제2회 대한뇌혈관내수술학회 I 대한신경중재치료의학회

SKEN-KSIN

합동춘계학술대회

Focused update on
acute ischemic stroke management

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장소 : **충남대학교병원 재활센터 3층 대강당**
주최 : **대한뇌혈관내수술학회, 대한신경중재치료의학회**
주관 : **대한신경외과학연구재단**

대한뇌혈관내수술학회 SKEN Society of Korean Endovascular Neurosurgeons

Korean Society of 1994 KSIN Interventional Neuroradiology

인사말

대한뇌혈관내수술학회(SKEN), 대한신경중재치료의학회(KSIN) 회원 여러분 안녕하십니까!

따뜻한 봄날의 여유를 잠시 느낄 겨를도 없이 여름의 문턱이 얼마 머지않아 보입니다. 작년 광주에서 처음으로 대한뇌혈관내수술학회와 대한신경중재치료의학회가 성황리에 진행했던 춘계합동학술대회가 올해는 대전에서 개최됩니다. 지난 학회의 경우 뇌혈관기형과 뇌동정맥기형의 기초부터 임상까지의 모든 영역을 심도 있게 다루었고 연관된 증례토론을 통해 우리 회원들의 만족도를 높일 수 있었다고 판단됩니다.

올해 5월 12일 대전에서 두 번째로 개최되는 춘계합동학술대회에서는 "Focused update on acute ischemic stroke management" 라는 테마로 최근 AHA/ASA에서 대폭 수정되어 발표된 치료 가이드라인에 대해 공유하고 이런 결과가 나오기 까지 많은 영향을 끼쳤던 DAWN trial이나 DEFUSE trial 등의 연구결과들에 대해 토론하고 향후 새롭게 대비해야 할 사항들에 대해 회원들의 consensus를 모으는 시간을 갖도록 하겠습니다. 항상 stroke과 관련된 응급환자들을 치료하시느라 밤낮으로 고생하시는 회원 여러분들의 노고에 경의를 표하면서 이번 춘계합동학술개회를 통해 학문적인 교류뿐 아니라 양 학회 회원들간의 친목을 도모하고 우정을 나눌 수 있는 소중한 시간이 되기를 기대합니다.

또한 이번 춘계합동학술대회 전날인 5월11일 서울에서는 pre-conference symposium & hands-on workshop 형식으로 intracranial arterial stenosis(ICAS) 영역의 전문가들을 모시고 서로의 의견을 교환 할 수 있는 별도의 모임도 준비하였으니 관심 있는 양 학회 회원들, 특히 젊은 회원들의 적극적인 관심과 참여 부탁드리겠습니다.

그럼 계절의 여왕 5월, 대전에서 뵙기를 고대하겠습니다! 감사합니다.

대단히 감사합니다.

대한뇌혈관내수술학회 회장 고준석

인사말

존경하는 대한뇌혈관내수술학회, 대한신경중재치료의학회 회원 여러분,

제 2회 SKEN-KSIN 합동춘계학술대회를 개최하게 되어 진심으로 기쁩니다.

양 학회의 전임 회장님들과 운영위원회에서 춘계학술대회를 같이 하기로 뜻을 모아, 작년에 전남대학교병원에서 첫 번째 합동학술대회를 성공적으로 개최했고, 올 해 두 번째 학술대회를 개최하게 되었습니다. 우리나라에서 중추신경계 혈관질환에 대해 거의 같은 방법의 중재적(혈관내) 치료를 시행하는 전문가들의 모임인 양 학회가 학술대회를 같이 하는 것은 큰 의미가 있다고 생각합니다. 양 학회가 이번과 같이 지속적인 공동작업을 통한 만남과 협의를 계속 하고, 그 분야를 넓혀 간다면, 서로 이해가 부족해서 생길 수 있는 일들은 줄어들 것이고, 나아가서 뇌혈관질환으로 생명과 정상적인 삶에 위협을 받는 환자들을 위해 최선의 치료를 제공할 수 있을 것으로 믿습니다.

그런 의미에서 이번 두 번째 합동학술대회는 공동작업의 지속성이라는 면에서, 첫 번째 대회 못 지 않게 큰 의미가 있다고 생각합니다. 이번 기회를 통해 양 학회 회원들이 학문적 배움뿐 만 아니라, 서로간의 이해를 증진시킬 수 있는 좋은 계기가 될 수 있기를 기대합니다.

마지막으로, 이번 두 번째 합동춘계학술대회를 준비하는데 수고하신 대한뇌혈관내수술학회 임원진 여러분께 감사의 말씀 드립니다.

대한신경중재치료의학회 회장 김병문

2018 대한뇌혈관내수술학회 임원진

명예회장

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명예회장	백민우	인봉의료재단 뉴고려병원

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2018 대한신경중재치료의학회 임원진

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제 10대 회장	백승국	양산부산대학교병원

운영위원

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발표자 및 좌장 준수사항

발표자 준수사항

1. 한 연제당 발표시간은 아래와 같습니다. 활발한 토론을 위하여 시간을 엄수해 주시기 바랍니다.

–Session Ⅰ : 6분 발표, 4분 토론

–Session Ⅱ : 25분 발표, 5분 토론

–Session Ⅲ : 35분 발표, 5분 토론

–Session Ⅳ : 10분 발표, 5분 토론

–Session Ⅴ : 6분 발표, 4분 토론

2. 사전에(최소한 발표 30분 이전에 회의장으로) 발표하실 자료를 제출바랍니다.

3. Computer projection은 single projection만 가능합니다.

4. 발표 시 개인 노트북은 사용할 수 없습니다.

좌장 준수사항

1. 시간을 엄격히 지켜 주십시오.

2. 한두 사람에 의해 토론이 독점되지 않도록 진행하여 주십시오

3. 토론이 없을 경우를 대비하여 좋은 토론 내용을 미리 준비하시기 바랍니다.

4. 주제를 벗어난 부적절한 발언이나 토론 내용은 즉시 제지하여 주시기 바랍니다.

프로그램

09:50-10:00	Opening Remark	대한뇌혈관내수술학회 회장 **고준석**, 대한신경중재치료의학회 회장 **김병문**	
10:00-11:00	**Session I. Acute Ischemic Stroke Case I**	좌장 : 가톨릭의대 **김성림**, 연세의대 **김병문**	
10:00-10:10	Mechanical thrombectomy with microcatheters for distal occlusion	충남의대 **권현조**	• 13
10:10-10:20	The early anticoagulant management of early repeated acute ischemic stroke	순천향의대 **오재상**	• 14
10:20-10:30	Removal of detached retrievable stent by using retrievable stent: Case report	광주기독병원 **문종현**	• 15
10:30-10:40	Successful stent-in-stent rescue for in-stent re-occlusion after revascularization with stent for acute stroke: A case report	가톨릭의대 **김상욱**	• 16
10:40-10:50	Posterior-to-anterior circulation access for mechanical thrombectomy of distal ICA occlusion	가톨릭의대 **이동훈**	• 17
10:50-11:00	A case of basilar artery occlusion accompanied with vertebral artery orifice stenosis	울산의대 **박성철**	• 18
11:00-12:30	**Session II. Patient Selection & Guideline Update for EVT of Acute Ischemic Stroke**	좌장 : 순천향의대 **김범태**, 성균관의대 **전 평**	
11:00-11:30	Clinical-based patients selection	인제의대 **홍근식**	• 20
11:30-12:00	Image-based patients selection	서울의대 **손철호**	• 30
12:00-12:30	New guidelines for AIS treatment	아주의대 **이진수**	• 32
12:30-13:30	Lunch		
13:30-14:10	**Session III. Special Lecture**	좌장 : 경희의대 **고준석**	
	Latest Acute Ischemic Stroke Trial Update - Trevo Registry and Trevo stent retriever Acute Stroke (TRACK) registry	Mercy Health-St.Vincent Medical Center **Dr. Osama Zaidat**	• 37
14:10-15:50	**Session IV. Review of Devices for EVT of AIS**	좌장 : 가톨릭의대 **성재훈**, 부산의대 **백승국**	
14:10-14:25	Penumbra®	전북의대 **곽효성**	• 40
14:25-14:40	Solitaire FR®	울산의대 **권순찬**	• 46
14:40-14:55	Trevo®	Mercy Health-St.Vincent Medical Center **Dr. Osama Zaidat**	• 51
14:55-15:10	Revive SE®	한림의대 **박정현**	• 52
15:10-15:25	Eric®	동국의대 **김병철**	• 58
15:25-15:40	Intermediate catheters	경북의대 **강동훈**	• 66
15:40-15:50	Q&A		
15:50-16:10	Coffee Break		
16:10-17:30	**Session V. Acute Ischemic Stroke Case II**	좌장 : 서울의대 **강현승**, 가톨릭의대 **김범수**	
16:10-16:20	Mechanical thrombectomy within 22 hours after symptom onset in ischemic stroke	인제의대 **유민욱**	• 73
16:20-16:30	Y-stent-retrieval technique in endovascular treatment of bifurcated cerebral artery	한림의대 **박정현**	• 74
16:30-16:40	Correlation with pial arterial filling score of multiphase CT angiography and clinical outcome in patients with acute ischemic stroke treated with intra-arterial treatment: Case report	순천향의대 **우호걸**	• 75
16:40-16:50	Salvageable penumbral tissue is valuable parameter compared with the time window: 2 cases	순천향의대 **박종현**	• 76
16:50-17:00	Retrograde stent-graft insertion via surgically-exposed CCA in a patient with acute cerebral infarction due to the left CCA narrowing after total aortic arch replacement in aortic dissection with Marfan's syndrome	중앙의대 **남택균**	• 77
17:00-17:10	Ischemic stroke due to occlusion of the same site occurring at intervals of two months	영남의대 **김종훈**	• 78
17:10-17:20	Acute thrombectomy 후 발생한 complication	울산의대 **송윤선**	• 79
17:20-17:30	Dural venous sinus thrombosis in straight sinus and vein of Galen: Multistep endovascular treatment and stenting	연세의대 **백성현**	• 80
17:30	Closing Remarks	대한신경중재치료의학회 회장 **김병문**	

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제2회 대한뇌혈관내수술학회 I 대한신경중재치료의학회

SKEN-KSIN

합동춘계학술대회

Session I. Acute Ischemic Stroke Case I

좌장 : 가톨릭의대 **김성림**, 연세의대 **김병문**

Mechanical thrombectomy with microcatheters for distal occlusion	충남의대 **권현조**
The early anticoagulant management of early repeated acute ischemic stroke	순천향의대 **오재상**
Removal of detached retrievable stent by using retrievable stent: Case report	광주기독병원 **문종현**
Successful stent-in-stent rescue for in-stent re-occlusion after revascularization with stent for acute stroke: A case report	가톨릭의대 **김상욱**
Posterior-to-anterior circulation access for mechanical thrombectomy of distal ICA occlusion	가톨릭의대 **이동훈**
A case of basilar artery occlusion accompanied with vertebral artery orifice stenosis	울산의대 **박성철**

1. Mechanical thrombectomy with microcatheters for distal occlusion

권현조, 정혜화, 유정부, 임정욱, 고현송

충남대학교병원 신경외과

Objective : Mechanical thrombectomy for large-vessel occlusion is being practiced mainly with stent-retriever or suction catheter. One of the merits of suction catheter is that we can try suction thrombectomy without passing the device through the thrombus and it is more useful for distal small vessel occlusion. However, the use of suction catheter devices is limited to proximal segment of cerebral vessel currently and covered up to MCA M2 segment and not for ACA and PCA by public health insurance in this country. We will present our experience of suction thrombectomy using microcatheters for various distal embolic occlusions.

