

Basic NeuroEndovascular Training Course 3 (BNET Course)

BNET 3rd : Carotid stenting and Mechanical thrombectomy

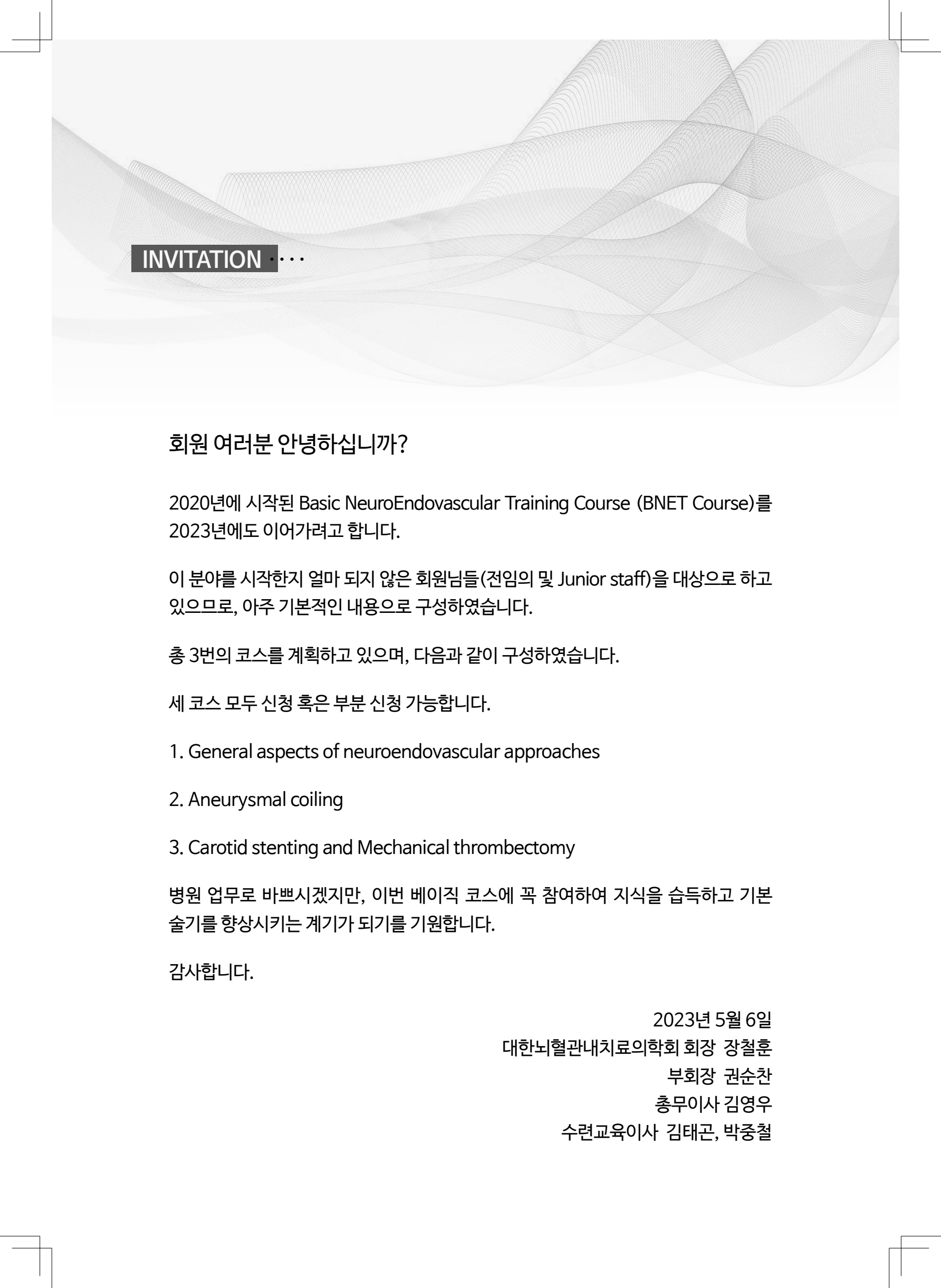
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일시 : 2023년 5월 6일(토)

장소 : 대웅제약본사 별관 베어홀 (지하1층)
(서울 강남구 봉은사로 644)

주최 : 대한뇌혈관내치료의학회

주관 : 대한신경외과학연구재단



INVITATION ···

회원 여러분 안녕하십니까?

2020년에 시작된 Basic NeuroEndovascular Training Course (BNET Course)를 2023년에도 이어가려고 합니다.

이 분야를 시작한지 얼마 되지 않은 회원님들(전임의 및 Junior staff)을 대상으로 하고 있으므로, 아주 기본적인 내용으로 구성하였습니다.

총 3번의 코스를 계획하고 있으며, 다음과 같이 구성하였습니다.

세 코스 모두 신청 혹은 부분 신청 가능합니다.

1. General aspects of neuroendovascular approaches
2. Aneurysmal coiling
3. Carotid stenting and Mechanical thrombectomy

병원 업무로 바쁘시겠지만, 이번 베이직 코스에 꼭 참여하여 지식을 습득하고 기본 술기를 향상시키는 계기가 되기를 기원합니다.

감사합니다.

2023년 5월 6일
대한뇌혈관내치료의학회 회장 장철훈
부회장 권순찬
총무이사 김영우
수련교육이사 김태곤, 박중철

PROGRAM

일시 : 2023년 5월 6일(토)

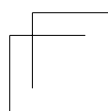
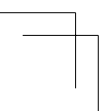
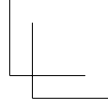
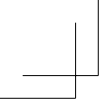
장소 : 대웅제약본사 별관 베어홀

08:30-08:50	Registration			
08:50-09:00	Course Introduction	김태곤	차의과학대 분당차병원	
	Welcome Address	장철훈	KoNES 회장	
09:00-09:30	Carotid Stenting – Review of Devices including stent, embolic protection devices, etc	조수희	울산대 강릉아산병원	07
09:30-10:00	Carotid Stenting – Patient selection, technical tips and basic tactics	신병국	동의의료원	19
10:00-10:30	Mechanical thrombectomy for acute ischemic stroke – Review of Devices including stent retriever and aspiration catheter, etc	고정호	단국대 천안병원	39
10:30-11:00	Mechanical thrombectomy for acute ischemic stroke – Stent retriever : Patient selection, technical tips and basic tactics	심유식	인하대병원	57
11:00-11:30	Mechanical thrombectomy for acute ischemic stroke – Aspiration technique: Patient selection, technical tips and basic tactics	박정현	한림대 동탄성심병원	63
11:30-12:00	Lunch			
12:00-13:00	Hands-on (Mechanical thrombectomy)		All	
	Closing & Photo time	김영우	KoNES 총무이사	

Carotid Stenting - Review of Devices including stent, embolic protection devices, etc

조 수 희

울산대 강릉아산병원



Carotid stenting Review of Devices including stents, embolic protection devices

강릉아산병원 신경외과 조수희

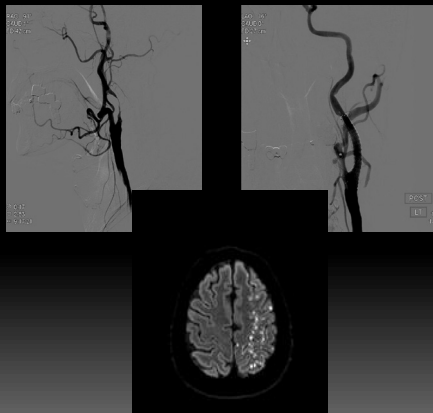
▪ Embolic protection devices

:embolic complication
:EPD techniques - proximal Vs distal
:review of devices
:outcome
:discussion

▪ Carotid stent

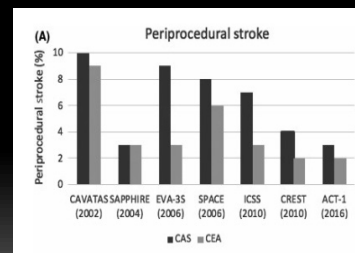
:Type of carotid stent
:Characteristics of devices
:Outcome

Periprocedural stroke



Periprocedural stroke Incidence

- Periprocedural stroke is more likely with CAS.
- Incidence has reduced with time.



2019 Acta Neurologica Anthony Lamanna et al

Periprocedural stroke Mechanism

- Periprocedural stroke after carotid revascularization is not always secondary to thromboembolism.
- Stroke often occurs due to hemodynamic disturbance.

Table 3. Stroke mechanism according to the procedural time interval^a

	Day 0, intraprocedural (n = 25)		Day 0, after the procedure (n = 37)		Days 1–30 (n = 21)	
	CAS n = 20	CEA n = 5	CAS n = 22	CEA n = 5	CAS n = 13	CEA n = 10
Ischaemic						
- Carotid-embolic	4 (20)	0 (0)	5 (23)	2 (40)	0 (0)	2 (20)
- Haemodynamic	4 (20)	0 (0)	8 (36)	0 (0)	1 (8)	2 (20)
- Thrombosis or occlusion of the carotid artery	2 (10)	0 (0)	2 (9)	1 (20)	7 (54)	2 (20)
- Hyperperfusion	1 (5)	0 (0)	1 (5)	0 (0)	0 (0)	2 (20)
- Cardiac-embolic	1 (5)	0 (0)	0 (0)	2 (40)	1 (8)	1 (10)
- Multiple	2 (10)	0 (0)	0 (0)	0 (0)	1 (8)	0 (0)
- Undetermined	4 (20)	2 (40)	6 (27)	0 (0)	3 (23)	1 (10)
	p = .854 ^b		p = .02		p = .181	
	Day 0, intraprocedural (n = 0)		Day 0, after the procedure (n = 0)		Days 1–30 (n = 7)	
	CAS n = 0	CEA n = 0	CAS n = 0	CEA n = 0	CAS n = 2	CEA n = 5
Haemorrhagic						
- Hyperperfusion	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	4 (80)
- No hyperperfusion/undetermined	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	1 (20)
					p = .427	

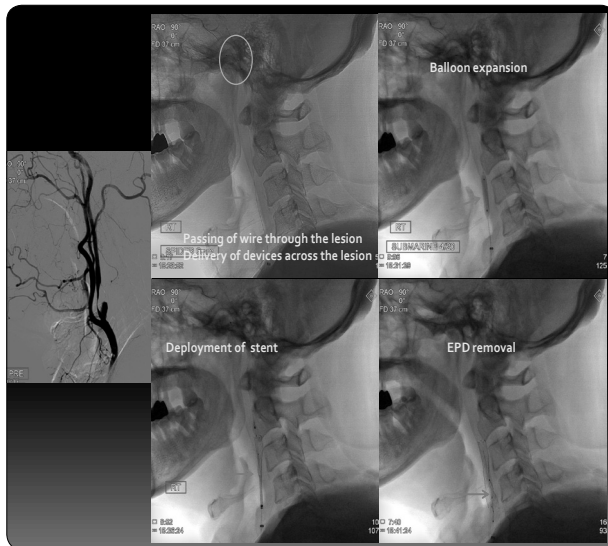
CAS = carotid artery stenting; CEA = carotid endarterectomy.
^a The three strokes with unknown timing are not included in the table. In these cases the mechanism was carotid-embolic (1), thrombosis or occlusion of the carotid artery (1), and undetermined (1).
^b p derived by use of chi-square test comparing stroke mechanism (on, respectively, day 0, intraprocedural, day 0 after the procedure, and days 1–30) between CAS and CEA.

2015 Eur J Vasc Endovasc Surg A.Hubers et al

Embolism complication Mechanism

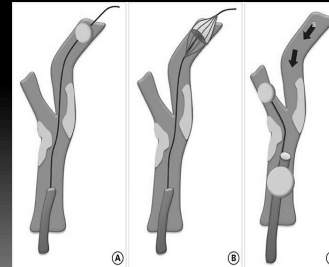
- Manipulation of sheaths and catheters in an atheromatous arch.
- Wiring and delivery of devices across the lesion
- Balloon expansion
- Stent deployment
- EPD removal

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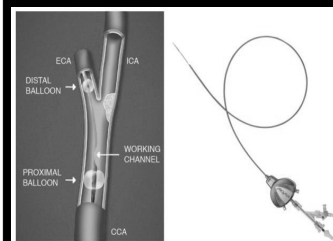
Embolic Protection device

- Proximal protection
 - : interrupting or reversing the blood flow at the level of the carotid bifurcation at the time of the procedure
- Distal protection
 - : entrap embolic material that becomes dislodged during the procedure
 - : distal balloon occlusion



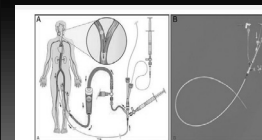
Embolic Protection device P-EPD

Embolic Protection device P-EPD



Mo.Ma (Invatec, Roncadelle, Italy)

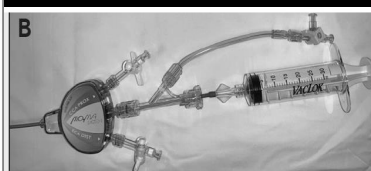
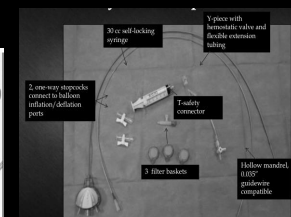
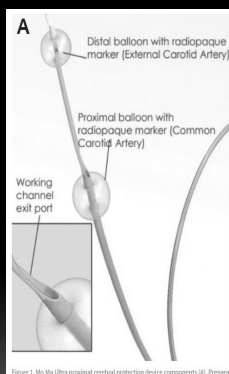
- The distal balloon is located close to the sheath tips and occludes the external carotid artery.
- The proximal balloon is positioned in the common carotid artery.
- When inflated, both balloons prevent flow in the internal carotid artery coming both antegradely from the common carotid artery and retrogradely from the external carotid artery.
- As a result, the carotid lesion can be crossed and treated under flow blockage, preventing cerebral embolization.



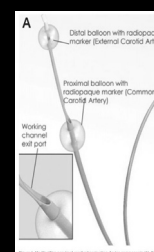
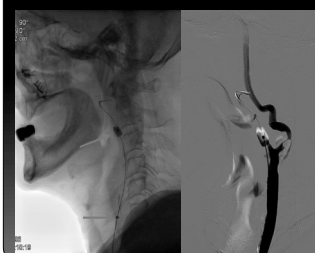
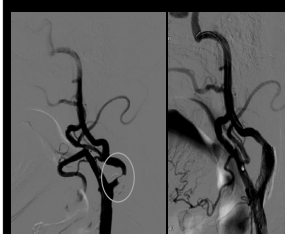
Gore (W.L. Gore & Associates, Flagstaff, Arizona)

2015 European Heart Journal Alberto Cremonesi et al

Mo.Ma™ device



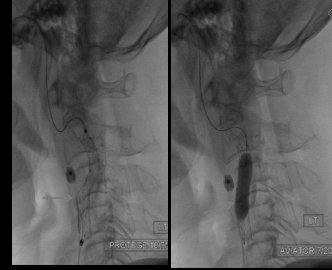
- 9Fr outer diameter shaft
- 6Fr inner diameter working channel port - lesion access, aspiration of debris



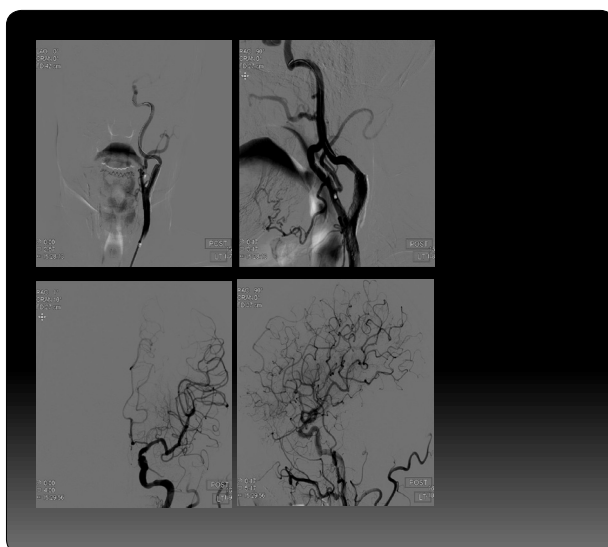
- Introducing of 0.035" wire into ECA
- Introducing of diagnostic catheter into ECA
- Remove 0.035" guidewire
- Introduce stiff 0.035" guidewire
- Remove diagnostic catheter
- Retain 0.035" wire to introduce Mo.Ma device
- Advance Mo.Ma device into ECA
- Inflate distal balloon in ECA and check the blockage of ECA flow



Remove 0.035" wire
Inflate proximal balloon in the CCA (check for absence of flow)
Advance 0.014" guidewire through lesion
Predilation balloon



Deploy stent
Remove stent delivery system
Postdilation balloon
Aspirate to remove debris (until no debris detected)
Deflate distal ECA balloon
Deflate proximal CCA balloon
Retract Mo.Ma device and guidewire

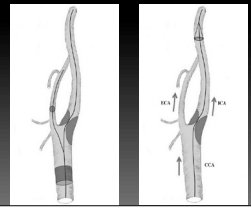



Proximal EPD advantage

- Protection established before crossing ICA lesion
- Effectively captures debris of various size
- Cerebral protection by debris aspiration through 6Fr working channel

-> Ideal complete protection for all parts of CAS procedure

- No distal landing zone required
- > Useful in case with distal lesion or distal vessel tortuosity
- Good proximal support

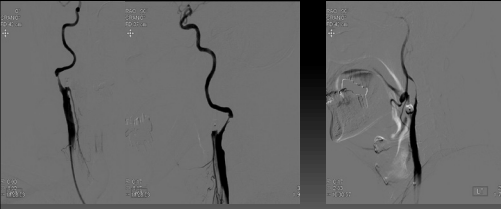


Proximal EPD disadvantage

- Require large introducer sheaths (8-9Fr vs 6Fr for dEPD)
- More difficult to navigate and obscure the lesion during stent deployment
- If flow through all ECA branches is not stagnated, the efficacy of the device may also be reduced.
- Intolerance
- Difficulties in case with contralateral lesion or poor collateral circulation
- Require shortened procedure time
- Difficulties in case with vascular lesion of CCA or ECA

Proximal EPD Technical strategy

- Persisting ECA flow
-> repositioning of ECA balloons
- Intolerance
-> Do not deflate the balloons
Do it stepwise, aspirate and deflate the balloons



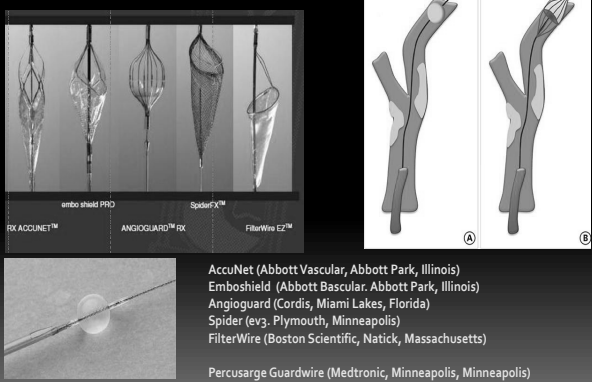
Proximal EPD
Technical strategy

- difficult to navigate and obscure the lesion
-> Use roadmap image and plain X-ray image
- Difficulties in aspiration after stent deployment
-> Inflate ECA and CCA balloons and aspiration before start the procedure



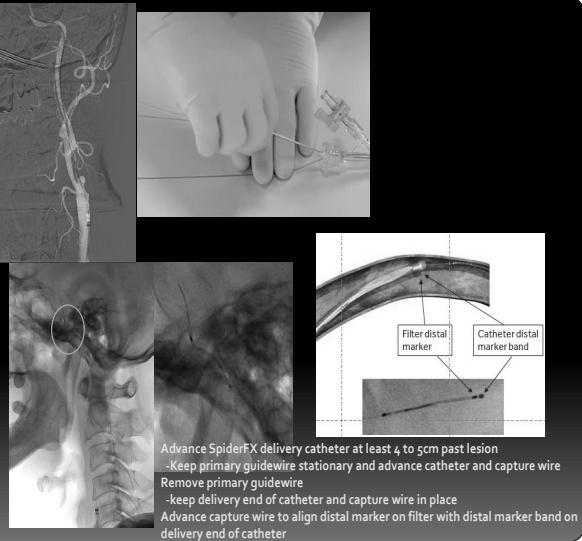
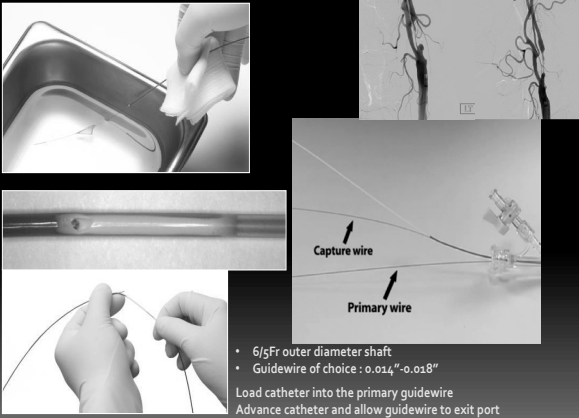
Embolic Protection device
D-EPD

