘 등), 혈전용해제(우로키나제, 알테플라제 등), 프로스타글란딘 E1 제제 및 그 유도체(알프로스타딘, 리마프로스트 알파엑스 등)를 투여중인 환자 2) 월경기간 중인 환자(출혈을 조장할 우려가 있다) 3) 관동맥 협착의 합병증 환자(이 약의 투여에 의한 맥박수 증가로 협심증을 유발할 가능성이 있다). 4) 중증 신장에 환자(크레아티닌 청소율 ≤ 25 mL/분)(이 약의 대사물의 혈중농도가 상승될 수 있다). 5) 중등도 또는 중증 간장애 환자(이 약의 혈중농도가 상승될 수 있다). 6) 당뇨병 또는 내당능 장애가 있는 환자(출혈성 유해증상이 발현하기 쉽다). 7) 지속적으로 혈압이 상승하고 있는 고혈압 환자(약성고혈압 등) 8) 심방이나 심실전위 환자, 심방세동이나 조동 환자, 심실빈맥, 심실세동 또는 다초점성심실이상성박동 환자, QT간격의 연장이 있는 환자 9) 5자형 심실 중격이 있거나 위험이 있는 환자(특히 고령자) : 5자형 심실 중격 환자에서 좌심실 유출로 폐쇄가 보고되었다. 실로스타졸 복용 시작 후 새로운 수축기 잡음 혹은 심장 증상의 발생 여부를 모니터링 한다. **【제조자】** 에스케이케미칼(주) 충청북도 청주시 흥덕구 산단로 149 **【판매자】** 에스케이케미칼(주) 경기도 성남시 분당구 판교로 310 2020.03.24

※ 처방하시기 전 제품설명서 전문을 참고하십시오. 최신 허가사항에 대한 정보는 '식품의약품안전처 의약품안전나라 (<https://nrdug.mfds.go.kr/index>)'에서 확인할 수 있습니다.

Reference. 리넥신서방정 허가정보, 의약품안전나라 [Cited 2020.03.25] Available from : <https://nrdug.mfds.go.kr/>

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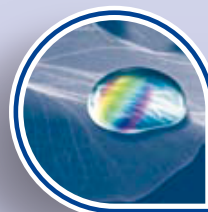
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【원료약품 및 분량】 1캡슐 중 클린알포세레이트(KP) 400mg **【성상】** 무색 투명한 액체가 충전된 빨간색의 띠로 감싸진 상하부 무색 투명한 캡슐체 **【효능·효과】** - 뇌혈관 결손에 의한 2차 증상 및 변성 또는 퇴행성 뇌기질성 정신증후군 : 기억력저하와 착란, 의욕 및 자발성저하로 인한 방황감각장애, 의욕 및 자발성 저하, 집중력감소 - 감정 및 행동변화 : 정서불안, 자극과민성, 주위무관심 - 노인성 가성우울증 **【용법·용량】** 클린알포세레이트로서 1회 400 mg을 1일 2~3회 경구투여한다. 증상에 따라 적절히 증감한다. **【사용상의 주의사항】** 1. 금기 1) 이 약 및 이 약의 구성성분에 과민반응 환자 2) 임부 또는 임신하고 있을 가능성이 있는 여성 **【저장방법】** 기밀용기, 실온(1~30℃)보관 **【포장단위】** 30캡슐/병, 60캡슐/병 **【첨부문서개정일】** 2018.10.2 **【제조·판매처】** (주)유한양행 서울시 동작구 노량진로 74 www.yuhan.co.kr 소비자상담실: 080-024-1188(수신자 요금부담) ※ 보다 자세한 사항은 최신의 제품설명서 전문을 참고하시기 바랍니다.

알포아티린®정(클린알포세레이트)

【원료약품 및 분량】 1정 중 클린알포세레이트(KP) 400mg **【성상】** 단방향의 장방형 필름코팅정 **【효능·효과】** - 뇌혈관 결손에 의한 2차 증상 및 변성 또는 퇴행성 뇌기질성 정신증후군 : 기억력저하와 착란, 의욕 및 자발성저하로 인한 방황감각장애, 의욕 및 자발성 저하, 집중력감소 - 감정 및 행동변화 : 정서불안, 자극과민성, 주위무관심 - 노인성 가성우울증 **【용법·용량】** 클린알포세레이트로서 1회 400 mg을 1일 2~3회 경구투여한다. 증상에 따라 적절히 증감한다. **【사용상의 주의사항】** 1. 금기 1) 이 약 및 이 약의 구성성분에 과민반응 환자 2) 임부 또는 임신하고 있을 가능성이 있는 여성 **【저장방법】** 기밀용기, 실온(1~30℃)보관 **【포장단위】** 30정(6정/PTPx5), 60정(6정/PTPx10) **【첨부문서개정일】** 2017.10.10 **【제조·판매처】** (주)유한양행 서울시 동작구 노량진로 74 www.yuhan.co.kr 소비자상담실: 080-024-1188(수신자 요금부담) ※ 보다 자세한 사항은 최신의 제품설명서 전문을 참고하시기 바랍니다.

알포아티린®연질캡슐(클린알포세레이트)

【원료약품 및 분량】 1캡슐 중 클린알포세레이트(KP) 400mg **【성상】** 무색투명의 정조한 액을 넣은 알알색을 띤 타원형의 연질캡슐체 **【효능·효과】** - 뇌혈관 결손에 의한 2차 증상 및 변성 또는 퇴행성 뇌기질성 정신증후군 : 기억력저하와 착란, 의욕 및 자발성저하로 인한 방황감각장애, 의욕 및 자발성 저하, 집중력감소 - 감정 및 행동변화 : 정서불안, 자극과민성, 주위무관심 - 노인성 가성우울증 **【용법·용량】** 클린알포세레이트로서 1회 400 mg을 1일 2~3회 경구투여한다. 증상에 따라 적절히 증감한다. **【사용상의 주의사항】** 1. 금기 1) 이 약 및 이 약의 구성성분에 과민반응 환자 2) 임부 또는 임신하고 있을 가능성이 있는 여성 **【저장방법】** 기밀용기, 실온(1~30℃)보관 **【포장단위】** 100캡슐(10캡슐/PTPx10) **【첨부문서개정일】** 2017.10.10 **【제조·판매처】** (주)유한양행 서울시 동작구 노량진로 74 www.yuhan.co.kr 소비자상담실: 080-024-1188(수신자 요금부담) ※ 보다 자세한 사항은 최신의 제품설명서 전문을 참고하시기 바랍니다.



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