Methods : Case 1. An 81-year-old female arrived at ER with drowsy mentality with left side weakness. She has had atrial fibrillation and been medicated with aspirin by a cardiologist. The initial NIHSS score was 8. MRA revealed concurrent right MCA, M1 and ACA, A3 occlusion. Despite the administration of i.v. tPA, no neurologic improvement was shown and thrombectomy was carried out. Initially 5MAX suction catheter was used 2 times successfully to remove the thrombi at right M1 and recanalized the MCA. Considering the small diameter of A3, we delivered Excelsior XT-27 microcatheter to ACA occlusion site and tried suction using 50cc syringe first. After withdrawal of microcatheter, a tiny embolus was found to be attached at the tip of catheter and completely recanalized ACA was confirmed by following angiogram. The NIHSS score at discharge was 3.

Result : Case 2. A 56-year-old male was admitted to retreat aneurysm with coil compaction at left MCA bifurcation. He had a history of IgA nephropathy, CKD stage II. Under general anesthesia, coil embolization for recurred sac was performed successfully. However, after removing the microcatheter for coil insertion, occlusion of two separate branches of distal MCA was found on angiogram. Excelsior XT-27 and Prowler select Plus microcatheters were positioned at each of occlusion site and thrombectomy were performed successfully with manual 50cc syringe suction. No neurological deficit was noted after awakening of the patient.

Conclusion : Suction thrombectomy using microcatheter can be a feasible option for acute distal occlusion.

2. The early anticoagulant management of early repeated acute ischemic stroke

Jae-Sang Oh, Jae-Min Ahn, Jae-Sung Han, Seok-Mann Yoon

Department of Neurosurgery, Soonchunhyang University Cheonan Hospital

Objective : The 2018 updated guideline of early management of patients with acute ischemic stroke was presented on the American Heart Association/American Stroke Association. They recommend that urgent anticoagulation with the goal of preventing early recurrent stroke is not recommended. But the timing of antiplatelet or anticoagulant seems to be under the debate.

Methods : Seventy-three years old female was admitted for left hemiparesis (NIHSS 13). Multiphase dynamic angio-CT showed the acute middle cerebral artery occlusion. She had atrial fibrillation, rheumatic mitral valve stenosis, so that she had the warfarin with INR 1.5~2.9. During recent 3 years, she was already treated with mechanical thrombectomy on two times in our hospital. Fortunately, she had no neurological sequale after repeated stroke. And in that time, occluded MCA was successfully recanalized with TICI 3 in one-time retrieval. However, left hemiparesis was suddenly occurred again after 14 hours. Follow up angiography showed the right internal carotid occlusion, and repeated IA thrombectomy resulted in TICI 3 with several times retrieval. After second thrombectomy, IV heparination was started and then warfarin 3mg was started after 2 days. Her NIHSS was 2 on discharge.

Result : After second thrombectomy, IV heparination was started and then warfarin 3mg was started after 2 days. Her NIHSS was 2 on discharge. And then the target INR of warfarin was set above on 2.5 -4. During one month, there was no additional relapsed ischemic stroke and no neurological deficit.

Conclusion : Atrial fibrillation is a high risk factor for ischemic stroke in a patient with rheumatic heart valve disease. If the risk of hemorrhagic transformation or intracerebral hemorrhage development was low after thrombectomy, early anticoagulant may be recommended.

3. Removal of detached retrievable stent by using retrievable stent: Case report

Jong Hyeon Mun

Department of Neurosurgery, Gwangju Christian Hospital

The introduction of retrievable stent for the treatment of ischemic stroke was an innovation. Recently, it has been reported that patients' time windows have been expanded, and the use of the instrument has improved patients' prognosis. However, the biggest drawback of detachable stent is unwanted detachment which has repeatedly been reported. This can also result in poor prognosis of patients. Ways that can rescue unwanted detachment has been suggested in forms of case reports, and if the method succeeds, the fibrinolytic/antiplatelet agents that need to be administered will be able to be reduced. Positive effects on patients' prognosis are also expected as well. An experience with unwanted detachment of retrieval stent that caused a secondary attack, which has been removed using retrieval stent, will now be introduced.

4. Successful stent-in-stent rescue for in-stent re-occlusion after revascularization with stent for acute stroke: A case report

Sang-Uk Kim[1], Hyun-Jeong Kim[2], Ji-Ho Yang[1], Il-Woo Lee[1], Hyung-Jin Lee[1]

Department of Neurosurgery[1], Department of Radiology[2], Daejeon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Daejeon, Republic of Korea

Objective : The intracranial stent cause occasionally re-occlusion in the stent. We report a case treated using stenting with solitaire FR as rescue treatment for acute ischemic stroke.

Methods : A 48-year-old man underwent mechanical thrombectomy and intracranial stent due to acute occlusion of the right middle cerebral artery (MCA) at the previous hospital 8 days ago. The patient came to our hospital with left side weakness (Gr IV) and mild dysarthria. During 1 week of dual antiplatelet therapy, he suddenly was deteriorated neurologic symptom from initial NIHSS 3 to 9. Follow-up MRI showed re-occlusion of the right MCA in-stent and we attempted thrombolysis again after onset 4 hours.

Result : Failed to reperfusion after direct aspiration and tirofiban IA injection, and the stent-in-stent rescue using solitaire FR was performed successfully and angiographic result was completely recanalized with Thrombolysis in Cerebral Infarction (TICI) scale 3. The patient's neurologic symptoms were also completely recovered.

Conclusion : Stenting in stent could be an option of the treatment after failure of other revascularizations for acute ischemic stroke due to in-stent re-occlusion.

5. Posterior-to-anterior circulation access for mechanical thrombectomy of distal ICA occlusion

Dong Hoon Lee, Jae Hoon Sung, Ho Jun Yi, Min Hyung Lee

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

Case Description A 77-year-old right-handed man presented to the emergency department with acute onset of aphasia, right-sided hemiplegia, and marked left-sided gaze preference, with a NIHSS score of 15. CTA revealed complete occlusion of the left cervical ICA. Volume perfusion CT demonstrated a perfusion defect in the right ICA territory. Diffusion-weighted imaging showed an area of restricted diffusion in the left parietal deep white matter. A cerebral angiography of the both common carotid artery revealed complete occlusion of the both ICA at its origin. The right vertebral artery injection showed filling of the supraclinoid segment of the left ICA via the left Pcom A. There was abrupt cutoff of the distal ICA. We decided to perform a stent-retriever thrombectomy for the ICA occlusion through the patent PComA. A 4 × 20 mm Trevo XP stent was then introduced through the microcatheter and fully deployed across the occluded left ICA. After retrieval, angiography showed partial recannalization of Lt ACA & MCA. Then the catheter was then advanced into the proximal M1 segment. A total of 0.5 mg of tirofiban was administered into the thrombus. Repeated arteriogram showed the contrast leakage. 5 minutes delayed angiography show no further contrast leakage. A noncontrast CT of the head and CTA were performed 24 hours later demonstrating left frontal lobe and left anterior aspect of putamen infarction with contrast leakage at left anterior medial aspect of temporal lobe and interpeduncular cistern. But CTA showed complete recanalization of the left MCA. At the time of 1 month after stroke, the patient's modified Rankin score was 3.

6. A case of basilar artery occlusion accompanied with vertebral artery orifice stenosis

Seong-Cheol Park, Su Hee Cho, Seung-Hoon You

Department of Neurosurgery, Gangneung Asan Hospital, University of Ulsan College of Medicine, Gangneung, Korea

Introduction : A Basilar artery thrombectomy case with basilar artery occlusion and vertebral artery orifice stenosis is reported.

Methods : Ninety years old female presented with acute loss of consciousness. The patient had DM, HTN and atrial fibrillation. The loss of consciousness suddenly occurred at 6:30 AM. The patient had GCS E1M1V1 at ER. MRI showed small left cerebellar infarctions and non-visualization of vertebrobasilar artery. Acute thrombectomy was performed at 10:25 AM. Vertebral artery flow was compromised at left SCA angiogram due to left vertebral artery orifice stenosis, and then delineated only to left V3 segment. Thrombectomy using Trevo Stentriever and CAT6 intermediate aspiration catheter was performed after selecting left PCA. After thrombectomy, vertebrobasilar artery and both PCA flow was fully recovered. However, vertebral flow decreased and nearly stopped when left subclavian angiography which was performed immediately after thrombectomy. Emergent Stent-angioplasty was performed for left VAO stenosis with Express SD stent (A peripheral stent).

Result : After angioplasty, left vertebrobasilar and both PCA flow was maintained without flow compromise. Three hours after the procedure, the consciousness recovered and the patient had left side motor grade II. At the next day, left side weakness recovered to grade III-IV.

Conclusion : Emergent Angioplasty should be considered in case of flow compromising stenosis remained after acute thrombectomy.

제2회 대한뇌혈관내수술학회 I 대한신경중재치료의학회

SKEN-KSIN

합동춘계학술대회

Session II. Patient Selection & Guideline Update for EVT of Acute Ischemic Stroke

좌장 : 순천향의대 **김범태**, 성균관의대 **전 평**

Clinical-based patients selection	인제의대 **홍근식**
Image-based patients selection	서울의대 **손철호**
New guidelines for AIS treatment	아주의대 **이진수**

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논문발표: 182 articles (2018–03–03)

42 articles as a first or corresponding author in international journals

89 articles as a co–author in international journals

51 articles as a first, corresponding, or coauthor in domestic journals

Clinical-based patients selection

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Clinical-Based Patients Selection for ERT: Extended Time Window

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On Behalf of CRCS-5 Investigators

Disclosure

- Nothing to disclose related to this topic

Topics

- Clinical-Diffusion mismatch
  - History and Studies' findings
- Impact of extended time window ERT on clinical practice

Salvageable tissue

- Perfusion – Diffusion mismatch
  - Theoretical salvageable tissue
  - PWI: complex, time-consuming, less available, less well standardized
- Severe clinical deficit – small diffusion lesion
  - Severe clinical deficit as profound perfusion deficit in hyperacute stage
    - NIHSS score better correlated with perfusion lesion than diffusion lesion
    - Clinical deficit as an alternative to perfusion lesion
  - Small diffusion lesion as small infarct core

NIHSS score vs. Perfusion MRI

- DWI/PWI within 6.5 h – 24 h NIHSS score

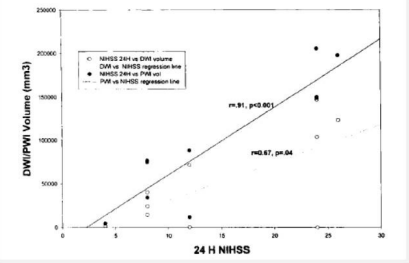


Table Initial L

Patient	NIHSS (initial)	NIHSS (24-hour)
LN	24	24
HR	14	12
FT	4	4
JB	8	8
ED	26	26
EW	8	8
MH	17	12
WB	8	8
PR	24	24
EE	22	24
Total/mean*	15.5	15

* Times are lis

Tong D et al., Neurology 1998;50:864-870

The clinical–DWI mismatch

A new diagnostic approach to the brain tissue at risk of infarction

A. Dávalos, MD, PhD; M. Blanco, MD, PhD; S. Pedraza, MD; R. Leira, MD, PhD; M. Castellanos, MD; J.M. Pumar, MD, PhD; Y. Silva, MD; J. Serena, MD, PhD; and J. Castillo, MD, PhD

Abstract—*Objective:* To evaluate the usefulness of a mismatch between the severity of acute clinical manifestations and the diffusion-weighted imaging (DWI) lesion in predicting early stroke outcome and infarct volume. *Methods:* One hundred sixty-six patients with a hemispheric ischemic stroke of <12 hours' duration were studied. The NIH Stroke Scale (NIHSS) score and the volume of DWI lesion were measured on admission and at 72 ± 12 hours. Infarct volume was measured on T2-weighted or fluid-attenuated inversion recovery images at day 30. Early neurologic deterioration (END) was defined as an increase of ≥4 points between the two NIHSS evaluations. Thirty-eight patients received IV thrombolysis or abciximab. Clinical–DWI mismatch (CDM) was defined as NIHSS score of ≥8 and ischemic volume on DWI of ≤25 mL on admission. The adjusted influence of CDM on END, DWI lesion enlargement at 72 hours, and infarct growth at day 30 was evaluated by logistic regression analysis and generalized linear models. *Results:* CDM was found in 87 patients (52.4%). Patients with CDM had a higher risk of END than patients without CDM because NIHSS < 8 (odds ratio [OR], 9.0; 95% CI,1.9 to 42) or DWI lesion > 25 mL (OR, 2.0; 95% CI, 0.8 to 4.9). CDM was associated with an increase of 46 to 68 mL in the mean volume of DWI lesion enlargement and infarct growth in comparison with non-CDM. All the effects were even greater and significant in patients not treated with reperfusion therapies. *Conclusions:* Acute stroke patients with an NIHSS score of ≥8 and DWI volume of ≤25 mL have a higher probability of infarct growth and early neurologic deterioration. The new concept of CDM may identify patients with tissue at risk of infarction for thrombolytic or neuroprotective drugs.