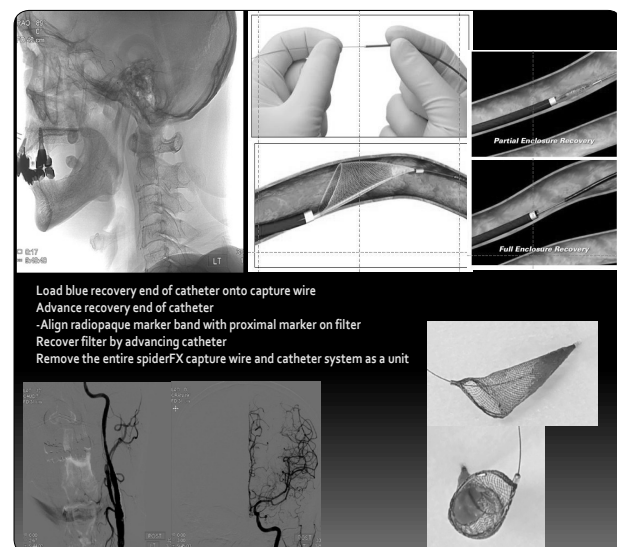
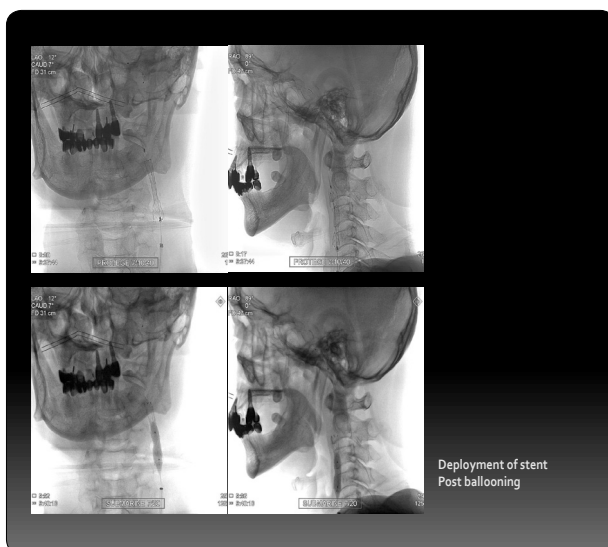
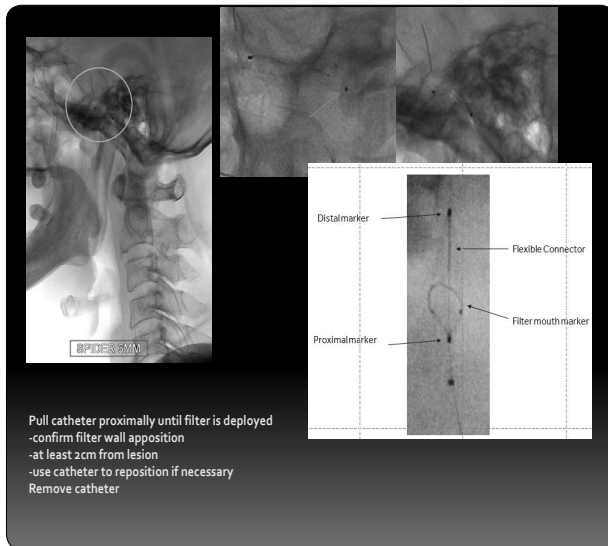
- Distal filter EPDs are inserted by traversing a wire through the lesion and placing the filter distally using a delivery sheath. Withdrawal of the sheath deploys the filter.
- Distal balloon occlusion



	Angioguard RX	RX AccUNET	Spider FX	FilterWire	EmboShield
Producer	Cordis, Milpitas, CA, USA	Abbott Vascular, Santa Clara, CA, USA	ev3/Covidien, Plymouth, MN, USA	Boston Scientific, Marlborough, MA, USA	Abbott Vascular, Santa Clara, CA, USA
Filter design	Porous membrane and nitinol frame	Porous membrane and nitinol frame	Flexible Nitinol braid filter	Porous membrane and nitinol frame	Porous membrane and nitinol frame
Recommend vessel size(mm)	4.5-5.5	5.0-6.0	3.0-7.0	3.5-5.5	4.0-7.0
Basket length(mm)	5.5	11	15	10	5.5
Pore size(µm)	100	Up to 150	70-200	110	120
Pore density	14.4	4.4	10	13.6	1.4
No. of pore	1100	912	1563	2536	400
Wire movement	no	rotational	longitudinal rotational	rotational	longitudinal

Spider FX™





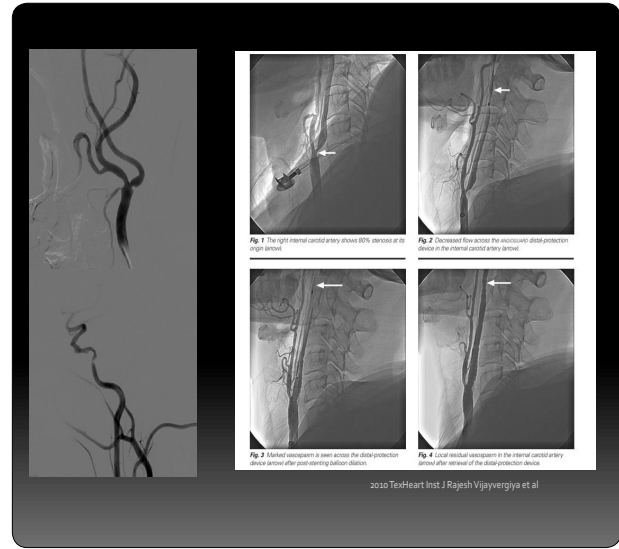
Distal EPD advantage

- Relatively easy to use
- Angiographic visualization is available
- Maintained cerebral perfusion
- Generally well tolerated and does not require collateral flow to treated hemisphere
- Overall favorable results

Distal EPD disadvantage

- No cerebral protection while the device is being inserted
- Filter may not provide complete cerebral protection
 - : Incomplete apposition to the vessel wall
 - : Small particles may pass through filter into the brain, (filter may allow passage of particles < 100-150µm)
- Filter is so full and can become obstructed with emboli which may impair cerebral flow
- When the filter is full of debris, particles spill out during retrieval
- Requires straight landing zone
- Difficult to deliver and use in tortuous ICA
- Spasm, dissection of ICA

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	Distal filter protection device	Proximal Balloon occlusion device
장점	대뇌로의 혈류공급이 지속적으로 유지된다 시술중 혈관조영술을 시행할 수 있다. Circle of Willis가 잘 발달되어 있지 않는 환자에서도 사용가능하다	기구가 병변을 통과할 필요가 없다. 모든 크기의 색전술물에 대해 방지효과가 있다. 심한 혈전이나 굴곡이 많은 병변에서 유용하다.
단점	작은 크기의 색전술물은 거름망을 통과할 수 있다. 내경동맥의 혈관연속이나 혈관벽의 위험성이 있다. 처음 병변을 통과할때는 색전 방지 효과가 없다. 병변을 통과하는 기구의 profile이 상대적으로 크다. 혈전의 정도가 심하거나 혈관의 굴곡이 심할 경우에는 기구가 병변을 지나가기 어려울 수 있다. 거름망이 혈관벽에 완전히 밀착되지 않을 수 있다. 색전술물이 거름망에 꼭 차게 되면 혈류저단이 있을 수 있다.	측부순환이 많이 발달되어 있지 않은 경우에는 위험이 생길 수 있다. 중경동맥이나 외경동맥의 혈관연속이나 혈관벽의 위험성이 있다. 혈류저단이 시작되면 시술중 혈관조영술을 할 수 없다.
device	Rx Account(Abbott Vascular) EmboShield(Abbott Vascular) FilterWire EZ, EX(Boston Scientific) Rubicon Filter(Boston Scientific) Angioguard XP, RX(Cordis Endovascular) SpiderRx (ev3) Filter Med(Lumen Biomedical) Interceptor PLUS(Medtronic)	Mo.Ma(Invetec) PercuSurge Guard wire, Export Catheter(Medtronic) TriActiv ProGuard(Kerny Nash)

Outcome

Embolic protection vs no protection

- It is not clear whether cerebral protection is beneficial, with single center RCTs using popular devices suggesting that EPDs provide no benefit.
- Multicenter prospective registry of 1483 patients reported that patients treated with EPDs had lower rates of ipsilateral stroke.
- Large registry of 11243 patients reports fewer periprocedural strokes and deaths with EPD use.
- A systematic review of 2357 patients reported lower periprocedural stroke/death rates in patients who received cerebral protection.

Outcome

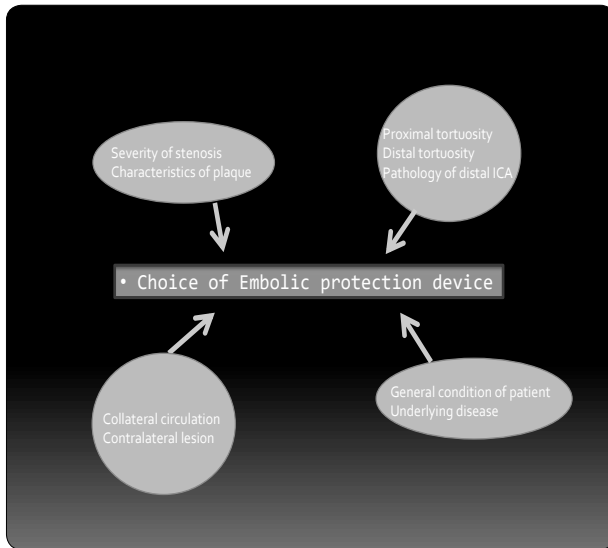
P-EPD Vs D-EPD

- There are no large multicenter RCTs comparing p-EPD and f-EPD.
- Published studies generally support proximal protection.

EPD

Characteristics of Ideal model

- Complete protection for all parts of CAS procedure
- Captures debris of all sizes
- Ease of use
- Stable device position
- Maintains cerebral perfusion
- Minimal/no restrictions on landing zone
- Documented results in high-risk lesions and patients



Stent for carotid angioplasty

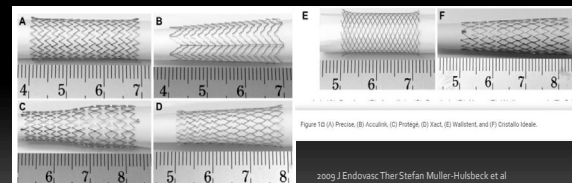
choice of stent

- Device availability
- Stent cell structure and shape
 - : stent size
 - pore density and metal coverage
 - pushability and trackability
 - radial force
- Specific embolic protection device characteristics
- Balloon expandable/self expandable
- Open/closed
- Bare metal/covered
- Tapered/non-tapered

Type of stent

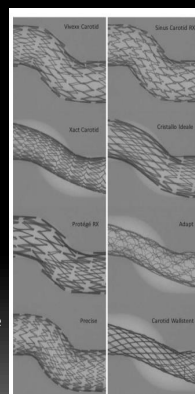
Self expandable stent, material

- Majority of self expanding carotid artery stents are made of nitinol.
- When exposed to the temperature of the human body, the thermal properties of nitinol stents allow them to achieve a predefined shape.
- Carotid Wallstent is made of Elgiloy. Expansion of this stent relies on a spring-like action as its delivery sheath is withdrawn.



Type of stent *open Vs closed*

- **Open cell stent**
 - Larger free cell area ($> 5\text{mm}^2$)
 - Good flexibility
 - Adapt well to the contour of the vessel
 - Suitable for twisted artery
 - Easier to delivery
 - Can be partially separated and evaginated, which reduces the possibility to block the crumbs
 - Physically cover less of the target lesion, potentially posing a higher risk of embolization as atherosclerotic material may prolapse through the stent struts.
- **Closed cell stent**
 - Much smaller mesh size - reduce risk of small embolus detachment during the dilation process.
 - Rigid and less flexible – may be prone to kinking or incomplete deployment in tortuous vessels.



2014, Experimentelle Radiologie C. Wessgott et al

Type of stent *open Vs closed*

- No published high-quality RCTs compare open-cell to closed-cell stents and available evidence is conflicting.
- Choice of the type of stent based on
 - : Arterial anatomy
 - : extent of lesion
 - : morphology of lesion
- Hybrid stents
 - : Combine characteristics of open cell and closed cell stents have been designed which possess a gradual change from open cell to closed cell design or have an abrupt point of change.

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Type of stent Bare-metal vs Covered

- Bare metal stent
 - metal scaffold that maintain patency of the vessel
 - covered with compounds such as polytetrafluoroethylene or polyethylene terephthalate which aim to prevent smooth muscle cell proliferation and restenosis.

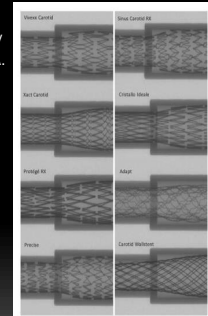
- Covered stent
 - Concealed strut openings



- The only RCT comparing BMSs against covered stents in carotid artery stenosis demonstrated a lower risk of periprocedural and postprocedural microembolism with covered stents.
- However, this trial was stopped early due to extremely high restenosis rates within the covered stent group.

Type of stent Tapered vs non tapered

- Tapered stents
 - larger diameter proximally and narrow diameter distally
 - designed to mimic the progressive narrowing of the ICA.
- Evidence on tapered vs non-tapered stents is poor.



2014 Experimentelle Radiologie C.Wissgott et al

Characteristics of commonly used carotid artery stents

TABLE 2 Names and characteristics of commonly used carotid artery stents

Stent	Manufacturer	Material	Closed/Open	Flow cell area (cm ²)	Tapered/Non-tapered
Cover	Microvention/Terumo (Tustin, CA, USA)	Nitinol	Closed	0.375/0.600 (double-layer)	Tapered
Waltent	Boston Scientific (Natick, MA, USA)	Elgiloy (non-magnetic Cobalt-Chromium Nickel-Molybdenum alloy)	Closed	1.08	Non-tapered
Xact	Abbott Vascular (Abbott Park, IL, USA)	Nitinol	Closed	2.74	Either
NiroStent	Boston Scientific	Nitinol	Closed	4.70	Tapered
Previo	Cardis (Bridgewater, NJ, USA)	Nitinol	Open	5.89	Non-tapered
Exponent	Medtronic (Minneapolis, MN, USA)	Nitinol	Open	6.52	Either
Protege	Cardion Int'lco, CA, USA	Nitinol	Open	10.71	Either
Aqualink	Abbott Vascular	Nitinol	Open	15.48	Either
Zilver SSI® RX	Cook Medical (Bloomington, IN, USA)	Nitinol	Open	12.76	Non-tapered
Cristalloideale	Medtronic	Nitinol	Hybrid closed cell center, open-cell ends	NA	Either
Siron Carotid Re	Optimed (Ettlingen, Germany)	Nitinol	Hybrid open cell center, closed cell ends	NA	Either

2013 Acta Neurologica Anthony Lamanna et al

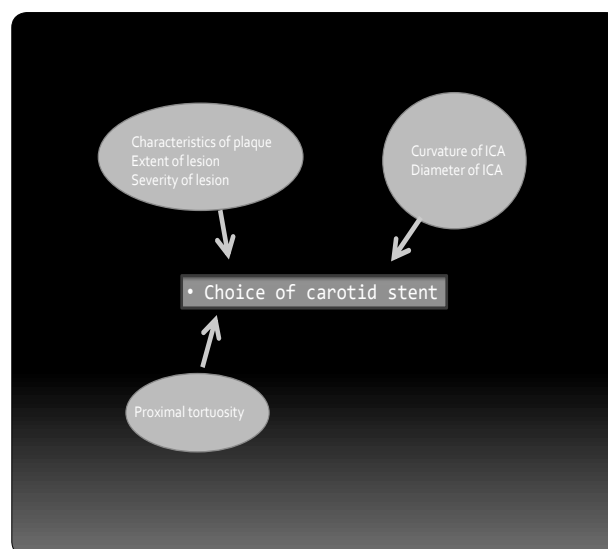
2014 Experimentelle Radiologie C.Wissgott et al

TABLE 2
Summary of Results From Analyzed Stents

	Previo	Aqualink	Protege	Xact	Waltent	Cristalloideale
Stent length, mm	29.70±0.29	36.90±0.30	33.70±0.29	29.80±0.30	23.90±0.30	33.90±0.30
Stent diameter, mm						
Distal	9.87±0.02	7.02±0.11	7.71±0.04	7.70±0.08	11.00±0.24	7.20±0.05
Middle	9.87±0.02	6.77±0.28	6.82±0.24	6.82±0.18	10.00±0.01	6.90±0.06
Proximal	9.97±0.02	9.07±0.16	9.08±0.01	9.25±0.08	11.00±0.24	9.90±0.09
Stent weight, mg	149.6±13.9	78.9±3.3	164.2±2.1	113.8±1.6	145.8±0.3	112.4±2.1
Stent weight, mg/mm	5.04	2.89	4.58	3.88	4.86	3.30
Stent thickness, mm						
Distal	0.182±0.004	0.122±0.012	0.192±0.006	0.181±0.008	0.180±0.010	0.179±0.005
Middle	0.188±0.007	0.125±0.014	0.203±0.011	0.183±0.005	0.182±0.009	0.174±0.013
Proximal	0.182±0.004	0.126±0.014	0.208±0.014	0.181±0.007	0.180±0.010	0.174±0.007
Cell area, mm ²						
Distal	5.70	16.60	16.40	3.10	1.36	12.50
Middle	9.00	15.10	9.80	3.55	1.36	3.30
Proximal	5.70	15.60	9.80	4.00	1.36	12.40
Flexed in circle diameter, mm						
Distal	1.25	1.20	1.70	1.25	1.96	1.90
Middle	1.20	1.18	1.80	1.18	1.96	1.20
Proximal	1.25	1.05	1.10	1.10	1.96	1.95
Number of flutes in circle/arc						
Distal	6	9	3	2	1	3
Middle	6	9	3	2	1	1
Proximal	6	9	3	2	1	3
Stent artery ratio, %						
Distal	17.62	13.14	23.48	16.42	21.35	12.75
Middle	17.59	9.84	19.39	14.23	21.37	16.68
Proximal	17.62	9.89	16.11	12.43	21.35	13.75
Force, N						
At 20° bending	0.099±0.012	0.114±0.021	0.087±0.004	0.100±0.012	0.093±0.003	0.093±0.003
At 30° bending	0.102±0.011	0.109±0.016	0.084±0.004	0.140±0.012	0.074±0.002	0.074±0.002
At 40° bending	0.116±0.010	0.022±0.009	0.103±0.011	0.055±0.004	0.069±0.003	0.069±0.003
At 50° bending	0.181±0.013	0.043±0.013	0.244±0.014	1.071±0.088	0.097±0.004	0.097±0.004
Resist force parallel pull, N						
Distal					4.43±0.006	
Middle					1.09±0.006	
Proximal	1.630±0.143	1.212±0.127	1.400±0.160	0.760±0.083	2.138±0.032	0.610±0.034
Resist force radial measure, N						
Distal					2.41±0.12	
Middle					0.90±0.46	
Proximal	19.72±1.46	11.26±0.81	24.09±1.14	10.05±0.75	4.31±0.59	3.89±0.20
Reposition force, N						
0-1.5 mm	0.18		0.10	0.80	0.12	0.06
0-2.5 mm	0.20		0.44	1.10	0.36	0.36
0-3.5 mm	0.30	0.08	0.50		0.84	
0-4.5 mm	0.40	0.12	0.54		1.34	
0-5.5 mm	0.74	0.20	0.96			
0-6.5 mm		0.49				

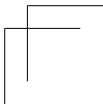
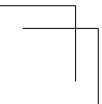
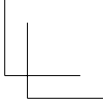
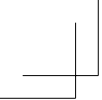
Continuous data are presented as means ± standard deviation. NA, not applicable. CI, Cristalloideale; Q, cover diameter.