NEUROLOGY 2004;62:2187–2192

Clinical–DWI mismatch (CDM)

- Early working definition
  - NIHSS score of ≥8
    - Cortical perfusion deficit + less spontaneous recovery
  - DWI lesion ≤25 mL
    - Data exploration: threshold for NIHSS score of 8
- Infarct growth on FU MRI without reperfusion therapy
  - CDM >> no CDM: salvageable tissue into infarct?

Davalos A. et al., Neurology 2004;62:2187

Clinical–DWI mismatch (CDM)

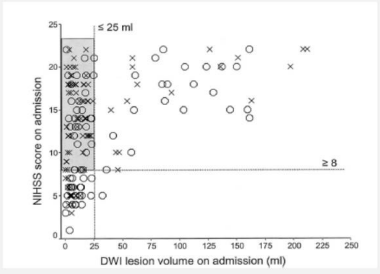


Figure 1. Scatterplot showing the correlation between the NIH Stroke Scale (NIHSS) score and the diffusion-weighted imaging (DWI) lesion volume on admission in the left (X's) and right (O's) hemispheric infarctions. The shaded area corresponds to patients with clinical–DWI mismatch according to the definition of the current study.
Note that almost all patients with an NIHSS score of <8 had DWI lesion volumes of >25 mL.

Davalos A. et al., Neurology 2004;62:2187

Clinical–DWI mismatch (CDM)

- Group A: CDM
- Group B: no CDM d/t DWI >25 mL
- Group C: no CDM d/t NIHSS <8

Table 2 Adjusted odds ratios (95% CI) of END for CDM on admission

CDM group	Total series, n = 166	*p* Value	Patients without reperfusion therapies, n = 128	*p* Value
Group A vs C	9.0 (1.9, 42)	0.005	22 (2.6, 183)	0.004
Group A vs B	2.0 (0.8, 4.9)	0.109	2.9 (1.1, 7.3)	0.028

All models were adjusted for time interval from symptom onset to baseline MRI, body temperature, and serum glucose on admission. See the text for group definitions.

END = early neurologic deterioration; CDM = clinical–diffusion-weighted imaging mismatch.

Davalos A. et al., Neurology 2004;62:2187

Clinical–DWI mismatch (CDM)

- Group A: CDM
- Group B: no CDM d/t DWI >25 mL
- Group C: no CDM d/t NIHSS <8

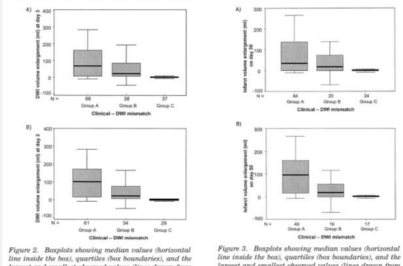


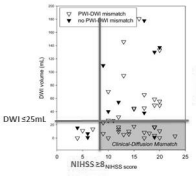
Figure 2. Boxplots showing median values (horizontal line inside the box), quartiles (box boundaries), and the largest and smallest observed values (lines drawn from the end of the box). Diffusion-weighted imaging (DWI) lesion volume enlargement between day 0 and 3 in patients with clinical–DWI mismatch (Group A) and in patients without because DWI > 25 mL (Group B) or NIH Stroke Scale score < 8 on admission (Group C) in the total series (A) ($p < 0.001$) and in patients who did not receive reperfusion therapies (B) ($p < 0.001$).

Figure 3. Boxplots showing median values (horizontal line inside the box), quartiles (box boundaries), and the largest and smallest observed values (lines drawn from the end of the box). Infarct volume enlargement between diffusion-weighted imaging (DWI) on day 0 and T2-weighted or fluid-attenuated inversion recovery imaging on day 30 in patients with clinical–DWI mismatch (Group A) and in patients without because DWI > 25 mL (Group B) or NIH Stroke Scale score < 8 on admission (Group C) in the total series (A) ($p < 0.001$) and in patients who did not receive reperfusion therapies (B) ($p < 0.001$).

Davalos A. et al., Neurology 2004;62:2187

Clinical-Diffusion Mismatch (CDM)

- 79 hemispheric AISs within 24 hours
- CDM vs. PDM (as a gold standard for penumbra)
  - High specificity & PPV, but low sensitivity



Sensitivity and Specificity Analysis for CDM as a Test for PWI (Tmax>4 sec)-DWI Mismatch

Time Window	All Patients (n=79)	0–6 Hours (n=54)
Sensitivity (95% CI)	55% (40%–69%)	53% (36%–68%)
Specificity (95%CI)	79% (59%–92%)	93% (66%–100%)
PPV (95%CI)	82% (65%–93%)	95% (77%–100%)
NPV (95%CI)	49% (34%–64%)	41% (24%–59%)
Correctly classified	63%	63%
Area under ROC curve (95%CI)	0.67 (0.56–0.77)	0.73 (0.62–0.83)

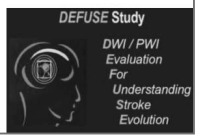
GYEONGSANG NATIONAL UNIVERSITY CHANGWON HOSPITAL Courtesy by 정승욱 Prosser J et al. *Stroke*. 2005;36:1700-1704

DEFUSE

12/81

- Single arm trial to identify MRI patterns that predict the clinical response to early reperfusion
  - PWI/DWI mismatch
  - MRA early recannalization
- 3-6 h window (n=74)
- DEFUSE history
  - DEFUSE: late window IV-TPA
  - DEFUSE 2: ERT single arm
  - DEFUSE 3: RCT for late window ERT

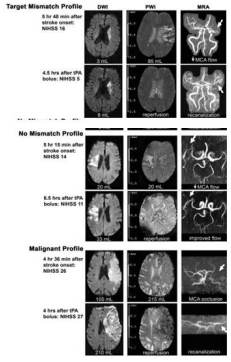
Albers et al., Ann Neurol 2006



DEFUSE

13/102

- Large mismatch + Early reperfusion
  - Favorable clinical response
- Large mismatch + No early reperfusion or No mismatch
  - Less favorable clinical response
- Malignant DWI lesion + Early reperfusion
  - High risk for ICH



Albers et al., Ann Neurol 2006

DEFUSE data exploration

- Clinical-Diffusion Mismatch (CDM)
  - DWI volume <25ml + NIHSS ≥8
  - High probability of infarct growth by Davalos et al (Neurology 2004)
- Validation of CDM model with DEFUSE dataset
  - Correlation with Perfusion-Diffusion Mismatch (PDM) model
  - Prediction of clinical response

Lansberg et al., Stroke 2007

CDM correlation with PDM

	CDM		
PDM	Present	Absent	Total
Present	24	13	37
Absent	18	13	31
Total	42	26	68

- No significant agreement between the two models (kappa 0.07)
- CDM model validation with the PDM model as a gold standard
  - Sensitivity 65% (95% CI, 49% to 78%)
  - Specificity 42% (95% CI, 26% to 59%)
  - Positive predictive value 57% (95% CI, 42% to 70%)
  - Negative predictive value 50% (95% CI, 32% to 68%)

Lansberg et al., Stroke 2007

Prediction of clinical response with early reperfusion

- Prediction of clinical outcome
  - ORs for favorable outcome in mismatch patients with reperfusion compared to those without reperfusion

Mismatch	OR unadjusted	OR adjusted (NIHSS, PWI)	Mismatch %
Predetermined			
PDM: PWI/DWI ratio >1.2‡	5.4 (1.1–25.8)	7.7 (1.3–44.8)	54
CDM	2.2 (0.6–7.8)	2.2 (0.6–8.2)	62
Retrospective			
PDM-R	70 (3.7–1318)		30
CDM-R	5.1 (1.0-25.6)		49

▪PDM: PWI at least 10 mL and 20% larger than the DWI lesion volume
▪CDM: DWI <25 mL and NIHSSS ≥8
▪PDM-R: PWI 10 mL larger than the DWI lesion volume and DWI lesion volume <15 mL
▪CDM-R: DWI <15 mL and NIHSSS ≥8

PDM vs. CDM model in DEFUSE

- PDM model, more accurate than CDM model to select patients with salvageable tissue for reperfusion therapy in the 3-6h window.
- New CDM criteria (DWI <15 mL and NIHSSS ≥ 8) might be useful, but need to be validated in separate independent datasets.

Lansberg et al., Stroke 2007

NIHSS score of 10

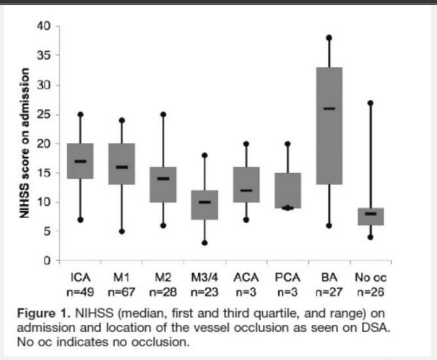
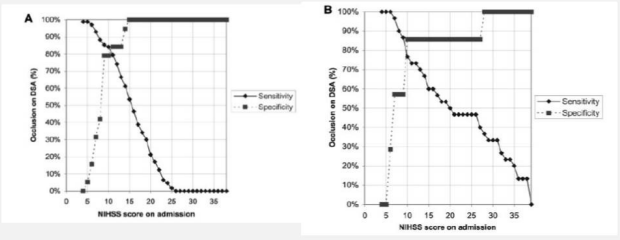


Figure 1. NIHSS (median, first and third quartile, and range) on admission and location of the vessel occlusion as seen on DSA. No oc indicates no occlusion.

Fischer U et al., Stroke 2005;36:2121-2125

NIHSS score of 10

- NIHSS scores 10 had positive predictive values (PPVs) to show arterial occlusions in 97% of carotid (<6 h) and 96% of vertebrobasilar strokes (<12 h)



- A: Anterior circulation: Sensitivity and specificity of NIHSS score on admission to find an occlusion on DSA (19 of 189 patients with no occlusion)
- B: Posterior circulation: Sensitivity and specificity of NIHSS score on admission to find an occlusion on DSA (7 of 37 patients with no occlusion)

Fischer U et al., Stroke 2005;36:2121-2125

IMS III

- NIHSS score inclusion criteria
  - Inception: CTA not widely available in ER
    - NIHSS score ≥10
  - Modification:
    - NIHSS score ≥10 or NIHSS score 8 or 9 with an occlusion in CTA

DAWN™ Study

DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention

A multi-center, phase II/III, prospective, randomized, open-label, blinded outcome (PROBE) trial

Patient	AIS Subjects with the **followings inclusion criteria**
Intervention	**Trevo thrombectomy** plus medical management
Comparison	**Medical management alone**
Outcome	Average weighted mRS score / proportion of good functional outcome at 90 days

Inclusion criteria	1. Clinical signs and symptoms consistent with the diagnosis of an acute ischemic stroke (IV-TPA contraindicated or no-response to IV-TPA) 2. Age ≥ 18 3. Baseline **NIHSS ≥ 10** (assessed within 1 hour prior to measuring core infarct volume) 4. Can be randomized between **6 to 24 hours** after **time last known well** 5. Pre-stroke mRS must be 0 or 1
Imaging inclusion criteria	1. **<1/3 MCA territory** involved, as evidence by CT or MRI 2. Occlusion of the **intracranial ICA** and/or **MCA-M1**, as evidence by MRA or CTA 3. **Clinical imaging mismatch** defined as one of the following on RAPID **MR-DWI or CTP-rCBF maps**: a. 0-20 cc core infarct and NIHSS ≥ 10 (and age ≥ **80 years old**) b. 0-30 cc core infarct and NIHSS ≥ 10 (and age < **80 years old**) c. 31-50 cc core infarct and NIHSS ≥20 (and age < **80 years old**)

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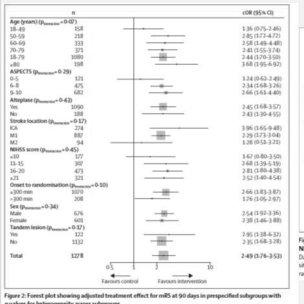
Clinical-Core Mismatch (CCM) in DAWN

- Infarct core (DWI or perfusion CT)
  - For accurate assessment: RAPID program
    - Validated by DEFUSE 2, SWIFT PRIME datasets
- NIHSS score rather than PWI
  - PWI, not sufficiently validated in extended time window
  - PWI, prone to artifact
  - PWI, a snapshot in time of a dynamic process
    - NIHSS score: real time measure
  - CCM as good as PDM for predicting favorable response to ERT
    - SWIFT PRIME data exploration (abstract 2017)

Age factor

- HERMES dataset



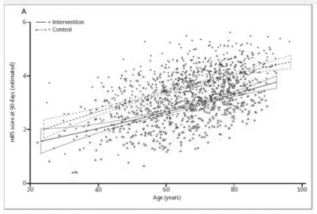


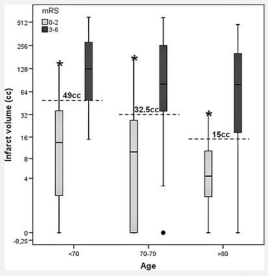
Figure 3: mRS score at 90 days estimated with a mixed methods linear regression versus age (A) and baseline NIHSS (B)
Data are stratified by intervention versus control. Models adjust for covariates (age, sex, baseline stroke severity, site of occlusion, intravenous alteplase [yes vs no], Alberta Stroke Program Early CT Score, and time from onset to randomisation). mRS=modified Rankin Scale. NIHSS=National Institutes of Health Stroke Scale.

Figure 2: Forest plot showing adjusted treatment effect for mRS at 90 days in prespecified subgroups with p values for heterogeneity across subgroups

Goyal M et al., Lancet 2016; 387: 1723–31

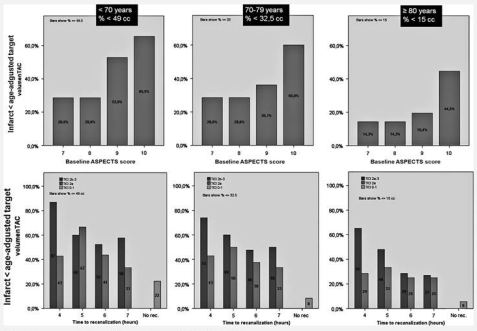
Age-adjusted target infarct volume

- ICA or M1 occlusion with ERT <8 h (n=214)
- Infarct volume on 24-36 h FU CT
- Volume less than age-adjusted target volume for good outcome: adjusted OR 5.5 (1.6-18.8); p<0.01
  - Adjusted for age, occlusion site, baseline NIHSS, infarct volume



Ribo M et al., J Neurointerv Surg. 2014 Jul;6(6):418-22

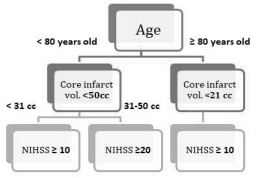
Percentage of patients achieving an infarct volume less than the age-adjusted target according to the Alberta Stroke Program Early CT score (ASPECTS) on initial CT and time/degree of recanalization.



Marc Ribo et al. J Neurointervent Surg 2014;6:418-422

JNIS

Definition of clinical imaging mismatch in DAWN



- Large treatment effects were noted both for M1 occlusions and M2 occlusions in the **NIHSS 11-20** strata, compared with NIHSS 4-10 (from PROACT II)
- A patient with **NIHSS of ≥ 20** were **defined as severe stroke in IMS III trial** (*NEJM* 2013;368:893)

- Although age was associated with poorer outcomes after thrombolysis, the efficacy of thrombolysis was maintained in the very elderly subjects.
- In order to **mitigate the potential risks associated with endovascular treatment in the elderly** as well as to **maximize the chance of a good outcome**, the **core infarct volume** will be restricted to **< 21cc**.

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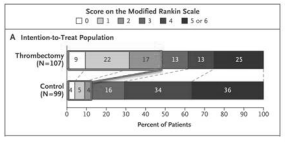
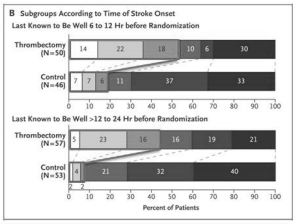
Distribution of Scores on the mRS at 90 days from DAWN trial





- The imaging-based approaches of "DAWN" for the selection of patients who are likely to benefit from thrombectomy that is performed far longer after the onset of stroke than current guidelines suggest, **at least** among patients who have ***severe stroke (NIHSS≥10)***, ***vascular occlusion*** and ***penumbral tissue (small core volume and clinical-DWI mismatch)***.

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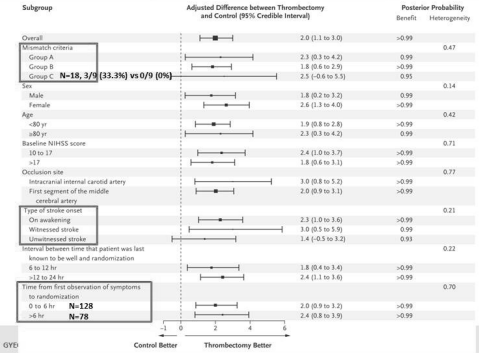
Subgroup Analyses of the First Primary End Point in DAWN trial



Keeping in mind

- Typical patient in both DAWN & DEFUSE 3
  - NIHSS scores of 16 to 18 and a very small core size of about 10 mL (despite of broader criteria)
- RAPID software
  - Other software: not validated
- Selection
  - Severe stroke
  - Large artery occlusion
  - Small core (semiquantitative measure)
  - Individual center protocol?

Experts are saying…

- Powers
  - We instituted a DAWN protocol at our institution without using the RAPID software. It's a little bit clutzy — it takes some operator interaction, and it's probably not quite as fast, but we do use CT perfusion imaging and plot out the volume of the perfusion deficit. It is possible to do."
- Saver
  - He stressed that each individual institution will have to decide the right approach for them. "RAPID is a good software to analyze the results but others can be used too, and we will undoubtedly see new software programs developed. But it is the biology that has been established by these trials that is foremost.

Extracted from the article in Medscape Neurology

CT perfusion without RAPID

- "We still use CT perfusion, and we interpret the results ourselves," he said. "It doesn't give us an exact computer readout but you need to estimate the core size, and anyone treating patients and doing CT perfusion regularly can tell the difference between a 20-mL and 80-mL core. And if I have a relatively young patient with a bad stroke, unless I see something terrible I'm probably going to intervene anyway up to 24 hours as there is good chance that it will be of some benefit.“
- Saver stressed that each individual institution will have to decide the right approach for them.

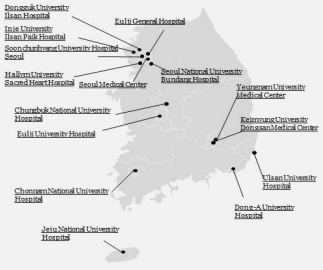
Impact of extended time window ERT

- Jeffrey Saver (UCLA, USA)
  - 10% of stroke patients are eligible to receive thrombectomy within 6 hours, and with the new extension out to 24 hours this could increase to about 15%.
  - However, these patients account for about one third to half of the burden of stroke disability as these are the patients having very large disabling strokes.

Extracted from the article in Medscape Neurology

CRCS-K registry

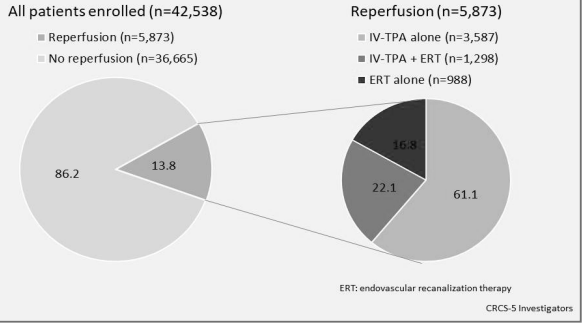
- Clinical Research Center for Stroke – 5th division since 2008
  - 17 centers, currently (9 centers in 2008)
  - Acute ischemic stroke within 7 days: more than 60,000 patients (DEC 2017)



CRCS-5 Investigators

Reperfusion therapy: CRCS-5 registry

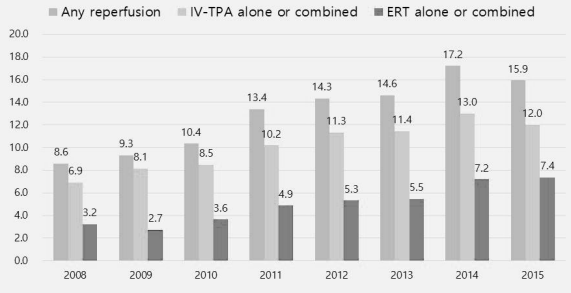
APR 2008 - SEP 2015



CRCS-5 Investigators

Reperfusion therapy by year

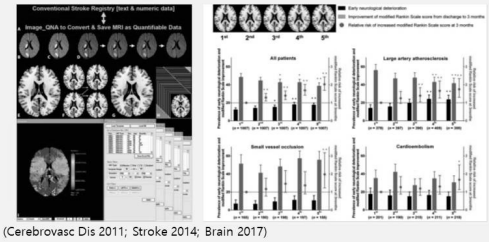
- 5,873 patients received reperfusion therapy
  - APR 2008- SEP 2015 (CRCS-5 registry)



CRCS-5 Investigators

DAWN eligibility estimation

- CRCS-K registry data
  - DAWN eligibility including DWI volume measurement
- Age- & sex-specific incidence data in Korea



(Cerebrovasc Dis 2011; Stroke 2014; Brain 2017)

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DAWN eligibility estimation

Criteria	N
All stroke patients admitted to 11 centers of CRCS-K registry (May 2011 - Dec 2012)	9452
Ischemic stroke or transient ischemic attack	9325
Available lesion volume on diffusion-weighted image MRI	6745
Age ≥ 18 (final subjects)	6742