2009 J Endovasc Ther Stefan Muller-Hulsbeck et al



Carotid Stenting - Patient selection, technical tips and basic tactics

신 병 국
동의의료원



Basic Endovascular Training Course

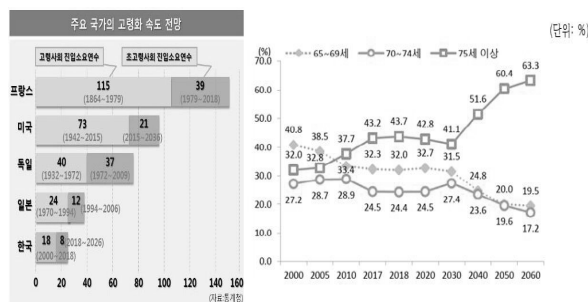
Patient Selection, Technical tips and Basic Tactics

동의료원
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

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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

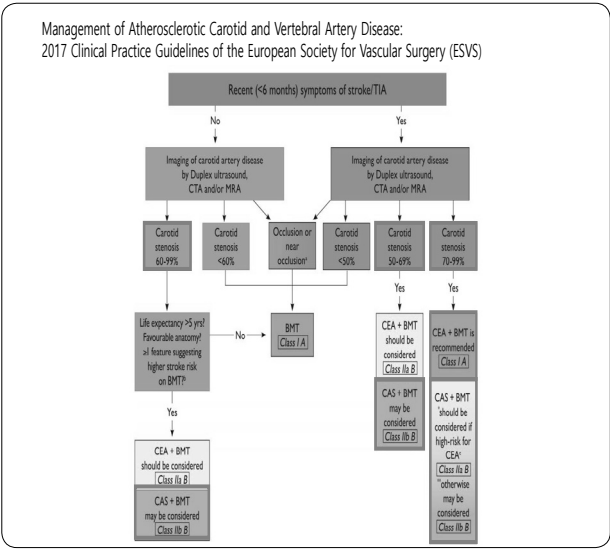
1. Patients at average or low surgical risk who experience nondisabling ischemic stroke¹ or transient cerebral ischemic symptoms, including hemispheric events or amaurosis fugax, within 6 months (symptomatic patients) should undergo CEA if the diameter of the lumen of the ipsilateral internal carotid artery is reduced more than 70%² 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

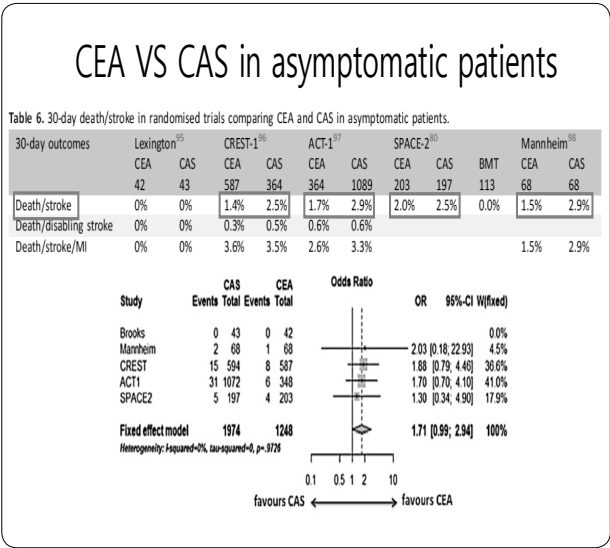
1. Prophylactic CAS might be considered in highly selected patients with asymptomatic carotid stenosis (minimum 60% by angiography, 70% by validated Doppler ultrasound), but its effectiveness compared with medical therapy alone in this situation is not well established (360). (Level of Evidence: B)



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	CEA	EVA-3S ¹⁸⁴	CAS	SPACE ¹⁸⁵	CEA	CAS	ICSS ¹⁸⁷	CEA	CAS	CREST ¹⁸⁹	CEA	CAS
	n = 262	n = 261	n = 589	n = 607	n = 857	n = 853	n = 653	n = 668				
Death	1.2%	0.8%	0.9%	1.0%	0.8%	2.3%	3.2%	5.5%				
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%	2.0%	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%				



Stroke

AHA/ASA GUIDELINE

2021 Guideline for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack

A Guideline From the American Heart Association/American Stroke Association

Reviewed for evidence-based integrity and endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons.

Endorsed by the Society of Vascular and Interventional Neurology

The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.

Dawn O. Kleindorfer, MD, FAHA, Chair; Amytis Towfigh, MD, FAHA, Vice Chair; Seemant Chaturvedi, MD, FAHA; Kevin M. Cockroft, MD, MSc, FAHA; Jose Gutierrez, MD, MPH; Debbie Lombard-Hill, BS, FAHA; Hooman Kamel, MD; Walter N. Kernan, MD; Steven J. Kittner, MD, MPH, FAHA; Enrique C. Leira, MD, MS, FAHA; Olive Lennon, PhD; James F. Meschia, MD, FAHA; Thanh N. Nguyen, MD, FAHA; Peter M. Polak, MD; Pasquale Santangelo, MD, PhD; Arjun Z. Sharifi, MD, MPH, FAHA; Sidney C. Smith Jr, MD, FAHA; Tanya N. Turan, MD, MS, FAHA; Linda S. Williams, MD, FAHA

Key Words: AHA Scientific Statements ■ ischemic attack, transient ■ secondary prevention ■ stroke

5.1.2.1. Extracranial Carotid Stenosis

Recommendations for Extracranial Carotid Stenosis

Referenced studies that support recommendations are summarized in online Data Supplement 39.

COR	LOE	Recommendations
1	A	1. In patients with a TIA or nondisabling ischemic stroke within the past 6 months and ipsilateral severe (70%–99%) carotid artery stenosis, carotid endarterectomy (CEA) is recommended to reduce the risk of future stroke, provided that perioperative morbidity and mortality risk is estimated to be <6%. ¹⁸⁶
1	A	2. In patients with ischemic stroke or TIA and symptomatic extracranial carotid stenosis who are scheduled for carotid artery stenting (CAS) or CEA, procedures should be performed by operators with established periprocedural stroke and mortality rates of <6% to reduce the risk of surgical adverse events. ¹⁹³
1	A	3. In patients with carotid artery stenosis and a TIA or stroke, intensive medical therapy, with antiplatelet therapy, lipid-lowering therapy, and treatment of hypertension, is recommended to reduce stroke risk. ¹⁹⁴
1	B-R	4. In patients with recent TIA or ischemic stroke and ipsilateral moderate (50%–69%) carotid stenosis as documented by catheter-based imaging or noninvasive imaging, CEA is recommended to reduce the risk of future stroke, depending on patient-specific factors such as age, sex, and comorbidities. If the periprocedural morbidity and mortality risk is estimated to be <6%. ¹⁸⁶

5.1.2.1. Extracranial Carotid Stenosis

2a	B-R	5. In patients >70 years of age with stroke or TIA in whom carotid revascularization is being considered, it is reasonable to select CEA over CAS to reduce the periprocedural stroke rate. ¹⁹⁵
2a	B-R	6. In patients in whom revascularization is planned within 1 week of the index stroke, it is reasonable to choose CEA over CAS to reduce the periprocedural stroke rate. ¹⁹²
2a	C-LD	7. In patients with TIA or nondisabling stroke, when revascularization is indicated, it is reasonable to perform the procedure within 2 weeks of the index event rather than delay surgery to increase the likelihood of stroke-free outcome. ¹⁹³
2a	C-LD	8. In patients with symptomatic severe stenosis (>70%) in whom anatomic or medical conditions are present that increase the risk for surgery (such as radiation-induced stenosis or restenosis after CEA) it is reasonable to choose CAS to reduce the periprocedural complication rate. ¹⁹⁴

The Carotid Stenting Trialists' Collaboration analyzed outcomes in 4754 patients from 4 clinical trials.

For patients assigned to CAS, the periprocedural HR aged 65–69 years compared with patients younger than 60 years was 2.16 (95% CI 1.13–4.13), with HRs of roughly 4.0 for patients aged 70 years or older.

In the group 65 to 69 years of age, the HR comparing CAS to CEA was 1.61 (95% CI, 0.90–2.88).

In the group 70 to 74 years of age, the HR comparing CAS to CEA was 2.09 (95% CI, 1.32–3.32).

This supports the recommendation for considering patient age in the selection of the procedure.

5.1.2.1. Extracranial Carotid Stenosis

2a	B-R	5. In patients ≥70 years of age with stroke or TIA in whom carotid revascularization is being considered, it is reasonable to select CEA over CAS to reduce the periprocedural stroke rate. ²⁷¹
2a	B-R	6. In patients in whom revascularization is planned within 1 week of the index stroke, it is reasonable to choose CEA over CAS to reduce the periprocedural stroke rate. ²⁷²
2a	C-LD	7. In patients with TIA or nondisabling stroke, when revascularization is indicated, it is reasonable to perform the procedure within 2 weeks of the index event rather than delay surgery to increase the likelihood of stroke-free outcome. ²⁷³
2a	C-LD	8. In patients with symptomatic severe stenosis (≥70%) in whom anatomic or medical conditions are present that increase the risk for surgery (such as radiation-induced stenosis or restenosis after CEA) it is reasonable to choose CAS to reduce the periprocedural complication rate. ²⁷⁴

The Carotid Stenosis Trialists' Collaboration evaluated 4138 patients randomly assigned to CEA or CAS.

In patients who received the procedure within 1 week of the last symptomatic event, the stroke/death rate was 8.3% with CAS versus 1.3% with CEA (RR, 6.7; $P=0.002$).

This supports a preference for CEA in patients who undergo early revascularization.

5.1.2.1. Extracranial Carotid Stenosis

2a	B-R	5. In patients ≥70 years of age with stroke or TIA in whom carotid revascularization is being considered, it is reasonable to select CEA over CAS to reduce the periprocedural stroke rate. ²⁷¹
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2a	C-LD	8. In patients with symptomatic severe stenosis (≥70%) in whom anatomic or medical conditions are present that increase the risk for surgery (such as radiation-induced stenosis or restenosis after CEA) it is reasonable to choose CAS to reduce the periprocedural complication rate. ²⁷⁴

5893 patients with 33 000 patient-years of follow-up were analysed.

Sex ($p=0.003$), age ($p=0.03$), and time from the last symptomatic event to randomisation ($p=0.009$) modified the effectiveness of surgery.

Benefit from surgery was greatest in men, patients aged 75 years or older, and those randomised within 2 weeks after their last ischemic event, and fell rapidly with increasing delay.

5.1.2.1. Extracranial Carotid Stenosis

2a	B-R	5. In patients ≥70 years of age with stroke or TIA in whom carotid revascularization is being considered, it is reasonable to select CEA over CAS to reduce the periprocedural stroke rate. ²⁷¹
2a	B-R	6. In patients in whom revascularization is planned within 1 week of the index stroke, it is reasonable to choose CEA over CAS to reduce the periprocedural stroke rate. ²⁷²
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2a	C-LD	8. In patients with symptomatic severe stenosis (≥70%) in whom anatomic or medical conditions are present that increase the risk for surgery (such as radiation-induced stenosis or restenosis after CEA) it is reasonable to choose CAS to reduce the periprocedural complication rate. ²⁷⁴

SAPPHIRE trial (Stenting and Angioplasty With Protection in Patients at High Risk for Endarterectomy)

Patients with high anatomic or physiologic risk for CEA were assigned to CEA or CAS

The primary end point was stroke, MI, or death within 30 days or ipsilateral stroke up to 12 months.

Among symptomatic patients, the primary end point occurred in 16.8% of patients undergoing CAS and 16.5% of patients undergoing CEA ($P=0.95$).

This study supports the option of CAS in patients at elevated surgical risk.

5.1.2.1. Extracranial Carotid Stenosis

2b	A	9. In symptomatic patients at average or low risk of complications associated with endovascular intervention, when the ICA stenosis is ≥70% by noninvasive imaging or ≥50% by catheter-based imaging and the anticipated rate of periprocedural stroke or death is <6%, CAS may be considered as an alternative to CEA for stroke prevention, particularly in patients with significant cardiovascular comorbidities predisposing to cardiovascular complications with endarterectomy. ²⁷⁵
2b	B-NR	10. In patients with a recent stroke or TIA (past 6 months), the usefulness of transcatheter artery revascularization (TCAR) for prevention of recurrent stroke and TIA is uncertain. ²⁷⁶
3: No Benefit	A	11. In patients with recent TIA or ischemic stroke and when the degree of stenosis is <50%, revascularization with CEA or CAS to reduce the risk of future stroke is not recommended. ²⁷⁷
3: No Benefit	A	12. In patients with a recent (within 120 days) TIA or ischemic stroke (ipsilateral to atherosclerotic stenosis or occlusion of the middle cerebral or carotid artery, extracranial-intracranial bypass surgery is not recommended. ²⁷⁷

CREST multicenter randomized clinical trial

CEA and CAS were directly compared in both symptomatic and asymptomatic patients.

1321 symptomatic pts, over the 4-year study period, the primary end point (periprocedural stroke, death, or MI, plus later ipsilateral stroke) occurred in 8.6% of patients undergoing CAS and 8.4% of patients undergoing CEA.

Both surgeons and interventionalists were required to be credentialed for the study, and a periprocedural stroke/death rate of <6% (or lower) has been suggested in earlier statements.

경피적 두개강외 스텐트 삽입술 급여기준 (2019. 08)

두개강외(경동맥)에 삽입하는 스텐트는 다음의 경우에 요양급여를 인정하며, 협착의정도(%)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) 가성동맥류(pseudoaneurysm)
 - 다) 동정맥루 치료를 위해 다른 방법이 가능하지 않은 경우
 - 라) 혈관박리로 인한 혈류 감소 또는 협착

Basic Tactics

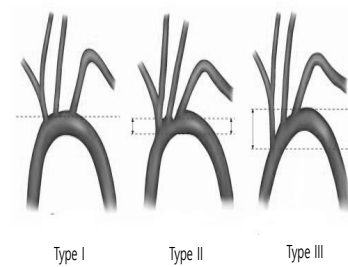
- Guiding Support : Proximal tortuosity
- Understand of Angiographic finding and 3D imaging
 - Degree and location of Stenosis
 - Morphological Topography of atheroma and plaque
 - Distal tortuosity
 - Contralateral stenosis or VA stenosis
- Characteristics of Plaque : Echo or CT finding
- Characteristics of Device : EPD, Balloon, Stent...

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
- Other problems

Guiding Support

Classification of aortic arch

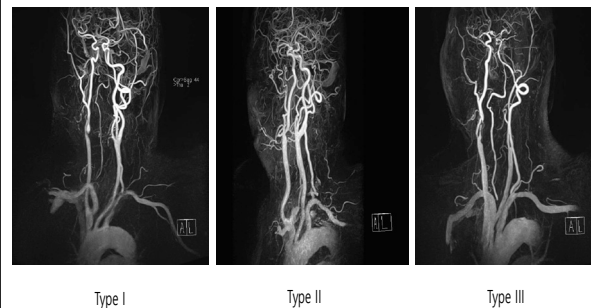


Guiding Support

Calcification of Great Vessel



Guiding Support



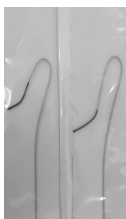
Nuances of Guiding Catheter Use

- Type II and III aortic arch

Vista Brite Tips
(OD 8F, ID 6.7F)



5F Long
Simmons 2 or 3



Terumo 035
Stiff wire



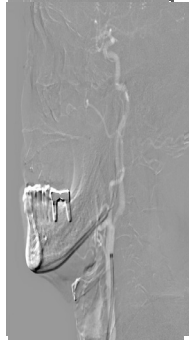
Nuances of Guiding Catheter Use

- Type II and III aortic arch



Nuances of Guiding Catheter Use

- Type II and III aortic arch



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
- Other problems

Case 1

- 73/M Symptomatic



Case 1

- 73/M Symptomatic



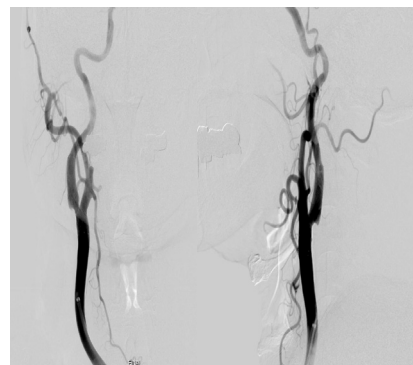
Case 1

-Transbrachial approach



Case 1

- 73/M Symptomatic NASCET 80%



- 82/F Symptomatic

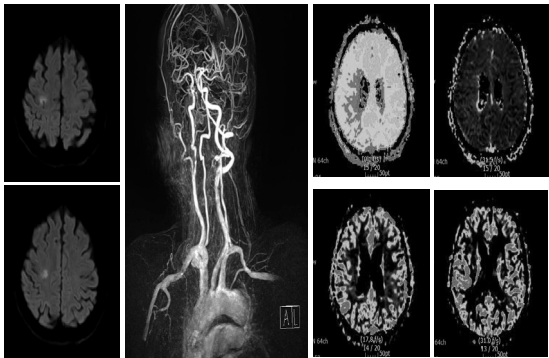
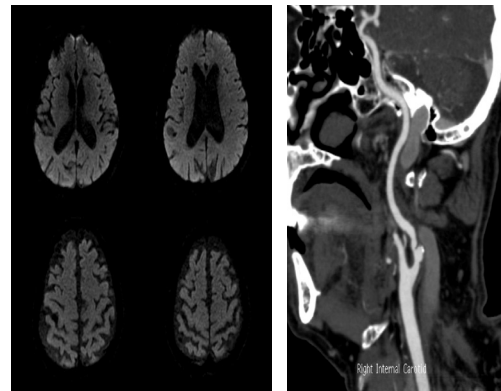
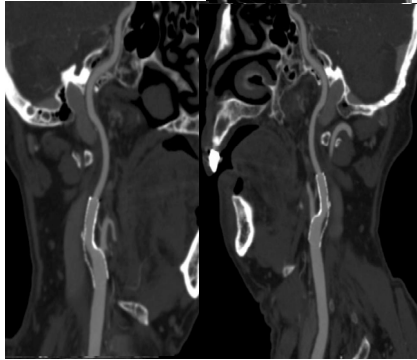
[illegible]

Figure 1 displays two panels showing 3D reconstructions of the left and right coronary arteries. The left panel shows the left coronary artery with a scale bar of 50mm and a label "(1.6 Hz) 19/23". The right panel shows the right coronary artery with a scale bar of 50mm. Both panels include a small inset image of the heart and a table of parameters.



F/U CT angio - 84/M Symptomatic 90%



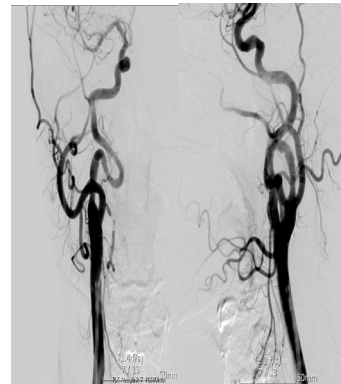
Case 4 - 82/F Symptomatic 90%



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
- Other problems

Case 5 - 79/M Symptomatic 90%



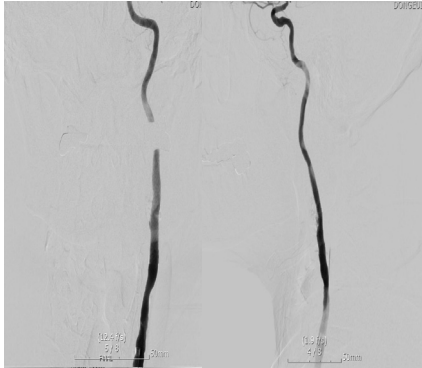
Case 6 - 62/F Symptomatic 70%



Case 7 - 75/M Symptomatic 80%



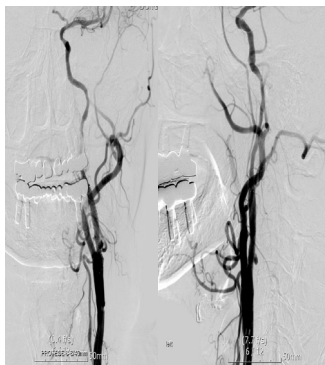
Case 8 - 69/F Symptomatic NASCET 90%



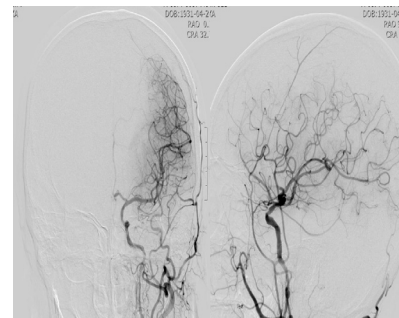
Case 9 - 87/M Symptomatic



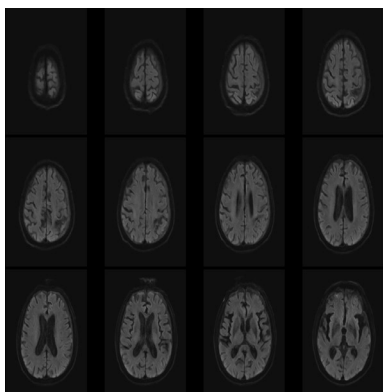
Case 9 - 87/M Symptomatic 80%



Case 9 - 87/M Symptomatic 90%



Case 9 - 87/M Symptomatic 90%



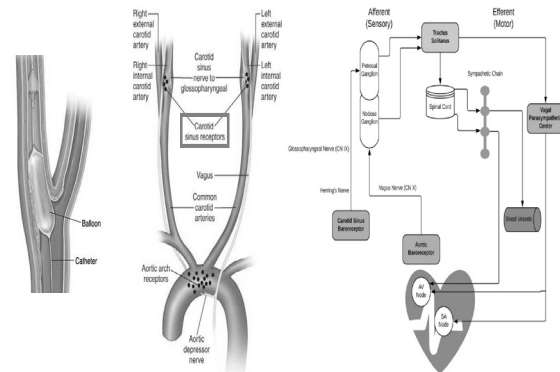
Case 10 - 78/F Symptomatic 80%



Technical Tips

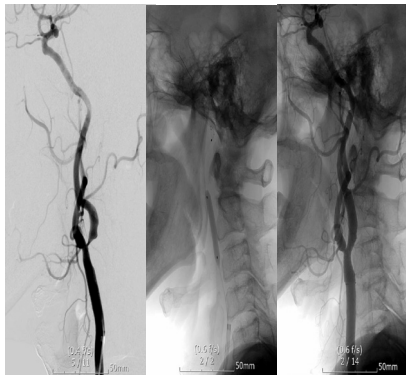
- Guiding Support
- Safe wire selection of Stenotic portion
- Delivery of EPD
- Balloon angioplasty
- Selection of stent and Precise Stent Placement
- Safe retrieval of EPD
- Other problems

Baroreceptor



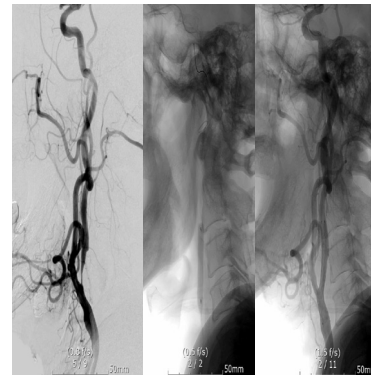
Case 11

- 76/M Asymptomatic 80%



Case 12

- 75/M Symptomatic 80%



Case 13

- 72/M Symptomatic 80%



Case 14

- 78/F Symptomatic 80%



Technical Tips

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

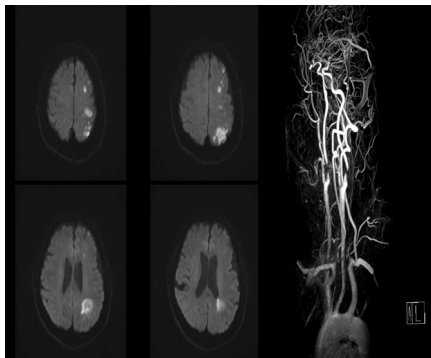
Case 15

- 80/F Symptomatic 80%



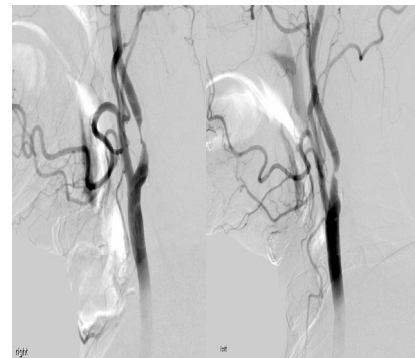
Case 16

- 73/M Lt Symptomatic
Rt Asymptomatic



Case 16

- 73/M Lt Symptomatic 80%
Rt Asymptomatic 85%



Case 16

- 73/M Lt Symptomatic 80%



Case 16

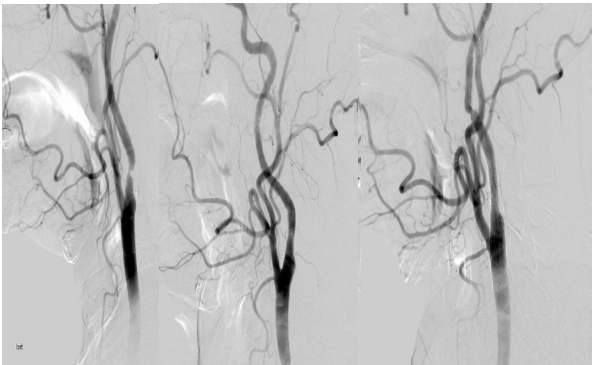
- 73/M Rt Symptomatic 85%



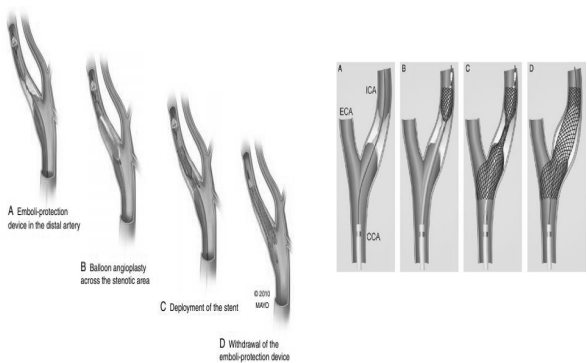
1yr later Rt carotid



1yr later Lt carotid



Pre-Balloon VS Post-balloon



© ISB, 2011
J Vasc Interv Radiol 2011; 22:661-666
DOI: 10.1016/j.jvir.2011.01.450

LABORATORY INVESTIGATION

Radial Force Measurements in Carotid Stents:
Influence of Stent Design and Length of the Lesion

Michiel T. Voûte, MD, Johanna M. Hendriks, MD,
Jorinde H.H. van Laanen, MD, Peter M.T. Pattynama, MD, PhD,
Bart E. Muhs, MD, PhD, Don Poldermans, MD, PhD, and
Hence J.M. Verhagen, MD, PhD

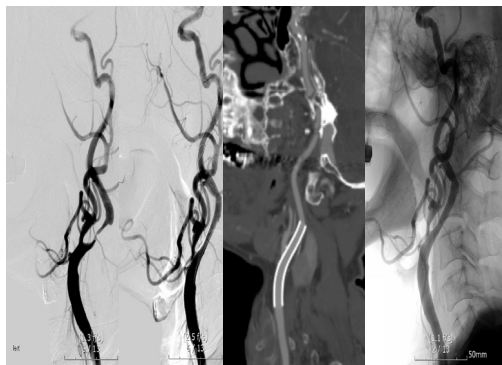
Table 1. Radial Forces in Short and Long Stenoses at Different Diameters

Outer Diameter (mm)	Radial Force, N				
	Protégé	Cristallo Ideale	Acculink	Wallstent	P Value
Short stenosis (8 mm)					
3.0	3.10 ± 0.45	1.73 ± 0.51	1.16 ± 0.21	0.84 ± 0.10	<.001
4.0	0.95 ± 0.13	0.50 ± 0.08	0.40 ± 0.05	0.29 ± 0.03	<.001
5.0	0.34 ± 0.10	0.28 ± 0.10	0.26 ± 0.04	0.15 ± 0.02	<.001
6.0	0.06 ± 0.04	0.12 ± 0.04	0.16 ± 0.04		<.001
Long stenosis (26 mm)					
3.0	1.67 ± 0.37	0.44 ± 0.13	0.95 ± 0.12	0.80 ± 0.06	.001
4.0	0.82 ± 0.36	0.26 ± 0.11	0.74 ± 0.13	0.55 ± 0.09	.013
5.0	0.39 ± 0.25	0.18 ± 0.08	0.63 ± 0.11	0.28 ± 0.12	.019
6.0	0.10 ± 0.11	0.10 ± 0.07	0.51 ± 0.10		.011

Note.—Values presented as means ± SD where applicable. P values calculated with the Kruskal-Wallis test.

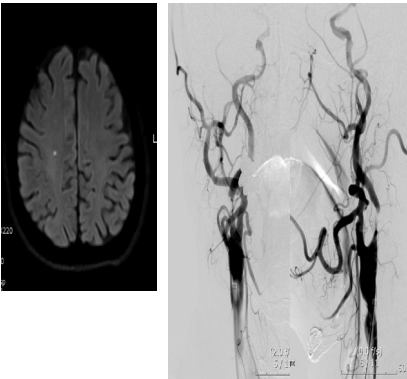
Case 17

- 84/M Symptomatic 80%

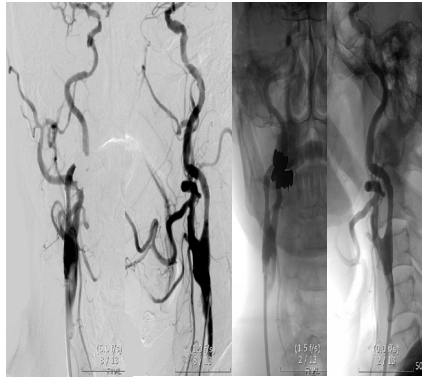


Case 18

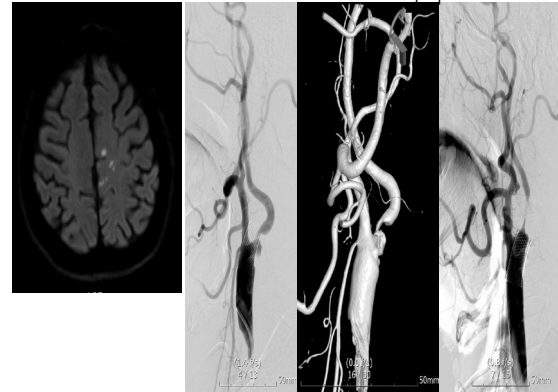
- 74/M Symptomatic 90%



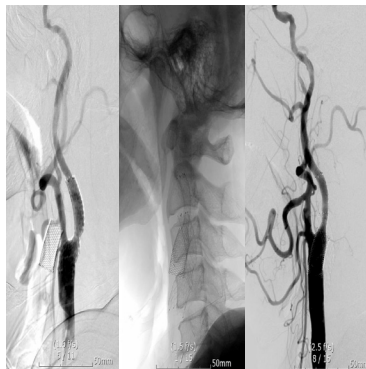
Case 18 - 74/M Symptomatic 90%



2yr later - 76/M Lt Symptomatic 80%
Rt Asymptomatic 90%



Case 18 - 76/M Lt Symptomatic 80%
Rt Asymptomatic 90%



Case 19 - 72/M Symptomatic 90%



Case 20 - 70/M Symptomatic 90%

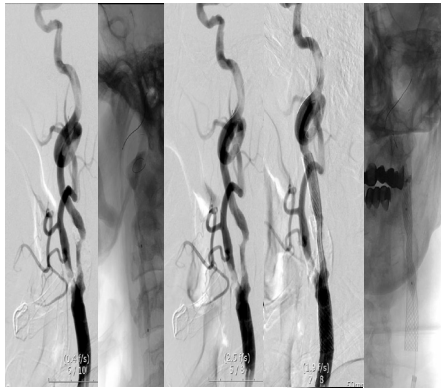


Case 21 - 73/M Symptomatic 75%



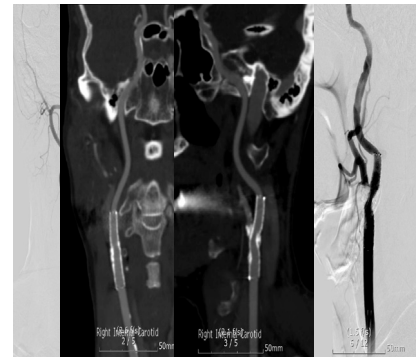
Case 21

- 73/M Symptomatic 75%



Case 22

- 72/F Symptomatic 70%

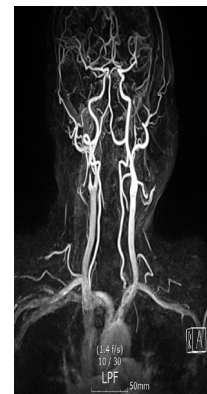


Technical Tips

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

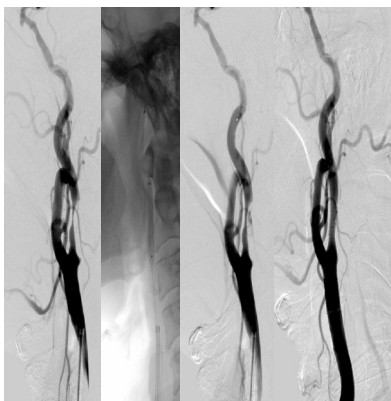
Case 23

- 75/M Asymptomatic 90%



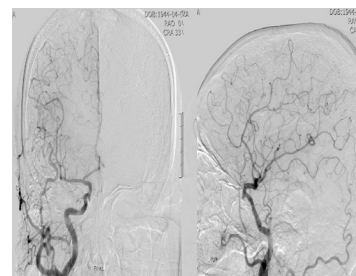
Case 23

- 75/M Asymptomatic 90%



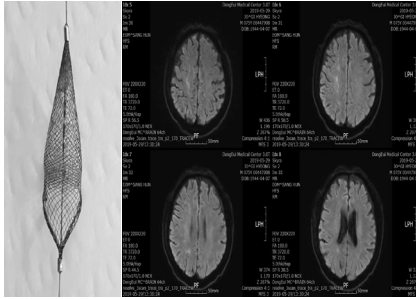
Case 23

- 75/M Asymptomatic 90%



Case 23

- 75/M Asymptomatic 90%



Recapture of EPD



Case 24

- 74/M Symptomatic 80%



Case 25

- 82/F Symptomatic 80%



Case 26

- 78/M Symptomatic 70%



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
- Other problems

Case 27 - 73/F Symptomatic 75%



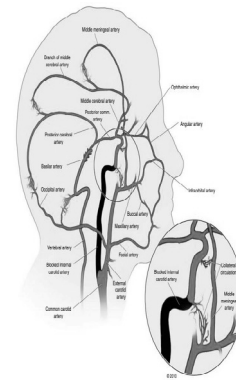
Case 28 - 79/M Symptomatic 90%



Case 29 - 82/F Symptomatic 80%



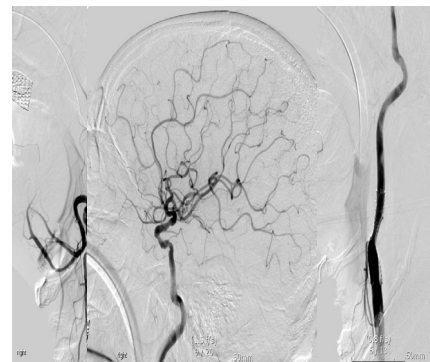
Dangerous EC-IC Anastomosis



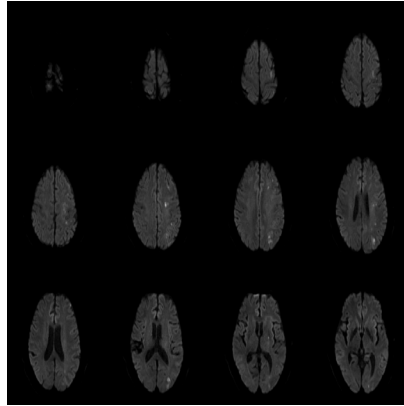
Case 30 - 71/F Symptomatic 80%



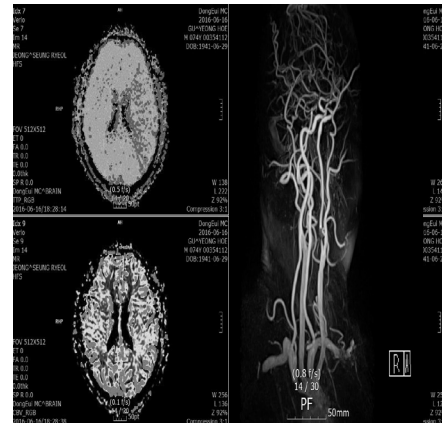
Case 31 - 73/M Symptomatic 90%



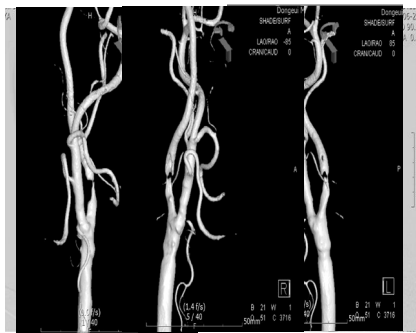
Case 32 - 74/M Symptomatic



Case 32 - 74/M Symptomatic



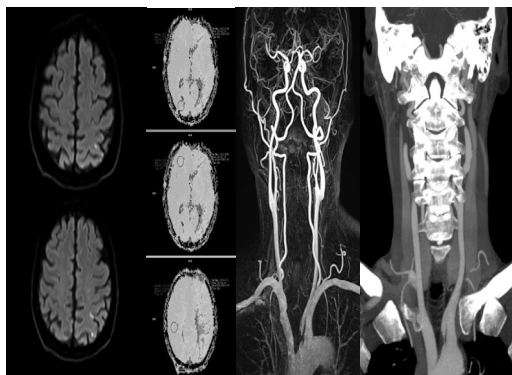
Planning - 74/M Symptomatic 90%



Adm # 14days - 74/M Symptomatic 70%



Case 33 - 63/M Symptomatic NASCET 80%



Case 33 - 63/M Symptomatic NASCET 80%



Technical Tips

- Guiding이 제일 중요 (type III arch : Vista Brite + long Simons 2or3 + 035 Stiff wire)
- Planning을 위해 3D imaging 반드시 확인
Degree of Stenosis
atheroma나 plaque의 정확한 Morphological topography 확인
working projection을 통해 safe wire selection
stent위치 선정
- Distal CCA와 ICA bulb가 acute angle인 경우
-> stent failure 가능성 높음
-> CEA고려

Technical Tips

- Stent의 특성을 잘 파악할 것
Stent의 radial force : Open-cell type > Closed-cell type
Calcification이 심한 경우
-> radial force가 좋은 open-cell type stent를 선택
postballoon의 가능성 높음,
calcification이 너무 심한 경우 CEA고려
ICA와 CCA의 size mismatch가 심한 경우
-> Closed-cell type stent 사용 시 stent migration가능성 높음
-> stent를 proximal부터 distal까지 충분히 길게 위치시킬 것
-> Open-cell type stent 사용고려
- Embolic complication
balloon angioplasty를 많이 할 수록 높다 Preballoon + Open-cell type stent
Open-cell type stent > Closed-cell type stent Closed-cell type stent + Postballoon

Technical Tips

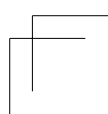
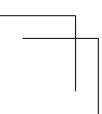
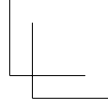
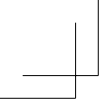
- Distal tortuosity 아주 심한 경우 distal EPD의 failure 가능성 높음
-> 그래도 CAS가 필요할 경우 proximal EPD (MO.MA) or CEA고려
- EPD 회수 시 retrieval catheter가 stent strut에 걸린다면
고개를 돌린다
Guiding을 stent 내로 위치시킨다
목을 살짝 눌러 CCA의 curve를 바꾸어 준다
- EPD 회수 시 full recovery VS partial recovery
Full recovery: stent에 걸리지 않는다
Partial recovery: thromboembolic complication감소
In vitro에서 얼마나 recapture할 지 영상으로 확인

Thank you for your listening

MEMO //////////////////////////////////////

Mechanical thrombectomy for acute ischemic stroke - Review of Devices including stent retriever and aspiration catheter, etc

고 정 호
단국대 천안병원



Mechanical Thrombectomy for Acute Ischemic Stroke (Review of devices including stent retriever and aspiration catheter, etc.)