Criteria	N	Percent (%)
Acute ischemic stroke patients (age ≥ 18)	6742	100
Last time known to be well to hospital arrival 6 to 24 hours	2145	31.8
pre-stroke mRS 0 or 1	1826	27.1
Intracranial ICA or MCA occlusion	282	4.2
Clinical deficit - infarct volume mismatch		
Group A (Age ≥ 80, NIHSS ≥ 10, infarct volume < 21mL)	13	0.2
Group B (Age < 80, NIHSS ≥ 10, infarct volume < 31mL)	60	0.9
Group C (Age < 80, NIHSS ≥ 20, infarct volume ≥ 31mL & < 51mL)	4	0.06
Final eligible patients	77	**1.1**

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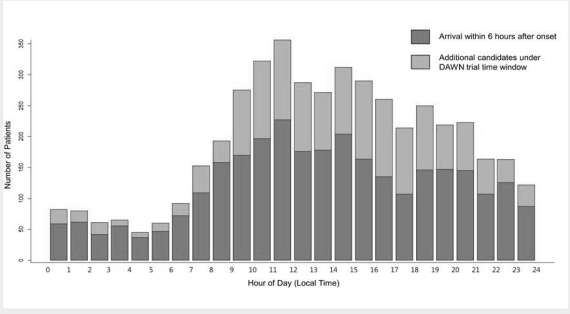
Number and proportion of patients who needs to be additionally screened (CRCS-K)



43.9% → 67.6% : should screen **additional 23.7%**

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Nationwide estimation for the number of patients meeting the eligibility criteria of DAWN trial (Korea)

Annually **1,331** patients in **Korea** and **5,371** in **US** met the criteria of DAWN trial

Age group	N of patients (CRCS-K)	N of patients who meets DAWN eligibility (CRCS-K)	Proportion (%)	Ischemic stroke incidence† (South Korea, per 100,000)	Total population N* (South Korea, 2016)	N of ischemic stroke patients (South Korea)	N of patients who meets DAWN eligibility (South Korea)
Male							
0-44	226	4	1.8	8	14752944	1180	21
45-54	579	6	1.0	120	4456893	5348	55
55-64	929	11	1.2	352	3660973	12887	153
65-74	1242	10	0.8	1,019	1879075	19148	154
75-84	845	6	0.7	1,902	919998	17498	124
≥85	142	1	0.7	2,318	157711	3656	26
Subtotal	3963	38	1.0	5719	25827594	59717	533
Female							
0-44	92	2	2.2	4	13799073	552	12
45-54	178	2	1.1	45	4310309	1940	22
55-64	342	4	1.2	211	3720372	7850	92
65-74	881	11	1.2	721	2139499	15426	193
75-84	993	17	1.7	1,563	1447022	22617	387
≥85	293	3	1.0	1,996	452347	9029	92
Subtotal	2779	39	1.4	4540	25868622	57413	798
Total	6742	77	1.1	10259	51696216	117130	1331

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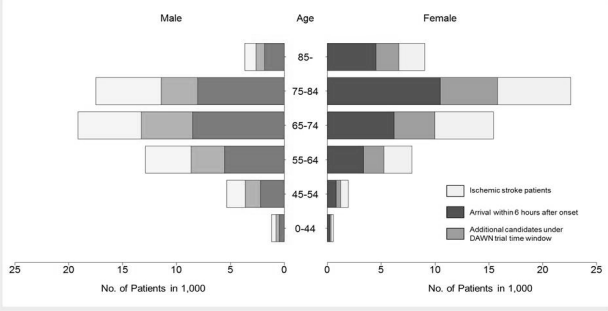
Nationwide estimation of the candidates of EVT who needs to be additionally screened (Korea)



Annually 52,195 → 79,672 : additional **27,477**

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Summary

◈ About 1,300 patients in Korea and 5,400 patients in US could benefit from EVT due to the extended time window annually

◈ However, annual number of 27,500 patients in Korea and 106,800 in US should be additionally screened.

➔ **More than 20 times !!**

More resources are needed
- **Staffs**: trained vascular neurologists
- **Stuffs**: equipment (brain MRI etc.)
- **System:** critical pathway for acute stroke patients

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Discussion: much LARGER number expected!

◈ 40% of the patients in the DEFUSE 3 trial have not met the DAWN selection criteria

→ Can expect much larger population would be able to undergo EVT if we apply the DEFUSE 3 criteria in addition to the DAWN criteria

◈ After the publication of pivotal trials for EVT the number of endovascular thrombectomy performed in US has doubled (Smith EE et al. Circulation. 2017)

→ Publications of DAWN and DEFUSE 3 trial themselves could enhance the EVT performance

◈ Hemorrhagic strokes or stroke-mimics are not considered

→ The candidate population needed to be screened might be much larger.

◈ There has been no effort to speed up from arrival to DWI in patients arriving in the DAWN time window.

→ Delay in taking DWI might lead to increase of the infarct volume and eventually underestimation of the eligible population in this study

Lee KJ et al Submitted

Thanks

- For providing invaluable slides
  - 분당서울대병원 신경과 김범준
  - 경상의대 창원병원 신경과 정승욱
  - 성균관의대 신경과 서우근
  - 동국의대 일산병원 신경과 류위선

Thank you for your attention!

Welcome to ICSU 2018 + the 1st Australian-Korean Joint Stroke Congress

Walkerhill Hotel in Seoul: 2018.09.13. (THUR) - 2018.09.15. (SAT)

REVITALIZE YOUR LIFE AND RESEARCH!

손 철 호 서울대병원 영상의학과

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1998–2002	계명대학교 동산의료원 영상의학과 부교수
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2008–2015	서울대학교병원 영상의학과 교수

▶ 학회활동

대한영상의학회
대한뇌졸중학회
American Society of Neuroradiology,
ISMRM

Image-based Patients Selection for EVT of Acute Ischemic Stroke

손 철 호
서울대병원 영상의학과

Imaging-based identification of eligible patients for reperfusion therapy will not only reduce treatment-related complications but also result in treatment of a larger population of patients over an extended time window than the current time-based approaches.

A neuroimaging modality best selects patients for an acute ischemic stroke trial by optimizing accuracy, reliability, efficiency, and safety, and should be tailored to the investigational intervention. Neuroimaging strategies have evolved in conjunction with clinical trials and the growing sophistication of neurovascular interventions. In the early 1990s, when the first landmark clinical trials evaluated the safety of intravenous thrombolytic therapy, noncontrast computed tomography (CT) was the optimal imaging strategy. It fulfilled its two roles efficiently: To exclude intracranial hemorrhage, and to identify any evidence of large infarcts occupying ≥1/3 of the middle cerebral artery (MCA) territory. Over the following decades, the stroke community understood the benefits of imaging the arterial occlusive lesion, ischemic core, penumbra, and collaterals in patient selection for endovascular therapy. Multimodal CT- and MRI-based techniques that provided angiographic imaging and demonstration of salvageable ischemic brain tissue have become the preferred strategies for many clinical endovascular therapy trials, especially for ongoing trials that are attempting to expand the treatment window beyond 6 h from symptom onset. Despite continuing advances in both CT and MRI in stroke imaging, the superiority of one over another remains a subject of debate.

Neuroimaging continues to play a central role in patient selection for acute ischemic stroke trials. Selection of the optimal imaging strategy for each clinical trial is a critical part of the study design and requires careful comparison of advantages and potential limitations of each modality considered. With continuing advances in imaging techniques, the definition of an "optimal" neuroimaging strategy for acute stroke imaging will continue to evolve.

이 진 수 아주대병원 신경과

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2002–present	Member of Korean Neurological Association
2003–present	Member of Korean Dementia Association
2006–present	Member of American Stroke Association
2007–present	Member of Korean Stroke Society
2009–present	Member of Korean Society of Interventional Neuroradiology
2011–present	Assistant editor in Journal of Stroke
2014–present	Member of World Stroke Organization

New guidelines for AIS treatment

이 진 수
아주대병원 신경과

급성뇌경색 환자를 위한 응급 재관류 치료 방법이 점차 확대되고 있다. 2018년 2월 International Stroke Conference에서는 급성뇌경색 치료에 대한 가이드라인이 새로이 발표되었고, 주요뇌동맥폐색으로 인한 뇌경색의 경우 선별된 환자에 한해 증상 발생 후 16시간 혹은 24시간 내에 혈전제거 시술을 시행하는 것이 효과적이고 근거가 충분하다는 내용이 포함되었다.[1] 이는 2017년 5월 European Stroke Organization Conference에서 발표된 DAWN 임상시험과 2018년 2월 International Stroke Conference에서 발표된 DEFUSE 3 임상시험의 결과에 기반한다.[2, 3]

상기 두 임상시험에는 공통점과 차이점이 있다(Table 1). 우선 두 연구 모두 증상 발생 6시간 이후부터 16시간까지 선별된 환자를 대상으로 한다. 차이점은 DAWN 연구는 24시간까지도 포함한다. 또한 경색중심(infarct core)의 부피를 보다 정확하게 계산하여 이를 환자 선별에 이용하는 공통점이 있다. 보다 이른 시간 시술에 대한 기존 연구(early window trial)에서는 경색중심의 부피를 noncontrast CT에서 ASPECTS로 경계가 명확하지는 않은 기준이 주로 사용되었다면,[4-6] 보다 지연된 시간 시술에 대한 이 두 연구(late window trial)에서는 경색중심의 부피를 MRI의 확산강조영상이나 CT perfusion의 Tmax 등으로 경계가 보다 명확한 영상을 이용하여 계측하였다. 다만 이 부피에 대한 기준이 DAWN 연구에서는 DEFUSE 3 연구보다 엄격하였고, 나이와 신경학적 증상의 중증도에 따른 차이를 두었다. 또한 경색중심의 부피가 작아야 하는 점 외에 이에 해당하는 증상의 정도의 차이를 보는 clinical imaging mismatch를 DAWN 연구에서 적용하였고, 허혈반음영(ischemic penumbra) 부피와의 차이를 보는 target mismatch를 DEFUSE 3 연구에서 적용하였다.

두 연구에서는 경색중심 혹은 허혈반음영의 부피를 측정하는데 RAPID 소프트웨어를 사용하였다. 이 소프트웨어는 빠른 프로세싱을 특장점으로 가지고 있지만 경색중심을 계측하는데 대한 ADC map의 threshold나 허혈반음영에 대한 영상 분석 방법에 대해 독특한 방법이 있는 것은 아니다. 따라서 같은 조건을 얼마든지 다른 소프트웨어에서 사용할 수 있는데, 새로운 측정 소프트웨어가 얼마나 정확하고 일정한지에 대한 규명(validation)이 앞으로의 중요한 과제가 될 전망이다.

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Table 1. Comparison of late window trials

	DAWN	DEFUSE 3
Inclusion criteria		
Age	≥ 18	18 – 90
Onset–to–randomization	6 – 24 hours	6 – 16 hours
Baseline NIHSS	≥10	≥6
Premorbid mRS	0 – 1	0 – 2
Imaging criteria		
Measurement of infarct core	DWI or CTP (RAPID, iSchemaView)	DWI or CTP (RAPID, iSchemaView)
Criteria of infarct core	〈21ml: ≥80y, NIHSS ≥10 〈31ml: 〈80y, NIHSS ≥10 〈51ml: 〈80y, NIHSS ≥20	〈70ml
Use of perfusion map	No	Yes
Criteria of ischemic penumbra	No	A ratio ≥1.8 AND an absolute volume ≥15 ml

제2회 대한뇌혈관내수술학회 I 대한신경중재치료의학회

SKEN-KSIN

합동춘계학술대회

Session III. Special Lecture

좌장 : 경희의대 **고준석**

Latest Acute Ischemic Stroke Trial Update – Trevo Registry and Trevo stent retriever Acute Stroke (TRACK) registry

Dr. Osama Zaidat

Mercy Health–St.Vincent Medical Center

Latest Acute Ischemic Stroke Trial Update – Trevo Registry and Trevo stent retriever Acute Stroke (TRACK) registry

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Mercy Health–St.Vincent Medical Center

제2회 대한뇌혈관내수술학회 I 대한신경중재치료의학회

SKEN-KSIN

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Session IV. Review of Devices for EVT of AIS

좌장 : 가톨릭의대 **성재훈**, 부산의대 **백승국**

Penumbra®	전북의대 **곽효성**
Solitaire FR®	울산의대 **권순찬**
Trevo®	Mercy Health–St.Vincent Medical Center **Dr. Osama Zaidat**
Revive SE®	한림의대 **박정현**
Eric®	동국의대 **김병철**
Intermediate catheters	경북의대 **강동훈**

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Penumbra®

곽 효 성

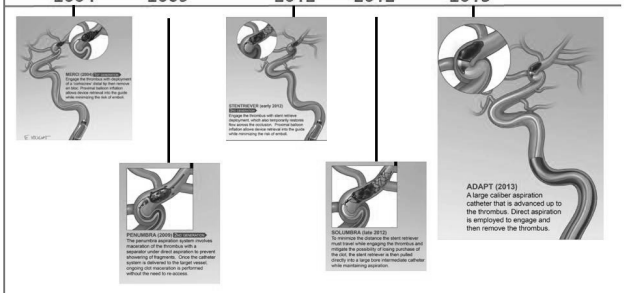
전북대병원 영상의학과

Penumbra

전북의대
곽효성

Evolution of thrombectomy technology

2004 2009 2012 2012 2013



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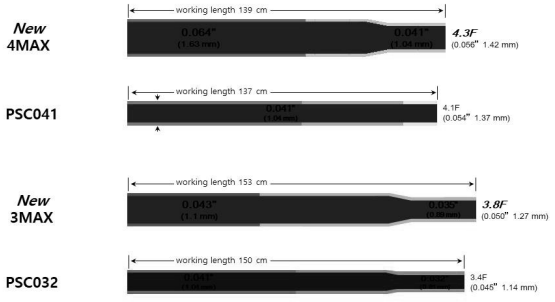
2

4MAX vs PSC041 and 3MAX vs PSC032



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first generation devices:
Clot Fragmentation

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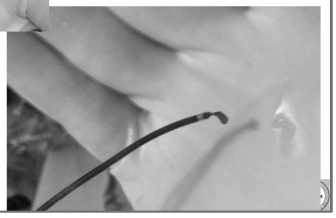
Penumbra + Stent Retriever

No clot on stent retriever on retrieval

Clot at end of Penumbra Catheter



ORIGINAL RESEARCH

Direct Thrombus Retrieval Using the Reperfusion Catheter of the Penumbra System: Forced-Suction Thrombectomy in Acute Ischemic Stroke

D.-H. Kang
Y.-H. Hwang
Y.-S. Kim
J. Park
O. Kwon
C. Jung

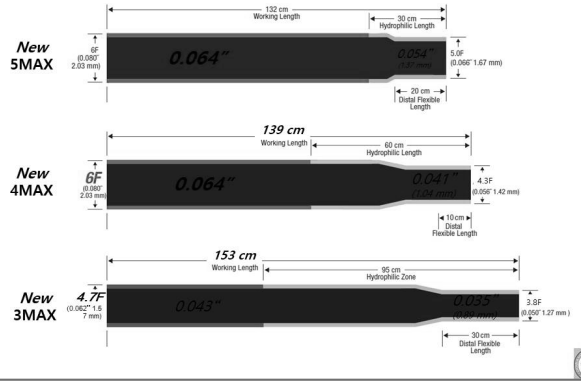
BACKGROUND AND PURPOSE: Although the PS has been the most promising mechanical thrombectomy device in terms of recanalization rates, even the PS cannot recanalize all cases of occlusion. Under such circumstances, we simply modified the PS, identified certain advantages, and applied this modification as a primary technique for recanalization. Here we describe and discuss the technical details and results of our preliminary experience.

MATERIALS AND METHODS: This study included 22 consecutive patients with acute ischemic stroke secondary to large-artery occlusion who underwent modified thrombectomy by using the PS for recanalization. Direct wedging between the tip of the reperfusion catheter and the proximal part of the clot followed by forceful suction by using a 20- or 50-mL syringe is a unique feature of this technique. What is distinctive is that this does not require use of a separator or aspiration pump.

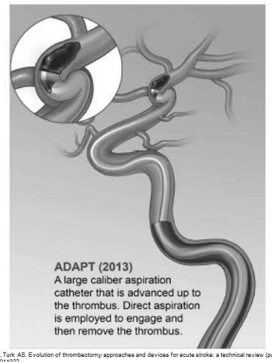
RESULTS: All treated vessels (100%) were successfully recanalized. A TICI scale of 2b or 3 was achieved in 81.9% of patients. A 3-month favorable functional outcome (mRS score, 0–2) was achieved in 45.5% of patients. The only procedural complication was a transient dissection of the proximal ICA, which developed while advancing the guide catheter.

CONCLUSIONS: Forced-suction thrombectomy is a simple modification of the PS. On the basis of our data, this technique allows safe and effective revascularization in acute large-vessel occlusion. Thus, for achieving the best outcome, the modified PS technique is proposed as a viable option for acute stroke management, either by itself or in conjunction with other devices or drugs.

PS MAX RC Spec Diagram



ADAPT technique



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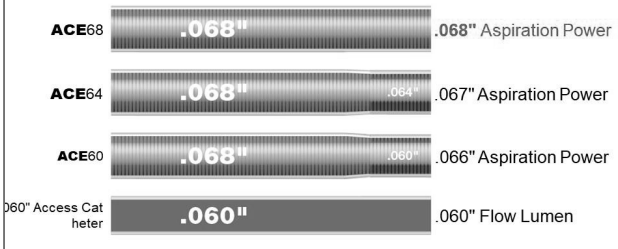
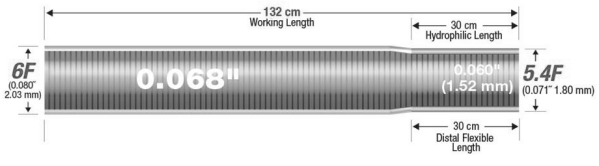
Comparison



Note: Aspiration Power denotes the dimension of a tapered catheter in terms of a straight catheter design. For example, ACE64 has equivalent aspiration power to an .067" straight catheter.

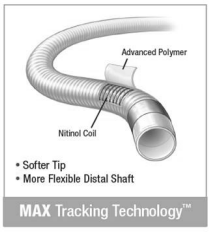
ACE™ dimensions



5MAX™ Enabled ADAPT Technique

Improved tracking allowed easy re-access

Increased aspiration power enabled better hold o n clot

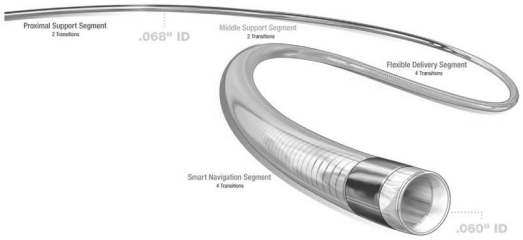


ACE™ DESIGN

12 Transition Zones enable outstanding force transmission and exceptional kink resistance

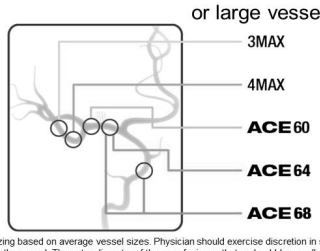
Advanced Polymer provides flexibility for superior tracking

Nitinol Round Wire Reinforcement maintains lumen integrity



One Powerful System

Complete suite of Reperfusion Catheters sized optimally f or large vessel occlusions*

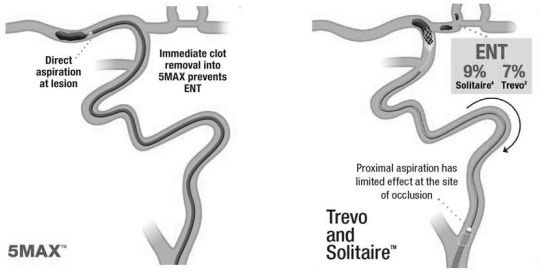


* Recommended catheter sizing based on average vessel sizes. Physician should exercise discretion in selecting the reperfusion catheter that will safely fit in the vessel. The outer diameter of the reperfusion catheter should be smaller than the vessel.

5MAX and Delivery Catheter

- **5MAX** compatible with
  - VELOCITY 160cm (*Low Profile*)
  - 3MAX (*Best Fit*)
  - Prowler Select Plus
  - Rebar 18/27
  - Marksman
  - Trevo microcatheter
- VELOCITY and **3MAX** have advantages:
  - VELOCITY: 160 cm, low profile
  - **3MAX**: Best Fit, 153 cm

5MAX *Direct Aspiration* Reduces ENT



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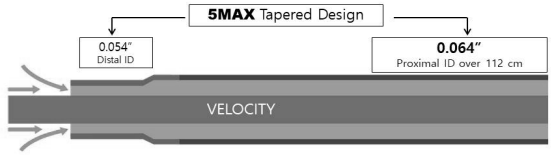
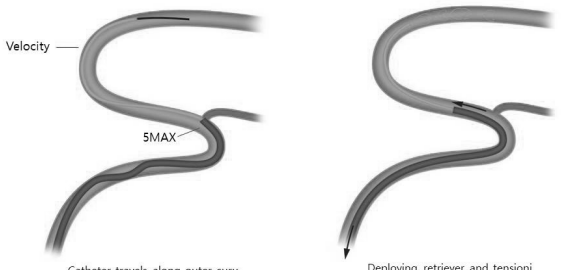
4MAX Applications

- Over-the-wire access
- Extreme tortuosity
- Smaller M1s
- Most M2s

VELOCITY inside **5MAX** – Equivalent to 041 Aspiration



Tensioning Technique



Catheter travels along outer curv e and can get stuck on the ostiu m of the ophthalmic.

Deploying retriever and tensioni ng may enable catheter to track past ophthalmic.

ADAPT FAST

Ischemic stroke

Table 1 Comparison of the 5MAX and 5MAX ACE final outcomes

	5MAX	5MAX ACE	p Value
No of cases	44	44	
Mean time to revascularization (min)	37.7	35.6	0.71
TICI 2b (%)	54.6	36.4	0.09
TICI 3 (%)	40.9	61.4	0.06
mRS 0–2 (%)	34	50	0.19

TICI 3 revascularization was achieved more frequently with 5MAX ACE than with 5MAX (61.4% vs 40.9%; p=0.055).
mRS, modified Rankin Scale; TICI, Thrombolysis in Cerebral Infarction.

The 5MAX ACE became clinically available during the present study. Outcomes for 5MAX and 5MAX ACE were compared.

Data were tracked at each site. De-identified data were submitted to the sponsoring institution (Medical University of South Carolina) which performed the primary analysis. Statistical analyses were performed using SAS V9.3 (SAS Institute, Cary, North Carolina, USA). Differences between groups were tested using Student's t test for continuous mea-

The primary ADAPT revascularization catheter was 5MAX in 44 cases, 5MAX ACE in 44 cases, 4MAX (Penumbra) in six cases, 3MAX (Penumbra) in four cases, Navien 058 (EV3 Covidien) in one case, and Neuron 088 MAX (Penumbra) in one case. TICI 2b or 3 revascularization with aspiration alone was achieved in 75% of cases in which a 5MAX was the primary catheter versus 82% (p=0.44) when a 5MAX ACE was used (table 1).

Clinical outcomes

There were no incidences of postprocedure sICH. The presenting NIHSS was 17.2 (median 17.0; SD=6.4) on average and improved to an average of 7.3 (median 4.0; SD=7.5) at discharge (table 2).