Dankook University College of Medicine
Department of Neurosurgery

Jung Ho Ko

Guiding Sheath

- **Shuttle sheath** (Cordis)
- **Neuron Max 088** (Penumbra)
- **Infinity LS** (Stryker)
- **Cerebase DA** (Cerenovus)

Delivery System

- Guiding Sheath
- 5 Fr 125cm Head hunter(H1,HN5) or David Cath.
- 180cm 0.35in guide wire

Guiding Sheath (Shuttle 6F)

Flexor® Tuohy-Borst Sidearm Introducers



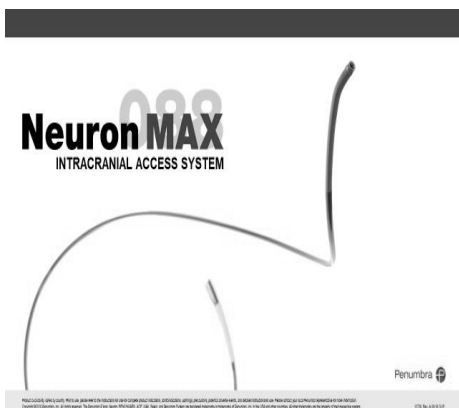
Product Information

Used for the introduction of catheters, balloons or other devices

- Uniquely fabricated sheath design provides maximum flexibility without kinking or compression
- Radiopaque band, incorporated within the sheath material, identifies precise location of sheath's distal tip for positioning accuracy
- Atraumatic soft S. (soft landing) tip design reduces vessel trauma during engagement
- A2[®] hydrophilic coating provides an extremely lubricious surface area for enhanced trackability
- Tuohy-Borst manual-adjusting valve seal minimizes blood loss during device insertion

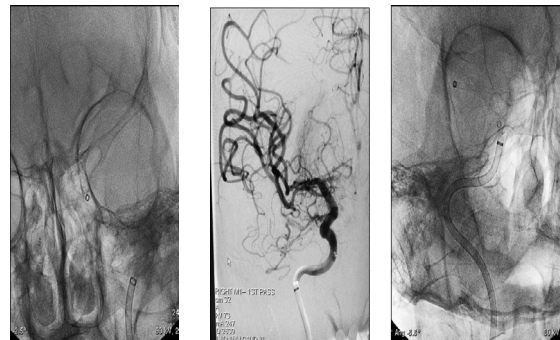
Supplied sterile in peel-open packages. Intended for one-time use.

Guiding Sheath (Neuron MAX 088)

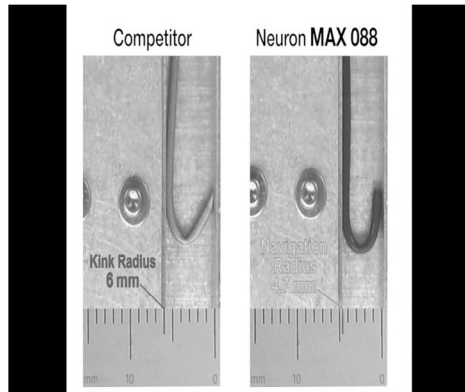


Guiding Sheath (Neuron MAX 088)

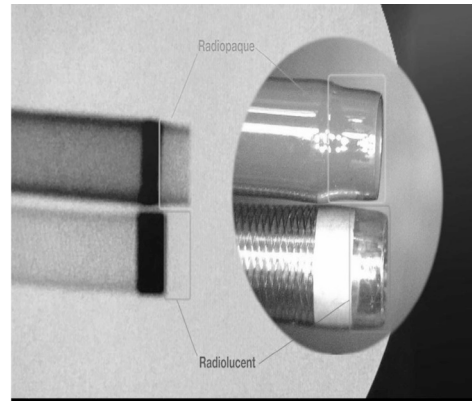
- Soft and atraumatic with full radiopacity



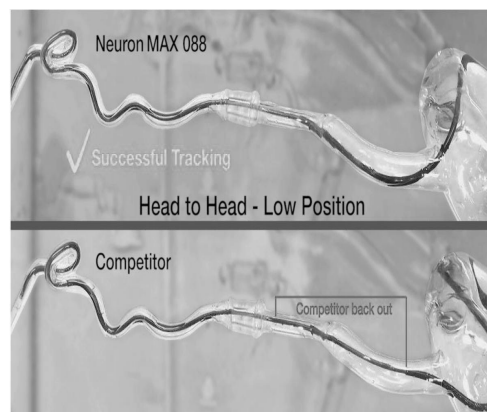
Guiding Sheath (Neuron MAX 088)



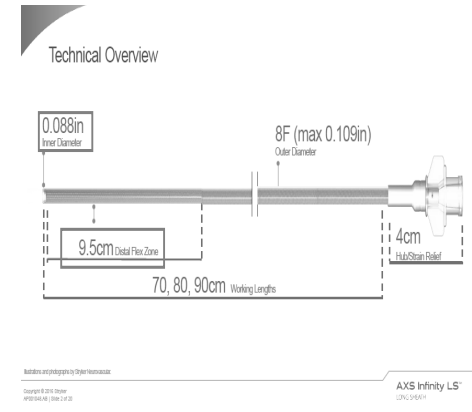
Guiding Sheath (Neuron MAX 088)



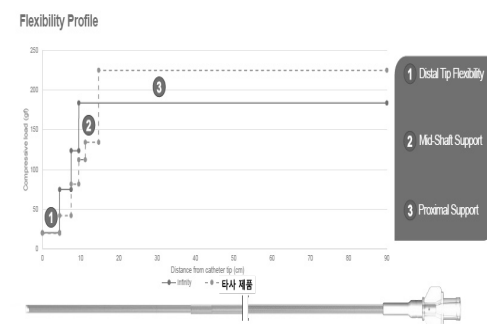
Guiding Sheath (Neuron MAX 088)



Guiding Sheath (Infinity LS)



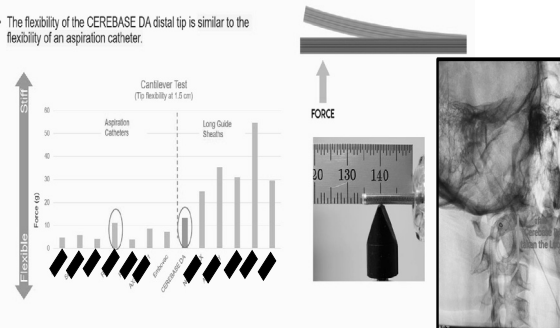
Guiding Sheath (Infinity LS)



Guiding Sheath (Cerebase DA)

More TRACKABILITY - Distal Tip Flexibility Similar to Aspiration Catheter

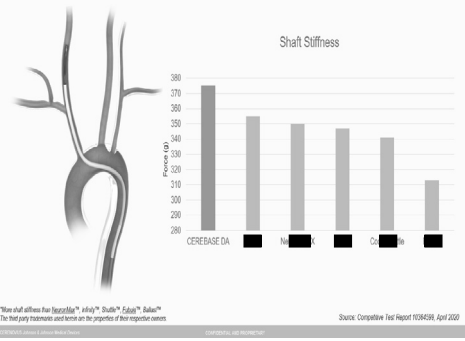
- The flexibility of the CEREBASE DA distal tip is similar to the flexibility of an aspiration catheter.



Guiding Sheath (Cerebase DA)

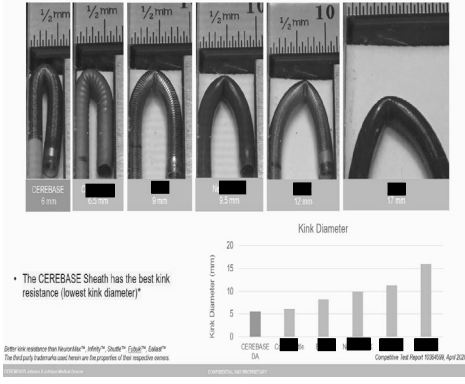
More SUPPORT – Proximal Shaft Stiffness

- CEREBASE Sheath has more proximal shaft stiffness* to provide additional arch support
- (10% more than Shuttle, 7% more than Infinity)



Guiding Sheath (Cerebase DA)

More TRACKABILITY – Excellent Kink Resistance

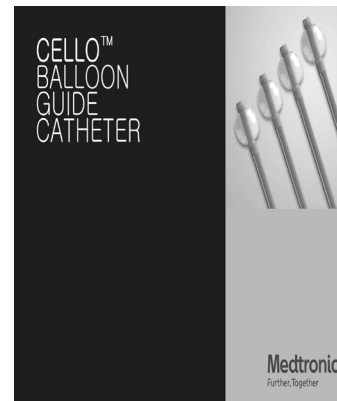


Balloon Guide Cath.

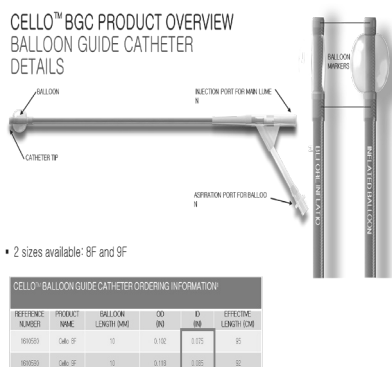
- Cello** (Medtronic)
- FlowGate2** (Stryker)
- Optimo** (Tokai medical)
- BOBBY** (Microvention), **Emboguard** (Cerenovus): 내년 출시

SWIFT Prime • Solitaire study • AIS, Age 18-80, NIHSS 8-29, IV-tPA within 4.5hrs of onset of stroke • BGC sub-analysis	UMASS • In Vitro • Favorable results to BGC arm • Merci® BGC, Merci Retriever, Trevo® Pro Retriever, Solitaire	NASA • All patients received the Solitaire FR device as the first choice device to restore blood flow • BGC sub-analysis	STAR • Solitaire registry • Mandatory use of BGC • Age ≥18 and <85, NIHSS 8-30, mRS ≤2	TRACK • Trevo Retriever must be the FIRST retrieval device used in the case, Any age, Any time of onset, All treatable anatomy • BGC sub-analysis
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Balloon Guide Cath. (Cello 8F & 9F)



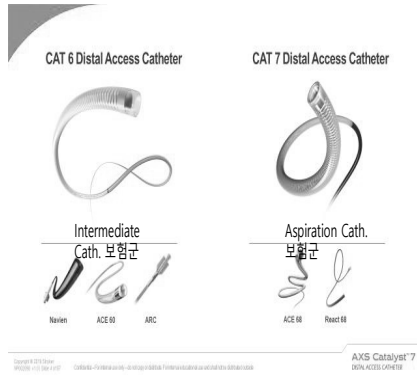
Balloon Guide Cath. (CELLO 8F & 9F)



Balloon Guide Cath. (FlowGate 8F)

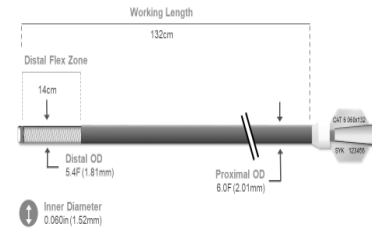


Intermediate (Aspiration) catheter Catalyst 6 & 7



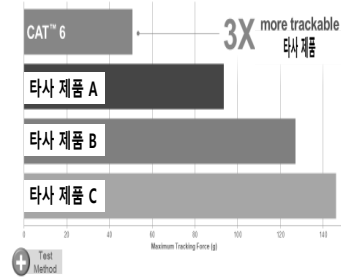
Intermediate (Aspiration) catheter (Catalyst 6)

Designed for High Performance



Intermediate (Aspiration) catheter (Catalyst 6)

Superior Trackability
Easy Access for a Faster Procedure



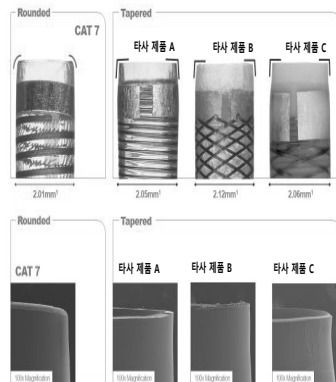
Intermediate (Aspiration) catheter (Catalyst 7)

Specification comparison

Device	ID (in)	Distal OD ¹ F (in) [mm]	Proximal OD ¹ F (in) [mm]	Effective Lengths (cm)
AXS Catalyst 6	0.058	5.3F (0.069) [1.78]	6.6F (0.073) [1.88]	115, 132
AXS Catalyst 6	0.060	5.4F (0.071) [1.81]	6.0F (0.079) [2.01]	132
AXS Catalyst 7	0.068	6.2F (0.082) [2.08]	6.3F (0.0825) [2.10]	115, 125, 132
ACE 68	0.068	6.4F (0.084) [2.1]	6.4F (0.084) [2.1]	132
React 68	0.068	6.3F (0.083) [2.1]	6.3F (0.083) [2.1]	132
Sofia Plus	0.070	6.3F (0.0825) [2.1]	6.3F (0.0825) [2.1]	125, 131

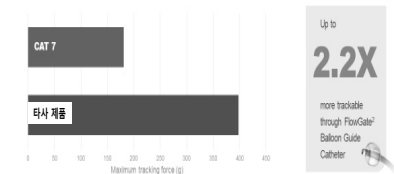
¹Specifications per FDA (109) Summary

Intermediate (Aspiration) catheter (Catalyst 7)

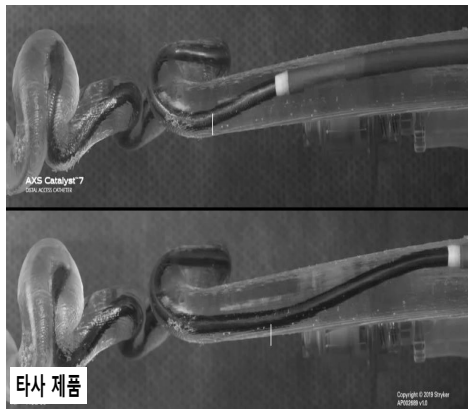


Intermediate (Aspiration) catheter (Catalyst 7)

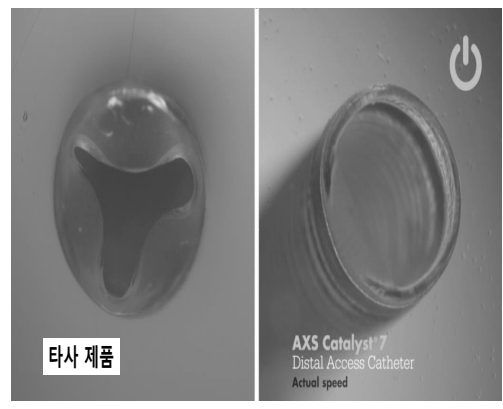
Competitive trackability testing
V 타사 제품 iFlowGate® BGC



Intermediate (Aspiration) catheter
(Catalyst 7)



Intermediate (Aspiration) catheter
(Catalyst 7)



Intermediate (Aspiration) catheter
(Vecta)

AXS Vecta[®]
Intermediate Catheter

stryker

Making a difference by **empowering complete clot ingestion**

How you perform thrombectomy is as unique as each of your patients. That's why we're introducing the AXS Vecta Intermediate Catheter. Equipped with Pro Technology, this catheter's extra-large lumen is designed to empower clot removal through aspiration alone or with a stent retriever. Together, with our customers, we are driven to make healthcare better.

Lower profile 2.1mm distal OD
Get more lumen without compromising access.

Extra-large 0.07in lumen to remove clot
Up to 20% more aspiration power* with the extra-large bore and 0.216in AXS Universal Aspiration Tubing.

Improved durability with Pro Technology

Includes reinforced coil that won't pull back into the catheter.

Includes reinforced coil that won't pull back into the catheter.

Includes reinforced coil that won't pull back into the catheter.

Includes reinforced coil that won't pull back into the catheter.

Intermediate (Aspiration) catheter
(Vecta)

		Medium-bore aspiration catheters		Large-bore aspiration catheters		
		AXS Catalyst 5 Distal Access Catheter	AXS Catalyst 6 Distal Access Catheter	AXS Catalyst 7 Distal Access Catheter	AXS Vecta 7 Aspiration Catheter	
Distal OD (Inches)	Distal OD (Inches)	0.0815/16	0.0715/16	0.0825/16	0.0825/16	0.0825/16
	Proximal OD (Inches)	0.0725/16	0.0725/16	0.0825/16	0.0825/16	0.0825/16
	Length (cm)	102	102	125, 102	125, 102	125, 102
	Distal ID (Inches)					
	Length (cm)					
	Distal ID (Inches)					
Distal ID (Inches)	Distal ID (Inches)	0.0815/16	0.0715/16	0.0825/16	0.0825/16	0.0825/16
	Proximal OD (Inches)	0.0725/16	0.0725/16	0.0825/16	0.0825/16	0.0825/16
	Length (cm)	102	102	125, 102	125, 102	125, 102
	Distal ID (Inches)					
	Length (cm)					
	Distal ID (Inches)					
Length (cm)	Length (cm)	102	102	125, 102	125, 102	125, 102
	Distal ID (Inches)					
	Length (cm)					
	Distal ID (Inches)					
	Length (cm)					
	Distal ID (Inches)					

Length and diameter compatible
Distal difference for maximum flow

Not compatible
+0.001in OD/ID difference

Catheter diameter compatibility
+0.001in diameter remaining lumen space for

Intermediate (Aspiration) catheter
(SOFIA)

PRODUCT DESIGN – SPECIFICATIONS

Sofia **Sofia plus**

Product Code Name Catheter Size Proximal OD Distal OD ID Working Length Distal Length Distal Tip Shape

DA5115ST	Sofia DAC	5	0.068/1.7	0.067/1.7	0.065	115	17	98	Straight
DA5125ST	Sofia DAC	5	0.068/1.7	0.067/1.7	0.065	125	17	108	Straight
DA6115ST	Sofia DAC	6	0.0835/2.1	0.0815/2.1	0.070	115	17	98	Straight
DA6125ST	Sofia PLUS	6	0.0835/2.1	0.0815/2.1	0.070	125	19	100	Straight

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Intermediate (Aspiration) catheter
(SOFIA)

Sofia **Sofia plus**

Large inner diameter for improved aspiration power and enhanced softness for superior distal navigation

One unit per box, includes shaping manifold and introducer sheath

PRODUCT CODE	CATHETER SIZE	PROXIMAL OD	DISTAL OD	ID	WORKING LENGTH	DISTAL LENGTH	PROXIMAL LENGTH	DISTAL TIP SHAPE
DA5115ST	5F	0.0685"/2.1mm	0.0675"/2.1mm	0.065"	125cm	18cm	108cm	Straight
DA5125ST	5F	0.0685"/2.1mm	0.0675"/2.1mm	0.065"	125cm	18cm	108cm	Straight

6F SOFIA[®] PLUS 125cm

6F SOFIA[®] PLUS 131cm

Intermediate (Aspiration) catheter (SOFIA)

More ASPIRATION POWER

LARGER INNER LUMEN

SOFIA™ PLUS Catheter has a 31% larger lumen than a .060" tapered catheter and an 18% larger lumen than a .064" tapered catheter

More ASPIRATION POWER

SOFIA™ PLUS Catheter has a 23% higher flow rate than a .064" tapered catheter and a 29% higher flow rate than a .060" tapered catheter

ATTRIBUTE	BENEFIT
0.070" Lumen	Wide Inner Lumen for Increased Aspiration Ability
Exceptionally Soft Distal Tip	Allows Smooth Bypass of the Ophthalmic Artery
125cm Working Length Available	More Microcatheter Length for Retrieval Device Deployment
Long 131cm Working Length Available	Ability to Reach Distal Vessels/Occlusions
Stream Shapeable Tip and Torqueable Shaft	Ability to Steer Distal Tip Past Difficult Bifurcations
Enhanced Kink Resistance	Maintains Distal and Proximal Lumen Integrity

Intermediate (Aspiration) catheter (SOFIA)

PRODUCT DESIGN – FEATURES & BENEFITS

More ASPIRATION POWER

SOFIA™ PLUS Catheter has a 23% higher flow rate¹ than 타사 제품 and a 29% higher flow rate than 타사 제품²

LARGER LUMEN

SOFIA™ PLUS Catheter has an 18% larger lumen than 타사 제품 and a 31% larger 타사 제품 lumen than 타사 제품³

A LARGER LUMEN CAPTURES LARGER CLOTS

Intermediate (Aspiration) catheter (SOFIA)

PRODUCT DESIGN – PROXIMAL CATHETER COMPATIBILITY

SOFIA™ PLUS 6F Guiding Sheath or Balloon Guide Catheter must have an ID of 0.085" or larger for SOFIA to fit.