ADAPT FAST

RESULTS

Patient demographics and procedural data

Ninety-eight patients with 100 occlusions were treated at the six institutions, including 46 women, with an average age of 66 years (median 69, SD=15.7). The average time from when the patient was last seen normal to groin puncture was 8.5 h (mean 507 min; median 241.5 min, SD=506 min). The overall successful revascularization rate (TICI 2b-3) was 95%. The average time to TICI 2b or 3 revascularization was 36.6 min (SD=26.4 min). The aspiration component of the ADAPT technique alone was successful in achieving successful revascularization of the occluded vessel 78% of the time. When the aspiration component of ADAPT was successful as a standalone technique, the average time from femoral access to final revascularization was 31.6 min (SD=23.3 min). In those cases where an adjunctive device was required, revascularization times were significantly (p<0.0001) prolonged (average 56.8 min (SD=29.1 min)).

Ten of 100 (10%) cases had downstream emboli within the

Table 2 Baseline characteristics

Variable	
Mean age (years)	66.3
Gender	
Men (n (%))	46 (47)
Women (n (%))	52 (53)
NIHSS	
Pretreatment	17.2/17.0*
Post-treatment	7.3/4.0*
IV tPA	
Yes (n (%))	27 (28)
No (n (%))	70 (72)
Average time to groin puncture (h)	8.5
Average time to TICI 2b/3 recanalization (min)	37
Site of occlusion (n (%))	
Right M1	20 (20)
Right M2	11 (11)
Right ICA	3 (3)
Left cervical ICA–MCA	3 (3)

*Mean/median values.
ICA, internal carotid artery; IV tPA, intravenous tissue plasminogen activator; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale; TICI, Thrombolysis in Cerebral Infarction.

removed with either subsequent aspiration at the occlusion site or utilization of a stent retriever. There were no instances of embolization to a new territory (ENT).

lying intracranial stenosis, which was successfully stented. One complication was related to advancing a 5MAC ACE from the distal ICA into the mid M1 middle cerebral artery without using an obturating microwire or microcatheter, and resulted in significant vessel dissection, which was unable to be opened.

ADAPT FAST

hemorrhage after treatment, with worsening of clinical examination by ≥4 points on the National Institutes of Health Stroke Scale (NIHSS). The 90 day functional outcomes were determined by the modified Rankin Scale (mRS), and were obtained from the available clinic records. A good functional outcome was defined as an mRS score of ≤2 at 90 days. Mortality was defined as death occurring wi
The 5MAX ACE became clin
study. Outcomes for 5MAX a
Data were tracked at each
mitted to the sponsoring i
South Carolina) which pe
Statistical analyses were pe
Institute, Cary, North Caro
groups were tested using Stu
sures and a χ^2 test for categori
groups were tested using Fisher's exact test for categorical measures with expected cell sizes <5. All tests were two sided and assessed at a significance level of 0.05.

Clinical outcomes

There were no incidences of postprocedure sICH. The presenting NIHSS was 17.2 (median 17.0; SD=6.4) on average and improved to an average of 7.3 (median 4.0; SD=7.5) at discharge (table 2).

The primary ADAPT revascularization catheter was 5MAX in 44 cases, 5MAX ACE in 44 cases, 4MAX (Penumbra) in six cases, 3MAX (Penumbra) in four cases, Navien 058 (EV3 Covidien) in one case, and Neuron 088 MAX (Penumbra) in one case. TICI 2b or 3 revascularization with aspiration alone was achieved in 75% of cases in which a 5MAX was the
per cent of patients achieved an mRS score of 0–2 and 20% an mRS score of 6 at the 3 month follow-up. In the 78% of cases

RESULTS
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Ninety-eight patients with 100 occlusions were treated at the six institutions, including 46 women, with an average age of 66 years (median 69, SD=15.7). The average time from when the patient was last seen normal to groin puncture was 8.5 h (mean 507 min; median 241.5 min, SD=506 min). The overall successful revascularization rate (TICI 2b-3) was 95%. The average time to TICI 2b or 3 revascularization was 36.6 min (SD=26.4 min). The aspiration component of the ADAPT technique alone was successful in achieving successful revascularization of the occluded vessel 78% of the time. When the aspiration component of ADAPT was successful as a standalone technique, the average time from femoral access to final revascularization was 31.6 min (SD=23.3 min). In those cases where an adjunctive device was required, revascularization times were significantly (p<0.0001) prolonged (average 56.8 min

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Average time to TICI 2b/3 recanalization (min)	37
Site of occlusion (n (%))	
Right M1	20 (20)

Quest for the ultimate device

	Merci	Original Penumbra System™	Stent Retriever	"Solumbra"	5MAX	ACE
Author		Kass-Hout (JNIS 2014)		Humphries (JNIS 2014)	Turk (JNIS 2014)	
n	81	91	115	105	44	44
TICI 2b/3	70%	78%	86%	88%	96%	98%
TICI 3	14%	9%	37%	44%	41%	61%
Puncture to Revas	91 min	75 min	79 min	57 min	38 min	36 min
sICH	7%	6%	7%	5%	0%	0%
mRS ≤ 2 at 90 days	25%	41%	36%	44%	34%	50%

Kass-Hout T, Kass-Hout O, Sun C-H J, et al. Clinical, angiographic and radiographic outcome differences among mechanical thrombectomy devices: initial experience of a large-volume center. [publishe d online ahead of print 21 March, 2014]. J Neurointervent Surg. doi:10.1136/neurintsurg-2013-010371.
Humphries W, Hoit D, Doss VT, et al. Distal aspiration with retrievable stent assisted thrombectomy for the treatment of acute ischemic stroke [published online ahead of print 2 January, 2014]. J Neurointervent Surg. doi:10.1136/neurintsurg-2013-010988.
Turk AS, Frei D, Fiorella D, et al. ADAPT FAST study: a direct aspiration first pass technique for acute stroke thrombectomy [published online ahead of print 25 February, 2014]. J NeuroIntervent Surg. doi:10.1136/neurintsurg-2014-011125.

Revas Comparison

	Solitaire		Trevo	5MAX	ACE	
Study	NASA Registry	EU Retrospective	Trevo 2	ADAPT FAST– 6 US Centers	ADAPT FAST - 6 US Centers	Swedish Medical Center
n	354	141	88	75	43	50
TICI 3	40%	37%	14%	48%	61%	66%
TICI 2b-3	**73%**	**85%**	**68%**	**95%**	**97%**	**96%**

Table 4 Comparison of outcomes from current ADAPT FAST, SWIFT, TREVO, NASA, and stent retriever meta-analysis

	ADAPT FAST (n=100)	SWIFT trial (n=89)	TREVO trial (n=88)	STAR study (n=202)	NASA registry (n=354)	Solitaire data* (n=355)	Trevo data* (n=221)
TICI 2a/2b/3 (%)	N/A	83†	90	N/A	87.5	82	83
Device TICI 2b/3 (%)	78	75.9‡	68‡	79‡ 91§	72.5	NR	NR
Final TICI 2b/3 (%)	95	75.9‡	68‡	85	72.5	82	83
mRS 0-2 (%)	40	36	40	55	42	47	51
Mortality (%)	20	17	34	19	30.2	14	31
Time to final revascularization (min)	37	NR	NR	NR	50¶	NR	NR
Device related complications (%)	2	8.6	9	7.5	NR	6	5
Symptomatic ICH (%)	0	2	7	4	9.9	6	8

*Meta-analysis of real world published experience.
†Site reported rate of recanalization.
‡Core laboratory reported.
§Site investigator reported data.
¶Time to revascularize after guide catheter access.
ICH, intracerebral hemorrhage; mRS, modified Rankin Scale; N/A, not applicable; NR, not reported; TICI, Thrombolysis in Cerebral Infarction.

The ultimate stroke device

Opens artery quickly

Removes thrombus intact and completely

Safe and simple procedure

Economical

25

권 순 찬 울산대병원 신경외과

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2010.10–2016.9	울산대학교병원 부교수
2016.10–현재	울산대학교병원 교수
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Solitaire FR®

권 순 찬
울산대병원 신경외과

Review of Devices for EVT of AIS : Solitaire FR

Kwon, SoonChan

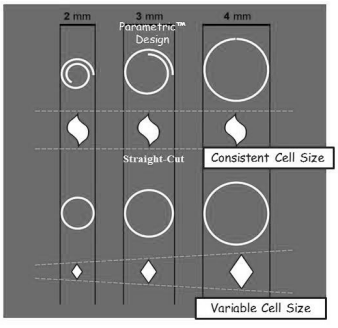
Department of Neurosurgery,
Ulsan University Hospital, University of
Ulsan College of Medicine

Solitaire Stent

- ❖ Fully deployed & completely retrieval stent
- ❖ Closed cell with open slit (overlapping) design
- ❖ Parametric design

- ❖ Point of overlap
  : Middle of the overlap is 180° from the proximal marker.

Parametric overlapping Design™*



History of Solitaire Stent

- ❖ Solitaire™ AB

  : Initially developed for the endovascular tx. of wide-necked intracranial Ans.

History

CASE REPORT

Intracranial thrombectomy using the Solitaire stent: a historical vignette

Marta Aguilar Pérez,[1] Elina Miloslavski,[1] Sebastian Fischer,[1] Hansjörg Bäzner,[2] Hans Henkes[1,3]

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[2]Klinik für Neurologie, Bürgerhospital, Klinikum Stuttgart, Germany
[3]Medizinische Fakultät der Universität Duisburg-Essen, Germany

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Revised 2 November 2011
Accepted 13 November 2011

ABSTRACT
Introduction The endovascular treatment of acute ischemic stroke has been revolutionized in the past years by the introduction of new devices for mechanical thrombectomy. Several tools were already available in 2008. The majority allowed the recanalization of acutely occluded intracranial arteries with acceptable levels of safety and efficacy, and with occasional failures.
Case presentation On 3 March 2008, a 67-year-old woman was treated 3.5 h after the clinical onset of a right hemispheric stroke due to an embolic middle cerebral artery (MCA) M1 occlusion. The National Institutes of Health Stroke Scale (NIHSS) score prior to treatment was 10. Mechanical thrombectomy with a microbrush yielded a significant amount of thrombotic material without recanalization. Given the urgency of the situation, the uncertain outcome in the case of a persistent occlusion of the right M1 segment and the fact that no other device was available, a Solitaire stent was deployed within the occluded right M1 segment. After several minutes of incubation, the expanded stent was slowly withdrawn under continuous aspiration with instantaneous removal of the entire thrombus and complete recanalization of the right MCA with reperfusion of the whole MCA supply territory. Digital subtraction angiography showed neither peripheral emboli nor vasospasm. The patient made a complete clinical recovery with an NIHSS score of 0 at the 30 day follow-up.
Conclusion The Solitaire stent was initially developed for the endovascular treatment of wide necked intracranial aneurysms but has been demonstrated to be safe and efficacious for intracranial thrombectomy. This was the first successful human clinical use of a Solitaire stent for this purpose and the ignition spark for the development of a whole generation of new devices, now called stent retrievers.