PRODUCT TYPE	COMPANY	PRODUCT NAME	ID" (in)	Compatible with SOFIA™ PLUS
Guiding Sheaths	Cook	Shuttle® 6F	0.087	YES
	Terumo	Destination® 6F	0.087	YES
	Cordis	Vista Brite Tip®	0.088	YES
	Pennumbra	Neuron™ MAX 088	0.088	YES
Balloon Guide Catheters	Stryker/Concentric	Mercy® 9F	0.085	YES
	Stryker/Concentric	Mercy® 8F	0.078	NO
	Stryker/Concentric	FlowGate® 8F	0.084	NO
	Covidien/Medtronic	Cello™ 9F	0.035 – 0.084	NO
	Covidien/Medtronic	Cello™ 8F	0.075	NO

Intermediate (Aspiration) catheter (ACE)

Clinical Evidence for Mechanical Thrombectomy

ADAPT: 2013-2015 ADAPT/ADAPT Fox, 2018 PROMISE

Stent Retriever: Merci (2004-2008), 2014-2016 MR CLEAN, ESCAPE, EXTEND-IA, SWIFT PRIME, REVASCAT, THERAPY

ADAPT vs SR RCT: 2017 ASTER, 2018 COMPASS, MR CLEAN Registry

Intermediate (Aspiration) catheter (ACE)

ACE® 68 Reperfusion Catheter: 6F (1.67 mm), 125 cm, 0.068" ID

ACE® 64 Reperfusion Catheter: 6F (1.67 mm), 125 cm, 0.066" ID

ACE® 60 Reperfusion Catheter: 6F (1.67 mm), 125 cm, 0.064" ID

4MAX™ Reperfusion Catheter: 6F (1.67 mm), 125 cm, 0.064" ID

3MAX™ Reperfusion Catheter: 6F (1.67 mm), 125 cm, 0.043" ID

Intermediate (Aspiration) catheter (ACE)

3MAX™

4MAX™

ACE® 60

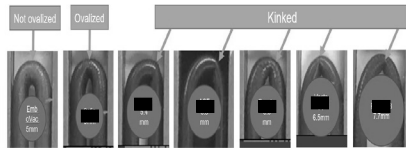
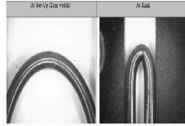
ACE® 64

ACE® 68

Intermediate (Aspiration) catheter
(Embovac)

More DURABILITY – Excellent Kink Resistance with Thin Wall Design¹

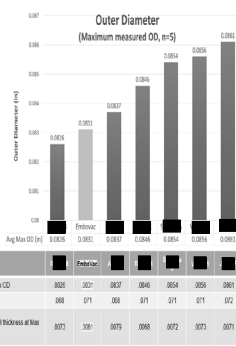
- At 5 mm, both EmboVac and S₁ did not kink
- At 5mm S₁ ovalized and EmboVac did not ovalize
 - EmboVac has a thin-wall design (less than 0.005" wall at the distal tip) – thinner than all competitive catheters
 - Thin Wall Design does not impact kink resistance – does not kink or ovalize at a very small radius (5 mm, where the catheter is folded over itself)



1. Competitive Test Report: 103628641, October 2013

More COMPATIBILITY – Lowest Profile

- EmboVac[®] has the smallest OD for all Large Bore catheters ($\geq 0.071"$ ID)
 - Thin wall design means catheter wall is thinner, giving EmboVac[®] a low profile
- Low profile allows for more compatibility options for a Large Bore catheter
 - Thinner wall/ low profile also allows for more room in between EmboVac[®] and base catheter
 - Due to the low profile of the LBC, there is more room for contrast injections at manipulation within base catheter

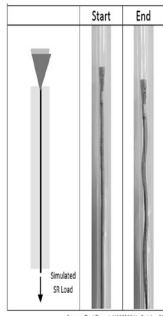
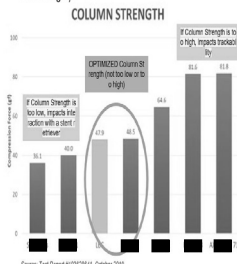


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Source: Competitive Test Report 103529641, October 2019.

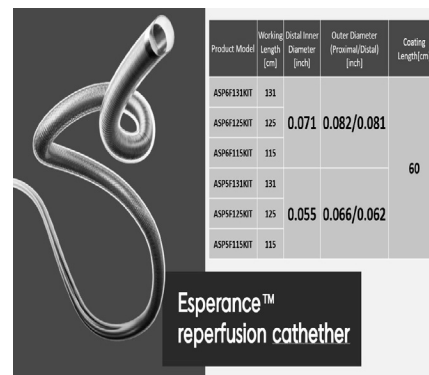
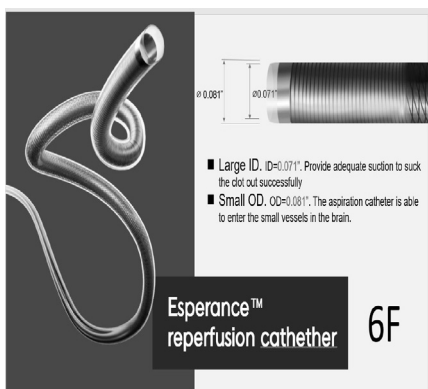
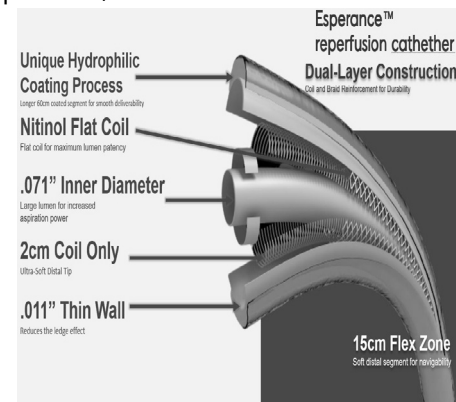
More DURABILITY – Column Strength

- Column Strength: Amount of force required to deflect the catheter
 - EmboVac has 33% more column strength than Sofia Plus*
 - EmboVac and Jet 7 Xtra Flex are very similar (Optimized Column Strength)



Increased to 5000 Plus

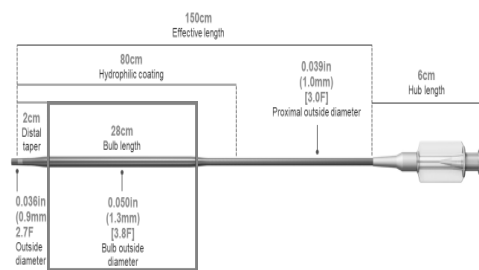
Source: Test Report #930620641, October 2011



Basic NeuroEndovascular Training Course 3 (BNET Course)

Offset

Technical overview

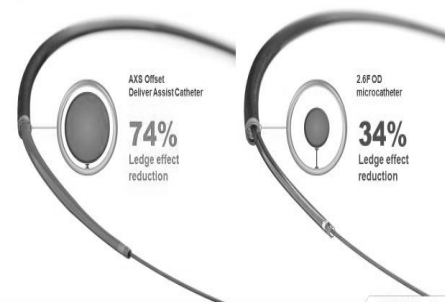


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AXS Offset™
DELIVERY ASSIST CATHETER

Offset

Conquer the Ledge.™



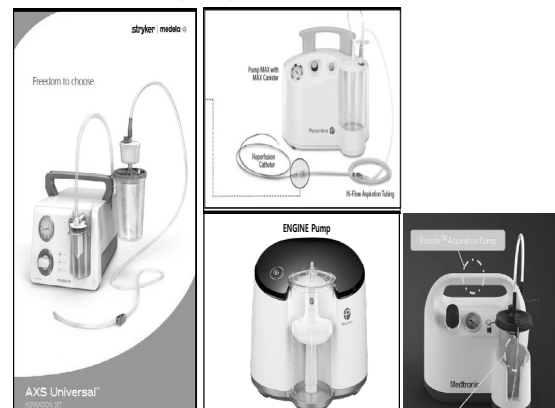
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AXS Offset™
DELIVERY ASSIST CATHETER

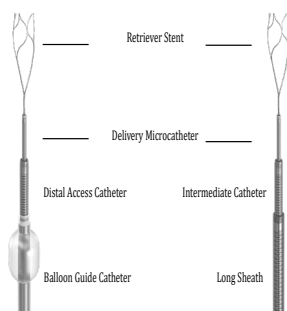
Aspiration syringe & Pump



Aspiration syringe & Pump



Mechanical Thrombectomy system (Stent)



Delivery Catheter

- Phenom 21 (Medtronic)
- Trevo Trek 21 (Stryker)
- Prowler select plus (Cerenovus)
- Headway 17 or 21 (Microvention)
- Neuroslide (Acandis)

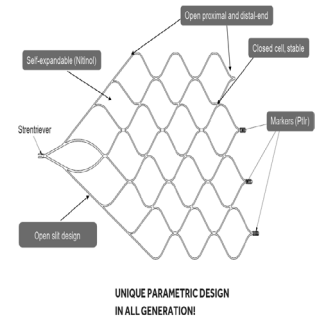
Stent

- **Solitaire X** (Medtronic)
- **Trevo NTX** (Stryker)
- **Embotrap III** (Cerenovus)
- **ERIC** (Microvention)
- **APERIO Hybrid** (Acandis)
- **pRESET** (Wallaby/Phenox)

Stent (Solitaire)

SOLITAIRE™ EVOLUTION OUR HISTORY OF INNOVATIVE CHANGE

- **SOLITAIRE™ FR LAUNCHES** 2011 국내 허가
 - 4 sizes: 4x15, 4x20, 6x20, 6x30
- **SOLITAIRE™ 2 LAUNCHES** 2016 국내 론치
 - New attachment junction
- **SOLITAIRE™ 2 4X40 LAUNCHES**
- **SOLITAIRE™ PLATINUM** 2018 국내 론치
 - 4x20, 4x40, 6x20
- **SOLITAIRE™ PLATINUM 6 X 40** 2018 국내 론치
- **SOLITAIRE X 6 X 40** 2021 국내 론치



- | 솔리테어FR (2011년) : detach 가능
- | 솔리테어2 (2016년) : detach 불가능
- | 솔리테어 플래티넘 (2018년) : detach 불가능
- | 솔리테어 X (2021년) : detach 불가능

Device history of Solitaire Generation 10 Years of Continuous Evolution

SOLITAIRE FR 1 ST GEN	SOLITAIRE 2 2 ND GEN	SOLITAIRE PLATINUM M	SOLITAIRE X 4 TH GEN
- Parametric Design - Detachment (off-label) - Clinically Proven with 5 RCTs - CE Mark Received in	- Redesigned Delivery system (Non-Detachable) - Complete Stroke Zone 4 0mm	- Improved Visibility (Platinum marker by 10mm) - Redesigned delivery system 10 Years of Innovation	- Lower Delivery Force - All Size Compatible with Phenom 21

KEY FEATURE & MESSAGE

Solitaire™ X

Stent (Solitaire)

SOLITAIRE™ X DEVICE ORDERING INFORMATION

Model	Recommended Vessel Diameter (mm)	Minimum Microcatheter ID (inch)	Push Wire Length (cm)	Stent Diameter (mm)	Stable Length (mm)	Stent Length (mm)	Length from Distal Tip to Proximal Marker (mm)	Radiopaque Markers	Radiopaque Stent Markers Spacing (mm)
SPR4 4-20-10	2.0	0.021	0.027	200	4.0	20.0	51.0	<130	3 1 10
SPR4 4-40-10	2.0	0.021	0.027	200	4.0	40.0	50.0	<130	3 1 10
SPR4 6-40-10	2.0	0.021	0.027	200	6.0	40.0	47.0	<130	4 1 10

A. Based on the smallest vessel diameter at thrombus site. B. Stable length that is less or equal to length of the thrombus. Up to 1 cm (in 1 cm) passes.

Stent (Solitaire FR to X)

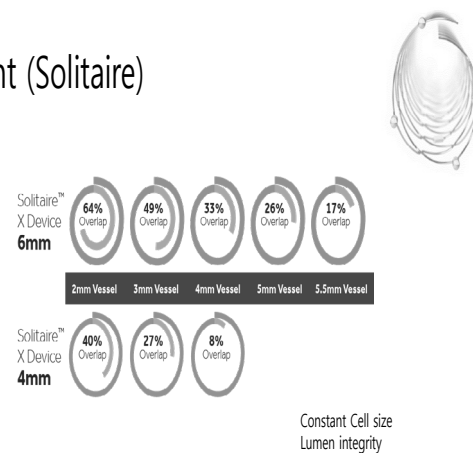
**LOWER PROFILE
GREATER FLEXIBILITY**

**.021" HC COMPATIBILITY
WITH ALL SIZES**

**17% LOWER CLOT™TM
CROSSING PROFILE**

**VISUALIZATION
& COVERAGE**

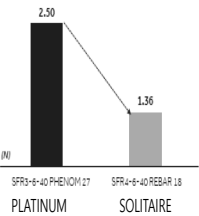
Stent (Solitaire)



Stent (Solitaire)

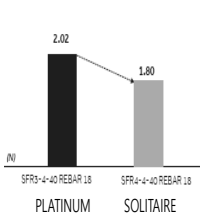
SOLITAIRE X VS. PLATINUM 6x40 MM SIZE

54% LOWER DELIVERY FORCE¹



SOLITAIRE X VS. PLATINUM 4x40 MM SIZE

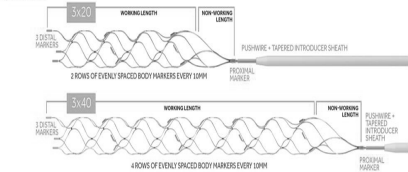
11% LOWER DELIVERY FORCE¹



Stent (Solitaire)

Solitaire™ X 3mm

Specifications¹



Model	Recommended Vessel Diameter* (mm)	Accession ID Range	Push Wire Length (cm)	Stent Diameter (mm)	Stent Length (mm)	Start Length (mm)	Length from Distal Tip to Proximal Marker (cm)	Distal Marker	Proximal Marker	Stent Markers Spacing (mm)
SFR3-3-20-10	3.0	0.027-0.027 0.028-0.028	200	3.0	20.0	30.6	<150	3	1	10
SFR4-3-40-10	3.0	0.027-0.027 0.028-0.028	200	3.0	40.0	51.6	<150	3	1	10

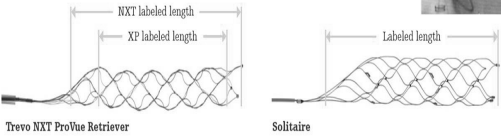
1. APPROVED FOR SALE IN THE UNITED STATES OF AMERICA ONLY. © 2008 Medtronic AVE. All rights reserved. Medtronic is a registered trademark of Medtronic AVE. All other trademarks are the property of their respective owners.

Medtronic

Stent (Trevor NXT)

2000-2011	2012-2013	2014-2019	2020+
• Merci Balloon Guide Catheters • Merci Retrievers X, L, V • DAC Distal Access Catheters	• Trevo Pro Retriever • Trevo ProVue Retriever	• Trevo XP ProVue 3mm, 4mm, 6mm	• Trevo NXT ProVue 3mm, 4mm, 6mm

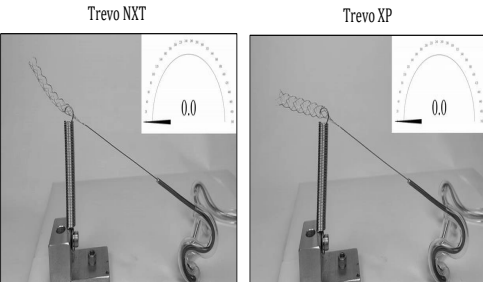
Stent (Trevor NXT)



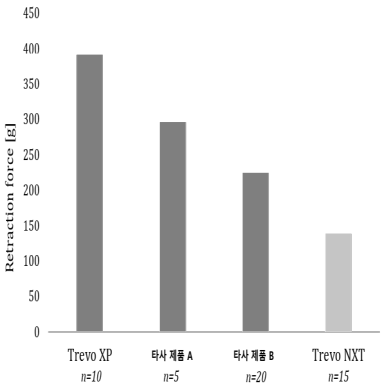
	3x32mm	4x28mm	4x41mm	6x37mm
Retriever diameter	3mm	4mm	4mm	6mm
Delivery wire diameter	0.015in	0.019in	0.019in	0.019in
Labeled length	32mm	28mm	41mm	37mm
Stent length	36mm	32mm	44mm	40mm
Delivery wire length	200cm	200cm	200cm	200cm
Distal radiopaque markers	2	3	3	3

Stent (Trevor NXT)

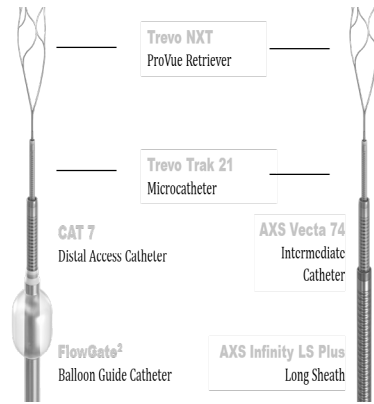
65% less retraction force than Trevo XP Retriever



Stent (Trevor NXT)



Stent (Trevor NXT)



Stent (Embotrap III)

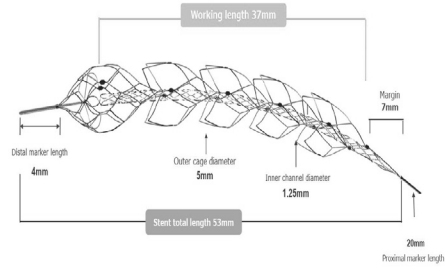
5 × 37

5mm × 37mm

Microcatheter with ID 0.021 inch or higher

5 Segment Outer cage

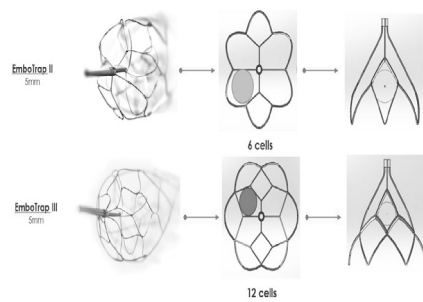
Inner channel + Outer cage



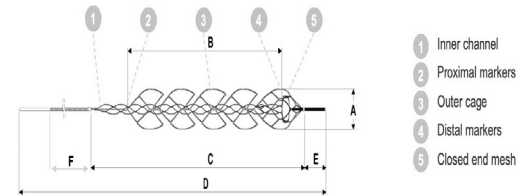
Stent (Embotrap III)

Enhanced Distal Mesh Design

Distal Mesh를 촘촘하게 하여 Embolization 최소화

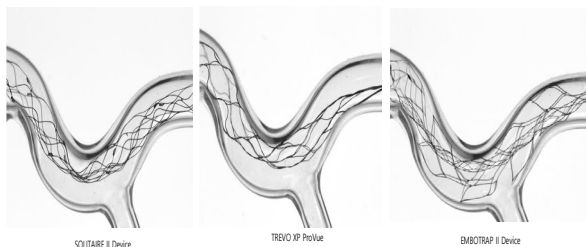


Stent (Embotrap III)



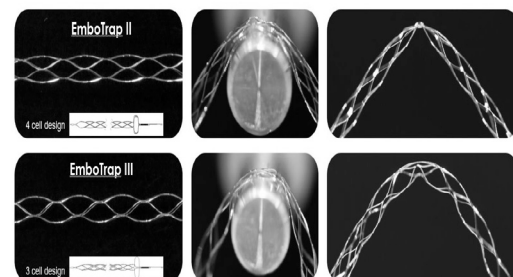
EMBOTRAP [®] III Revascularization Device										
Product Code	Outer Cage Diameter	Recommended Vessel Diameter	Working Length	Overall Length	Microcatheter compatibility	Radiopaque Tip Length	Proximal coil length	Number of Radiopaque Markers		
								Proximal	Body	Distal
ET307622	6mm	1.5-6.0mm	22mm	194cm	0.021"	4mm	20mm	2	8	3
ET307637	6mm	1.5-6.0mm	37mm	195cm	0.021"	4mm	20mm	2	16	3
ET307646	6.5mm	1.5-6.5mm	45mm	196cm	0.021"	4mm	20mm	2	16	3

Stent (Embotrap III)



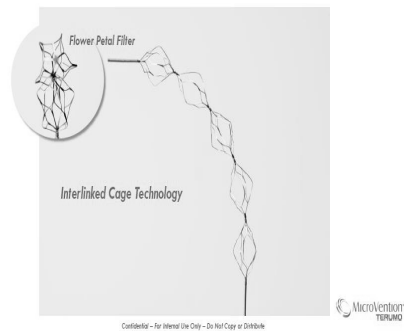
Stent (Embotrap III)

Kink Resistance를 위하여 Cell Design 변경



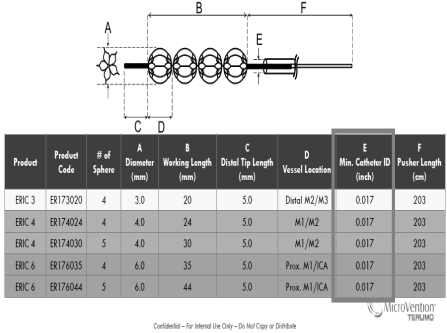
Stent (ERIC)

PRODUCT DESIGN – COMPONENTS



Stent (ERIC)

PRODUCT DESIGN – SPECIFICATIONS



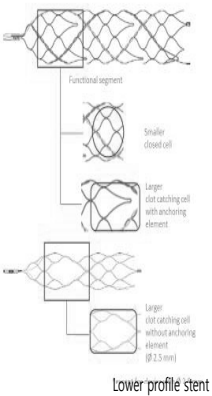
Stent (APERIO Hybrid/Hybrid¹⁷)



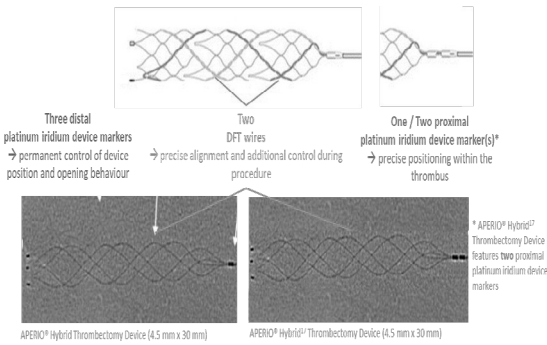
Stent (APERIO Hybrid/Hybrid¹⁷)

RELIABLE.

- Effective hybrid cell design consisting of
- Smaller closed cells
featuring higher radial force for good vessel wall apposition and improved expansion into the clot
 - Larger clot catching cells
ensuring good clot integration and efficient clot retention
 - Integrated anchoring elements*
featuring additional support in larger vessel diameters for confident and atraumatic retrieval even in tortuous anatomies



Stent (APERIO Hybrid/Hybrid¹⁷)



Stent (APERIO Hybrid/Hybrid¹⁷)

	APERIO [®] Hybrid ¹⁷			APERIO [®] Hybrid					
Device Diameter (mm)	2.5	3.5	4.5	3.5	4.5	4.5	4.5	6.0	6.0
Device Length* (mm)	16 (18, 28)**	28	30	28	30	40	50	40	50
Recommended Vessel Diameter (mm)	1.0–2.0	1.5–3.0	2.0–4.0	1.5–3.0	2.0–4.0	2.0–4.0	2.0–4.0	3.5–5.5	3.5–5.5
Required MC for Delivery (inch)	0.0165–0.021			0.021–0.027					
Recommended MC for Delivery	NeuroSlider [®] 17 DLC NeuroSlider [®] 21 DLC			NeuroSlider [®] 21 DLC NeuroSlider [®] 27					

Stent (APERIO Hybrid/Hybrid¹⁷)

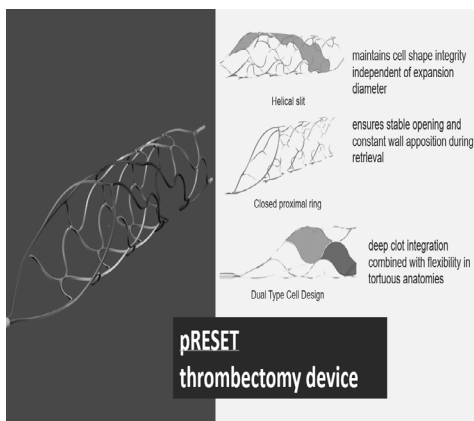
Target Region	Vessel Diameter	Recommended Thrombectomy Device
M3 – M4 A3 – A4	1 mm – 2 mm	APERIO® Hybrid ¹⁷ 2.5 x 16 (18, 28) mm
M1 – M2 A1 – A4 PCA	1.5 mm – 3 mm	APERIO® Hybrid ¹⁷ 3.5 x 28 mm
M1 – M2 A1 – A2 PCA VA BA	2 mm – 4 mm	APERIO® Hybrid ¹⁷ 4.5 x 30 mm
C4 – C7 VA BA	3.5 mm – 5.5 mm	APERIO® Hybrid 6.0 x 40, 50 mm

Stent (pRESET)

REF	Shaft Diameter (mm)	Working Length (mm)	Shaft Length (mm)	Microcath (inch)	vessel diameter (mm)
PRE-4T-3-20	3	20	30	0.0165	> 1.5
PRE-4T-4-20	4	20	30	0.0165	> 1.5
PRE-4-20	4	20	30	0.021	> 2
PRE-6-30	6	30	48	0.021	> 3
PRE-5-40	5	40	52	0.021	> 2

pRESET thrombectomy device

Stent (pRESET)



Take Home message

一長一短 (일장일단)
 知彼知己 (지피지기)
 百聞不如一見 (백문 불여일견)
 志在有還 (지재유경)

Thanks For Your Attention!!!!

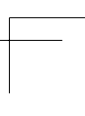
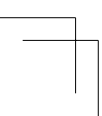
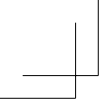
MEMO //////////////////////////////////////

Mechanical thrombectomy for acute ischemic stroke

- Stent retriever : Patient selection, technical tips and basic tactics

.....

심 유 식
인하대병원



4th Basic Neuroendovascular Training Course, 2023

Mechanical thrombectomy with Stent retriever for Acute ischemic stroke

인하대병원 심유식

Stent Retriever Thrombectomy

Patient Selection (2018 AHA/ASA Guideline)

- IA** (1) prestroke mRS 0-1
(2) ICA / MCA (M1) occlusion
(3) age $\geq$ 18 years
(4) NIHSS $\geq$ 6
(5) ASPECTS $\geq$ 6
(6) within 6 hours of symptom onset (groin puncture)
- Iib** (1) M2 or M3
(2) ACA, VA, BA, PCA
(3) mRS $>$ 1, ASPECTS $<$ 6, NIHSS $<$ 6

New Rec

- IA** (1) DAWN / DIFFUSE 3: 6~16 hours
Ila (1) DAWN / DIFFUSE 3: 16~24 hours

Stent Retriever Thrombectomy

장점

- (1) 익숙하다
- (2) 폐색부위까지 접근성이 용이하다
- (3) 스텐트를 펼치면 일시적인 혈류의 재개통이 일어난다
- (4) 여러 조각의 혈전을 한꺼번에 제거 가능
- (5) Aspiration 과 병행이 가능 (combined thrombectomy: Solumbra, ARTS, SAVE, CAPTIVE)
- (6) 심한 동맥경화에서 우선적으로 사용가능 (ex. stenting)

단점

- (1) 작업반경이 넓고 보조자의 역할이 중요함
- (2) 절차가 복잡하고, 시간이 오래걸림
- (3) Vessel dissection

Stent Retriever Thrombectomy

시술 전 준비

- (1) Conscious sedation:** Dexmedine (PreceDEX), Propofol, Fentanyl
cf) Etomidate, Midazolam

(2) General anesthesia

Meta-Analysis > J Neurosurg Anesthesiol. 2021 Jan;33(1):21-27.
doi: 10.1097/ANA.0000000000000646.

General Anesthesia Versus Conscious Sedation in Endovascular Thrombectomy for Stroke: A Meta-analysis

Conclusions: In centers with high quality, specialized neuroanesthesia care, GA treated thrombectomy patients had superior recanalization rates and better functional outcome at 3 months than patients receiving CS.

- (3) BP control :** pain control / iv CCB / labetalol
(4) airway protection : suction / O2 nasal prong or mask preparation
(5) heparin flushing line

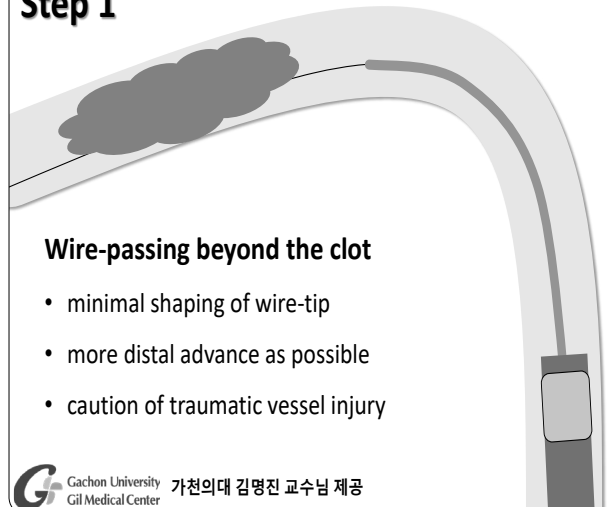
Stent Retriever Thrombectomy

시술 시작

- (1) 8Fr femoral sheath,** long sheath, cf) 6Fr shuttle
(2) Diagnostic angiography, esp. ICA occlusion / VB occlusion
collateral
occlusion point
planning
(3) Balloon guiding catheter (OPTIMO-TMP, Cello, TransForm, BGC), Shuttle, NeuronMax088, etc
(4) Intermediate catheter (SOFIA, DAC, Navien, Penumbra system)
(5) Stent delivery catheter (21,27)
(6) Stent Retriever (**Trevo**, **Solitaire**, Embotrap, ERIC)

Step 1

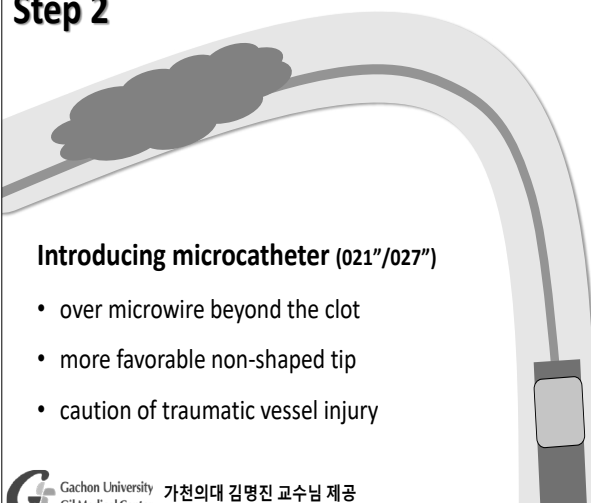
Design & Graphic by MJ KIM



Wire-passing beyond the clot

- minimal shaping of wire-tip
- more distal advance as possible
- caution of traumatic vessel injury

Step 2 *Design & Graphic by MJ KIM*

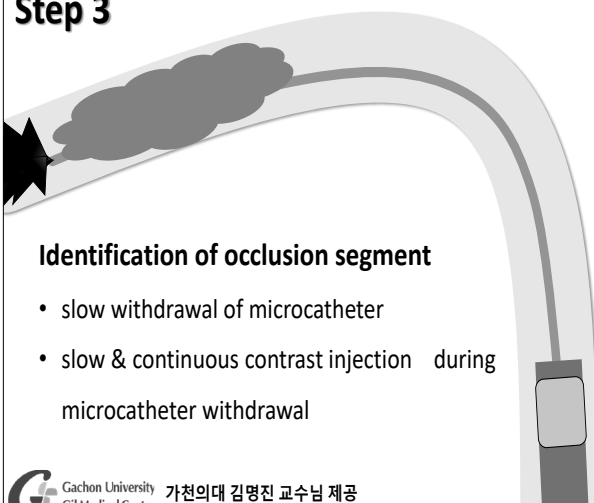


Introducing microcatheter (021"/027")

- over microwire beyond the clot
- more favorable non-shaped tip
- caution of traumatic vessel injury

 Gachon University Gil Medical Center 가천의대 김명진 교수님 제공

Step 3 *Design & Graphic by MJ KIM*

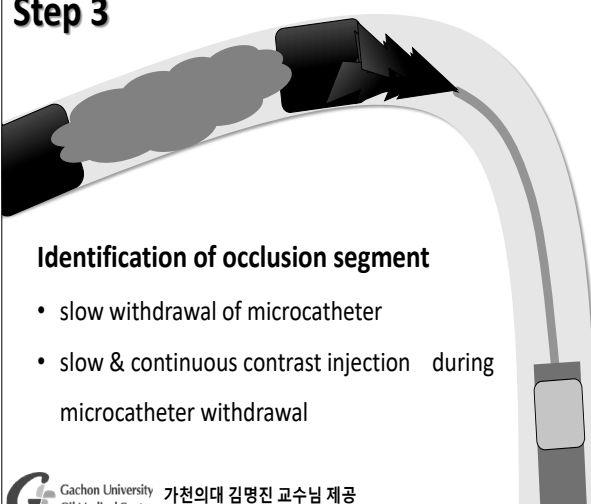


Identification of occlusion segment

- slow withdrawal of microcatheter
- slow & continuous contrast injection during microcatheter withdrawal

 Gachon University Gil Medical Center 가천의대 김명진 교수님 제공

Step 3 *Design & Graphic by MJ KIM*

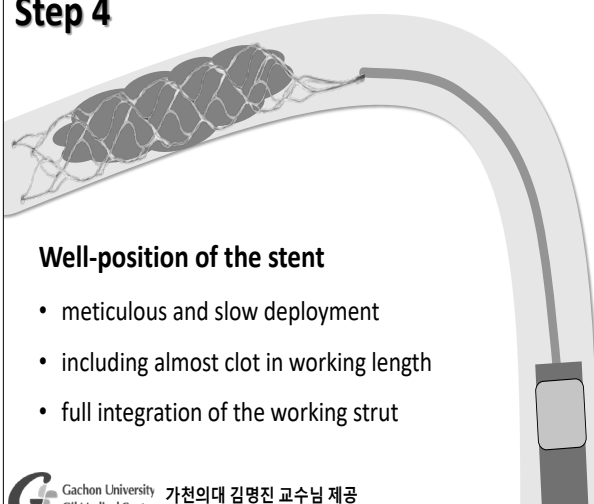


Identification of occlusion segment

- slow withdrawal of microcatheter
- slow & continuous contrast injection during microcatheter withdrawal

 Gachon University Gil Medical Center 가천의대 김명진 교수님 제공

Step 4 *Design & Graphic by MJ KIM*

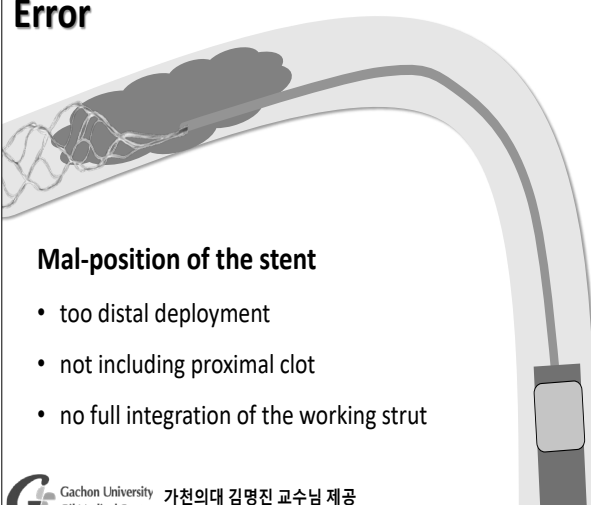


Well-position of the stent

- meticulous and slow deployment
- including almost clot in working length
- full integration of the working strut

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Error *Design & Graphic by MJ KIM*

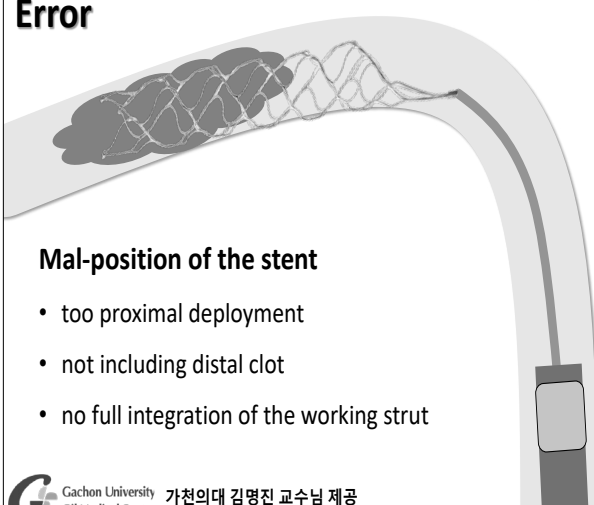


Mal-position of the stent

- too distal deployment
- not including proximal clot
- no full integration of the working strut

 Gachon University Gil Medical Center 가천의대 김명진 교수님 제공

Error *Design & Graphic by MJ KIM*

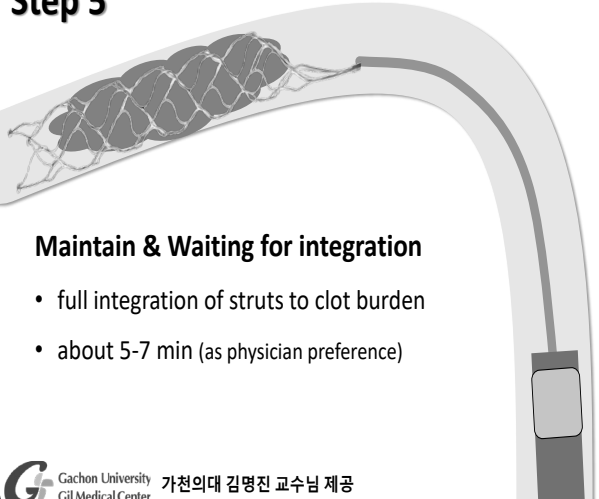


Mal-position of the stent

- too proximal deployment
- not including distal clot
- no full integration of the working strut

 Gachon University Gil Medical Center 가천의대 김명진 교수님 제공

Step 5 *Design & Graphic by MJ KIM*

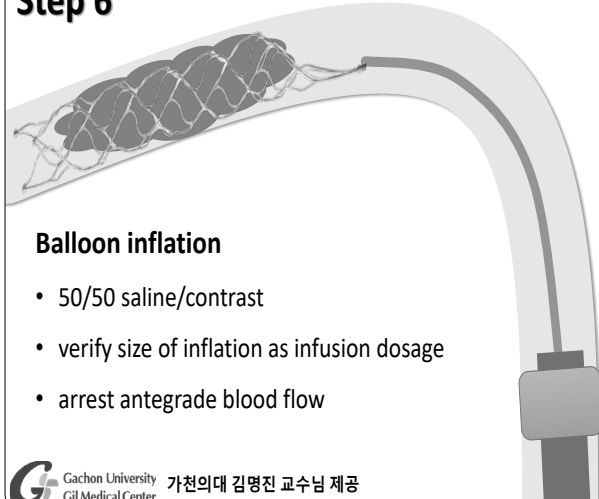


Maintain & Waiting for integration

- full integration of struts to clot burden
- about 5-7 min (as physician preference)

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Step 6 *Design & Graphic by MJ KIM*

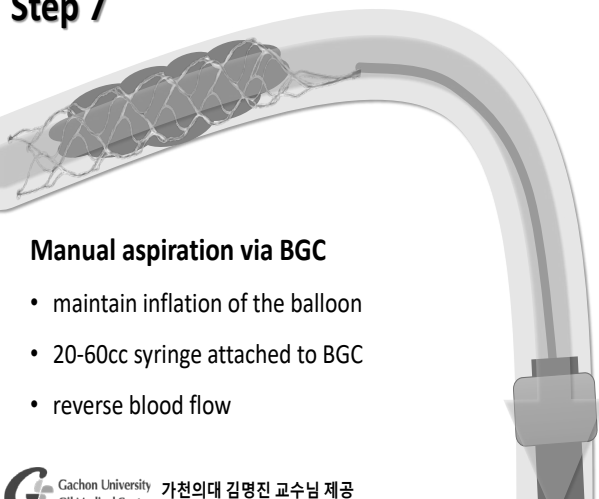


Balloon inflation

- 50/50 saline/contrast
- verify size of inflation as infusion dosage
- arrest antegrade blood flow

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Step 7 *Design & Graphic by MJ KIM*

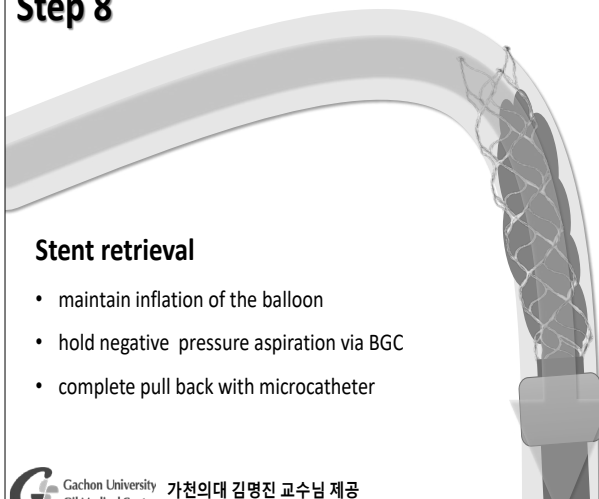


Manual aspiration via BGC

- maintain inflation of the balloon
- 20-60cc syringe attached to BGC
- reverse blood flow

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Step 8 *Design & Graphic by MJ KIM*



Stent retrieval

- maintain inflation of the balloon
- hold negative pressure aspiration via BGC
- complete pull back with microcatheter

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Cases

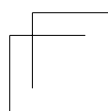
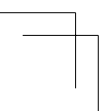
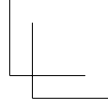
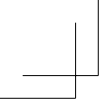
1. MCA occlusion
2. Basilar artery occlusion
3. ICA occlusion (T-occlusion)
4. ICA occlusion (Tandem)
5. Stent retriever+ Aspiration (Solumbra)
6. Rescue treatment I (Intracranial stenting)
7. Rescue treatment II (GP IIB/IIIA RI inject)

Mechanical thrombectomy for acute ischemic stroke

- Aspiration technique: Patient selection, technical tips and basic tactics

박 정 현

한림대 동탄성심병원



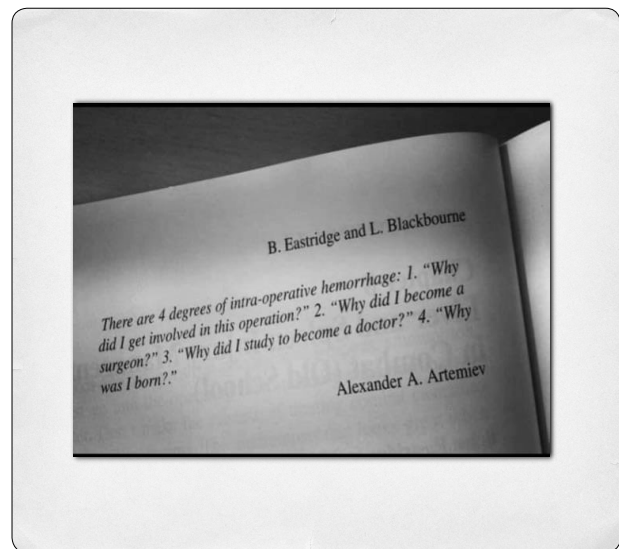


Mechanical Thrombectomy
for acute ischemic stroke –
Aspiration technique:
Patient selection, technical
tips and basic tactics

Jung Hyun Park
E-mail: parkjunghyun0707@gmail.com
Department of Neurosurgery,
Dongtan Sacred Heart Hospital

14th MAY 2022

BNET 3rd: Carotid Stenting and Mechanical Thrombectomy



Contents

- ❖ Patients selection
- ❖ When and how ?
- ❖ Hand Syringe Aspiration vs Aspiration Pump
- ❖ Make your own protocol

Which Devices to use

ACE68
Catalyst 7
SOFIA Plus
Vecta 71 / 74
React 68 / 71
Embovac
Esperance 6

4MAX, 3MAX
Catalyst 5/6
SOFIA 5

Patient selection

- ❖ Curvature of vessels

Proximal ICA curvature

just proximal site of occlusion

- ❖ Characteristics of occlusion

No.1	210360739	KKH	59/M
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- ❖ Lt. MCA Occlusion
- ❖ Aspiration Fail Case

Device Note>

FlowGate 2 BGC 8Fr. 95cm

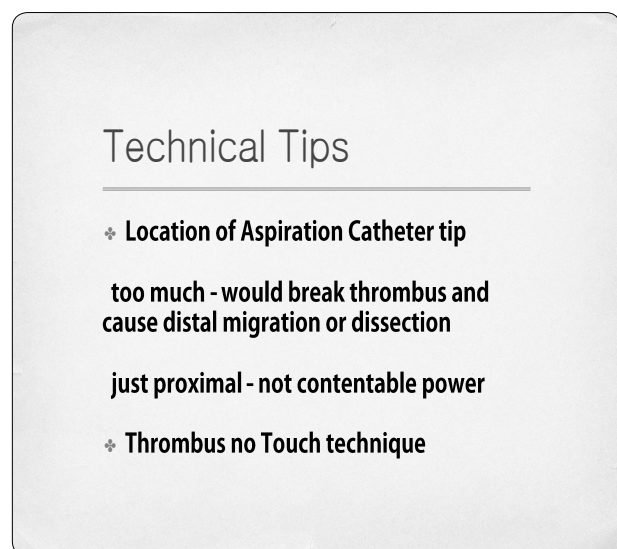
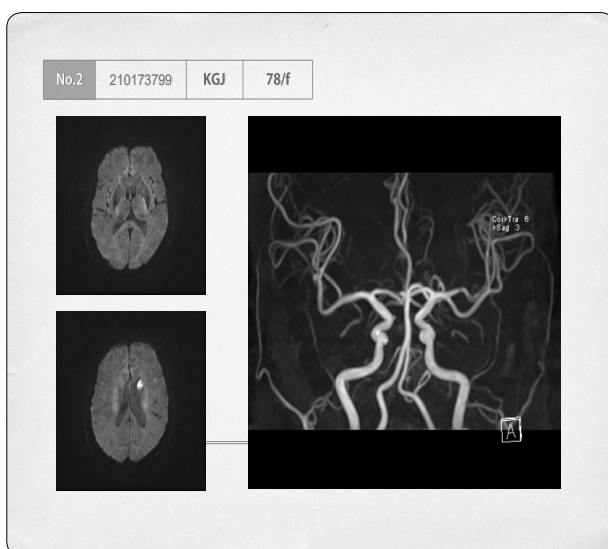
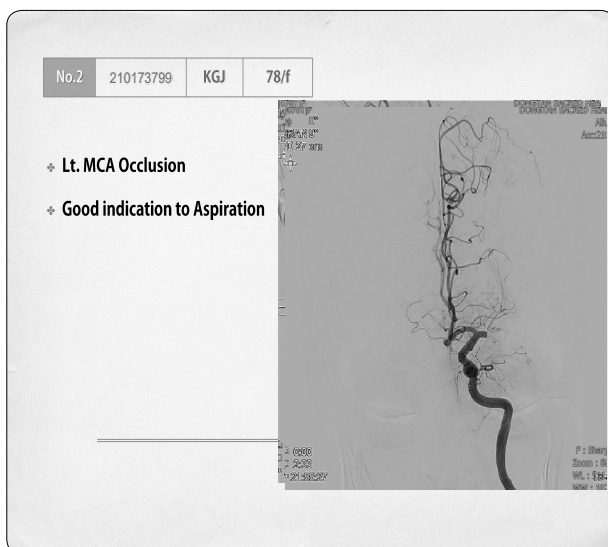
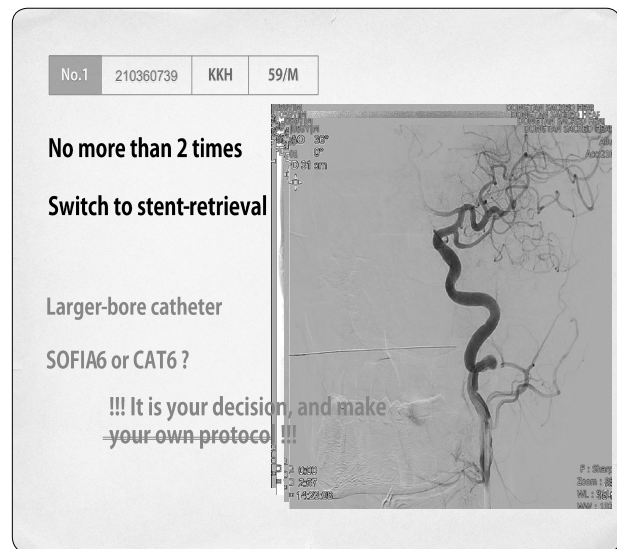
SOFIA Distal Access Catheter 5Fr. 125cm

Synchro-14 0.014in x 200cm

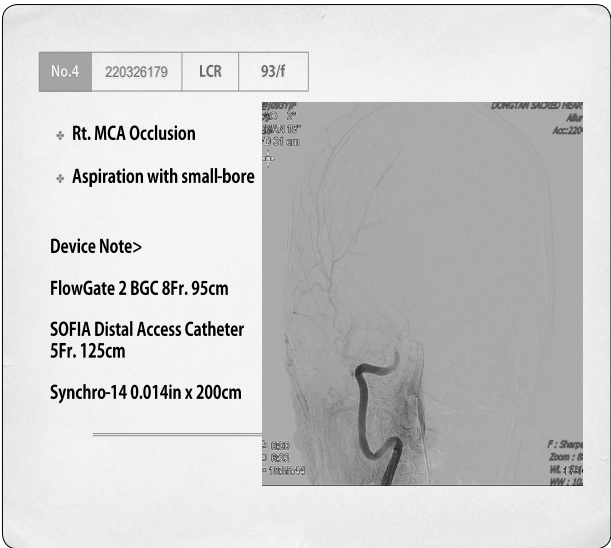
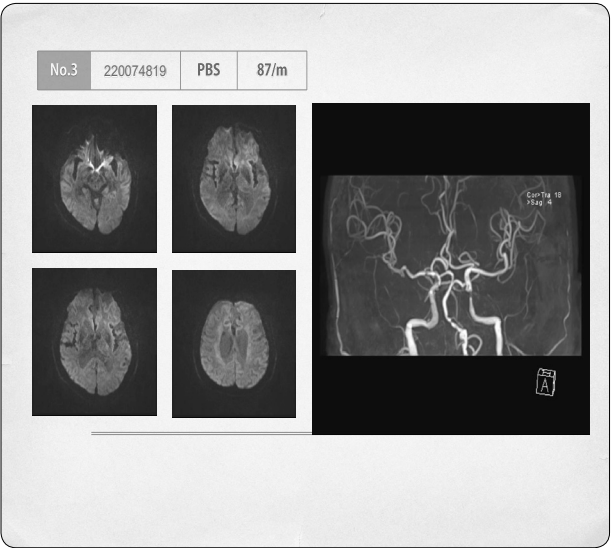
Marksman Catheter 160cm



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Technical Tips

- ❖ ICA occlusion: Remote Proximal Aspiration through Balloon Guiding Catheter (BGC) or Aspiration Catheter.
- ❖ MCA (M1) or Post. Circulation occlusion: Just try to push aspiration catheter alone, it works frequently.

No.5 210408839 JEN 84/f

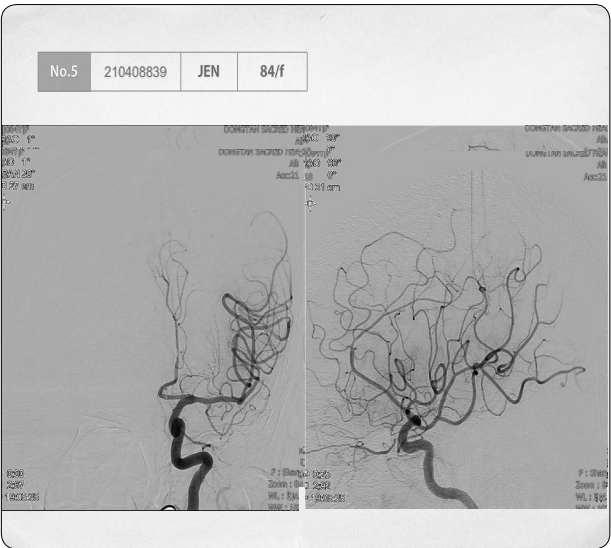
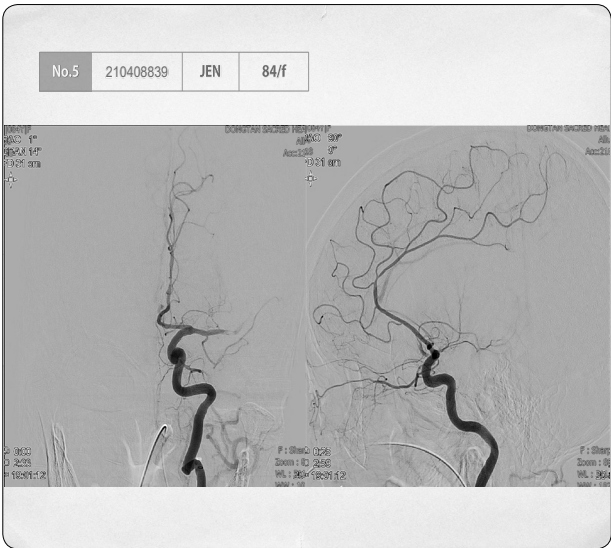
- ❖ Lt. MCA Occlusion
- ❖ Aspiration with small-bore

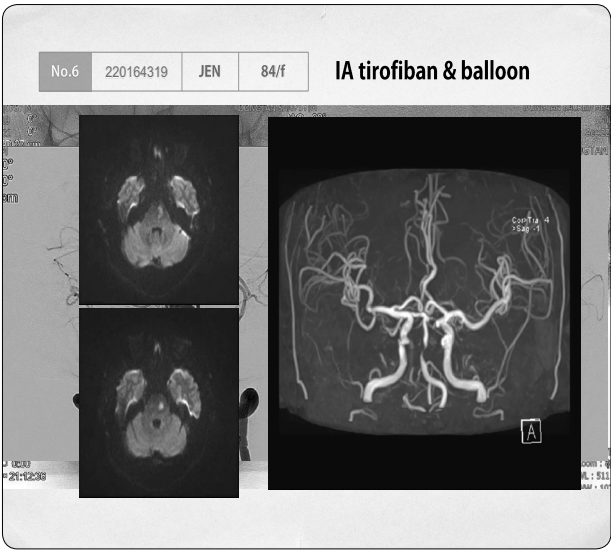
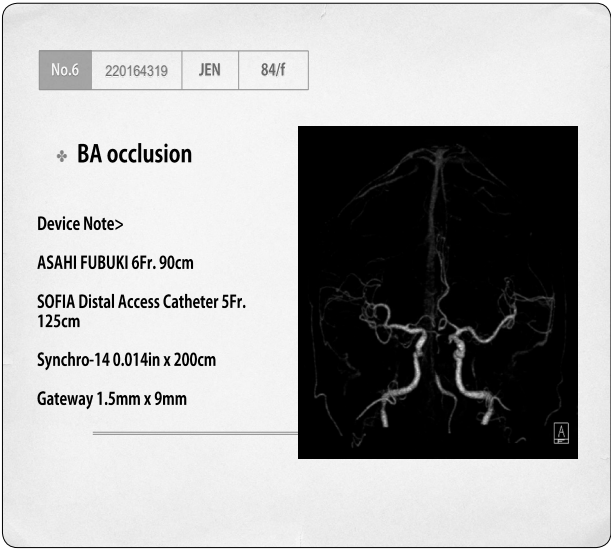
Device Note>

FlowGate 2 BGC 8Fr. 95cm

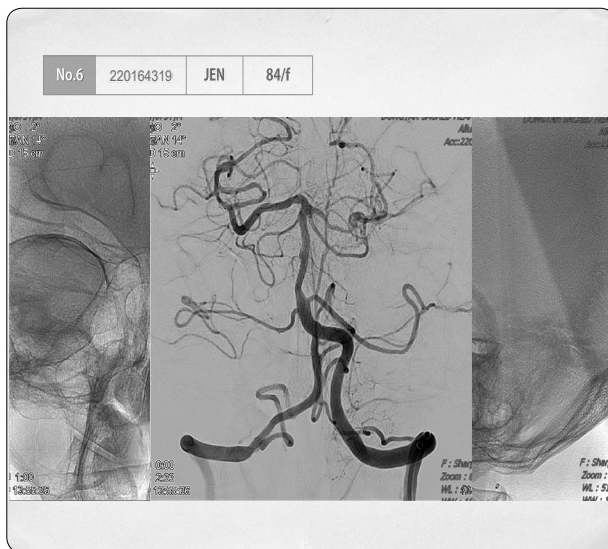
SOFIA Distal Access Catheter 5Fr. 125cm

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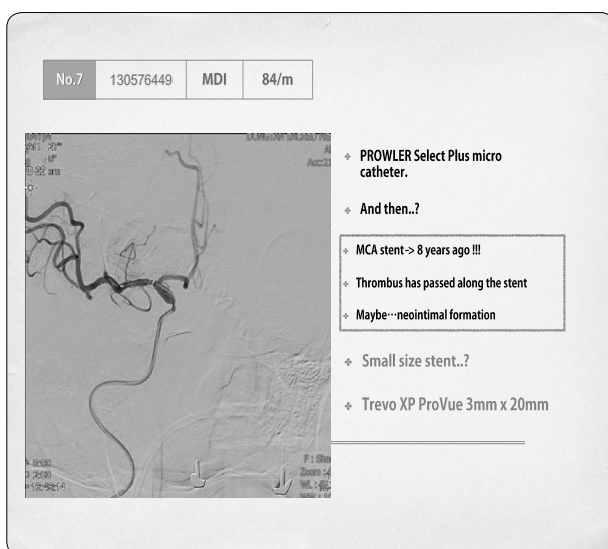
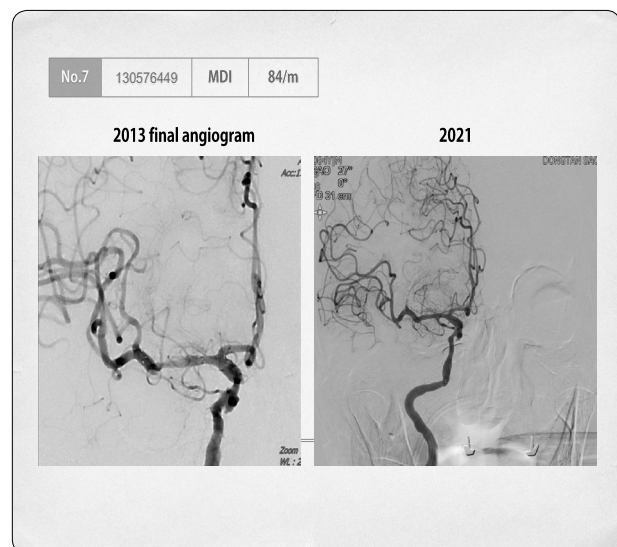


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My counsel

- ✦ 1st attempt with aspiration, especially BA
- ✦ Do not insist large-bore catheter
ICA- 6Fr. catheter would be enough, perhaps 5Fr.
- ✦ Appropriate catheter location / No thrombus-touch
- ✦ Especially ICAS-suspicious lesion
- ✦ Keep all devices as you can in your cabinet



Basic NeuroEndovascular Training Course 3 (BNET Course)



MEMO //////////////////////////////////////

MEMO //////////////////////////////////////

Basic NeuroEndovascular Training Course 3 (BNET Course)

인 쇄: 2023년 5월 3일

발 행: 2023년 5월 6일

발행처: 대한뇌혈관내치료의학회

(06631) 서울 서초구 서초대로 350 (서초동, 동아빌라트2타운) 407호

Tel_02-2279-9560 / E-mail_kones@konesonline.or.kr

<https://www.konesonline.or.kr>

회 장: 장철훈

부회장: 권순찬

총 무: 김영우

수련교육: 김태곤, 박중철

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서울특별시 강남구 헌릉로 569길 18, 운성빌딩 4층 T. 02-2294-1614 F. 02-2294-1655

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* Data on File at MicroVention.

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The SOFIA Catheter is indicated for general intravascular use, including the neuro and peripheral vasculature. The SOFIA Catheter can be used to facilitate introduction of diagnostic or therapeutic agents. The SOFIA Catheter is not intended for use in coronary arteries. Moreover, the SOFIA Catheter is intended for use in the removal/aspiration of emboli and thrombi from selected blood vessels in the arterial system, including the peripheral and neuro vasculatures.

For Healthcare Professional Intended Use Only

RX Only: Federal law restricts this device to sale by or on the order of a physician.

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