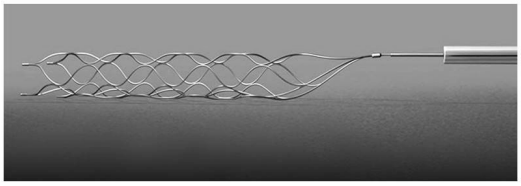
approval of the recombinant tissue plasminogen activator alteplase for use in ischemic stroke within 3 h of symptom onset. The difference between the two arms in these studies was quite sobering and <15% of all stroke patients were eligible for IVT. The general acceptance of IVT, however, was pivotal in anchoring acute ischemic stroke in neurology and was instrumental for the installation of dedicated stroke units. Apart from these merits, the practice of IVT undermined the momentum of further development of endovascular treatment concepts. The first dedicated tool approved by the Food and Drug Administration (FDA) in 2004 for endovascular intracranial thrombectomy was the Merci retriever (Concentric Medical, Mountain View, California, USA), a nitinol spiral. In 2005, Catch (Balt Extrusion, Montmorency, France), a braided nitinol basket proximally attached to a wire and distally occluded, was CE marked (CE=Conformité Européenne, the CE logo indicates free marketability of an industrial product within the European Economic Area) in Europe for the same indication. Both devices were limited in their efficacy and had some safety issues. The Merci retriever was evaluated in large US trials[6] and achieved a certain acceptance both in the USA and in Europe. Competing developments were brushes and braided cages for intracranial thrombectomy.[7] In 2006, Penumbra (Alameda, USA) came up with an aspiration catheter together with a dedicated aspiration pump and a modified wire ('separator'). The Penumbra system was shown to be both efficacious and safe for endovascular intracranial thrombectomy in European and US trials and received FDA approval in 2008.[8]

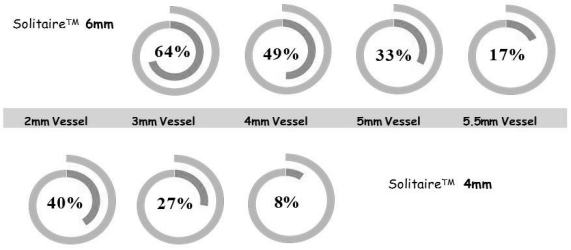
In 2003, completely independent of the efforts on engineering stroke devices, a new stent for the endovascular treatment of intracranial aneurysms

History of Solitaire

- ❖ Solitaire™ AB for SAC
- ❖ Solitaire™ FR for Thrombectomy
  - Solitaire FR (1st Generation)
    : KFDA, 2011-08
    FDA, 2012-03
  - Solitaire FR 2 (2nd Generation)
  - Solitaire FR Platinum (3rd Generation)

Solitaire™ AB Neurovasular Remodeling Device
: Designed for the treatment of intracranial neurovascular disease.





Solitaire™ FR Revascularization Device

- ❖ Two Mechanisms of Action
  - Mechanical Thrombectomy
  - use with adjunctive medical therapy

- ❖ Solitaire FR (1st Generation)

- Absolutely same one with Solitaire AB

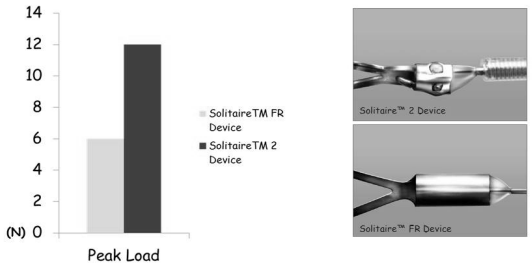
- Parametric design
- Detachment (off-label)
- 5 RCTs
  : MR CLEAN, ESCAPE, EXTEND-IA, REVASCAT, SWIFT PRIME

❖ Solitaire FR 2 (2nd Generation)

- Re-designed Delivery System
- 4x40mm Longer size
- Non-detachable stent

Key Benefit Messages
Solitaire 2-Improved tensile Strength

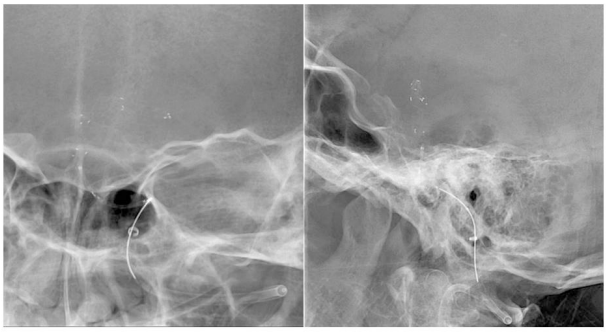
The Solitaire™ 2 Revascularization Device also employs a redesigned attachment zone offering a 2x improvement in joint strength designed to eliminate unintended detachments



❖ Solitaire FR Platinum (3rd Generation)

- Body Marker, Visibility
- Re-design non-working length (shorter non-working length)

Solitaire FR Platinum

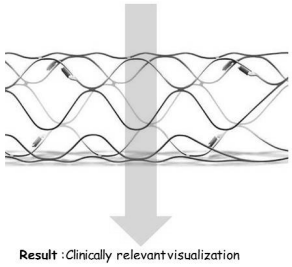


❖ Ideal Stent-retrieval Device

- Improved Clot Capture
- Improved Radio-opacity
- Improved Ease of Delivery (Delivery Friction / Retrieval Friction)
- Reduction of Intimal Damage

Solitaire Platinum
What's changed?

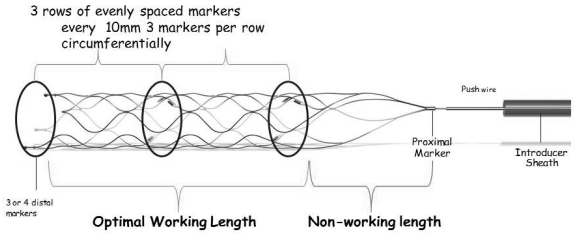
Feature :Evenly Spaced Platinum Markers



Result :Clinically relevant visualization

Solitaire Platinum

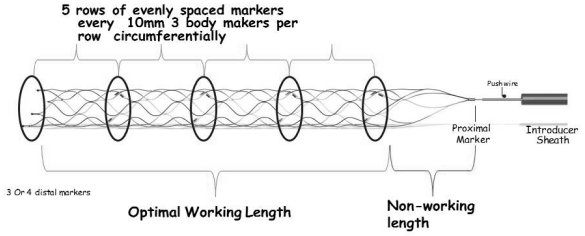
What's changed?



Solitaire™ Platinum device 4-20 or 6-20 with 10mm spacing

Solitaire Platinum

What's changed?



Solitaire™ Platinum device 4-40 with 10mm spacing

❖ Available Solitaire FR Platinum in Korea

- 4x20
- 4x40
- 6x40

Cf. Longer one is better.
Bigger one is better.

Thank you
for Your Attention.

Trevo®

Dr. Osama Zaidat

Mercy Health-St.Vincent Medical Center

박 정 현 한림의대 동탄성심병원 신경외과

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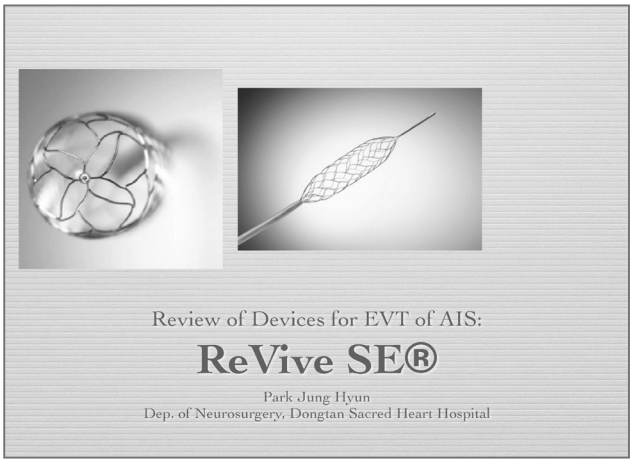
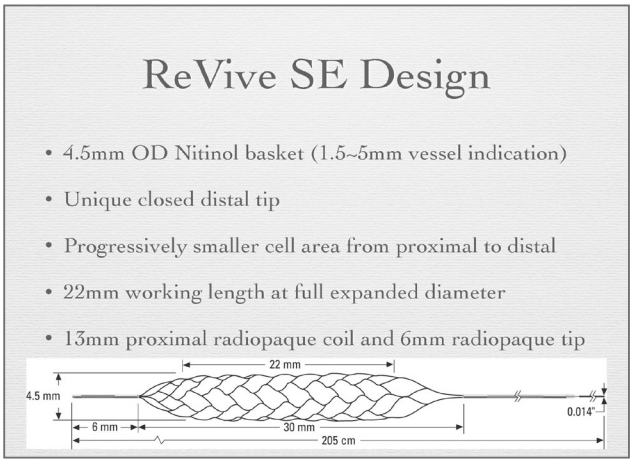
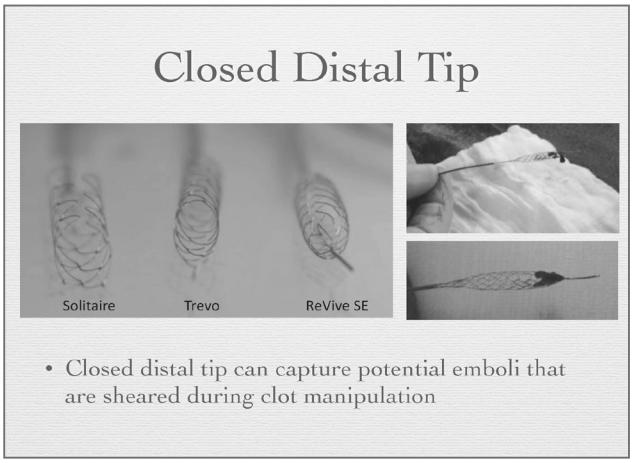
대한신경중환자의학회 정회원
대한신경집중치료학회 정회원

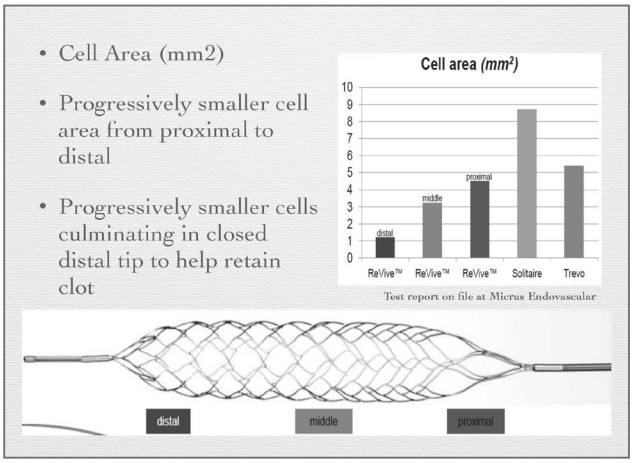
Revive SE®

박 정 현
한림의대 동탄성심병원 신경외과







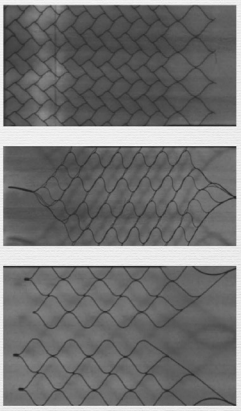


Number of Cells

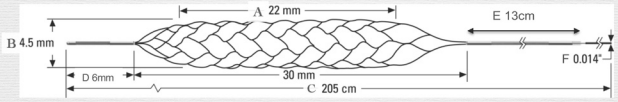
Product	Cell Count
Revive SE	84
Trevo Provue	32
Solitaire	31

Test report on file at Micrus Endovascular

- Images of "unzipped" structures
- Higher cell count provides additional interaction points between the stent strut and clot surface



Basic Design



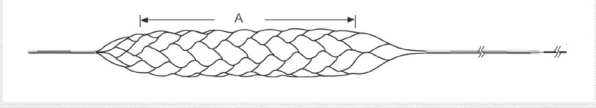
(A) Working length *	(B) Basket diameter *	(C) Full length of device	(D) Distal tip length (O.D.)	(E) Proximal length (O.D.)	(F) Wire size O.D.
22mm	4.5mm	205cm	6mm (0.0145 inch)	13cm (0.0155 inch)	0.014inch

〈Maximum number of use per device〉
Up to 5 times

〈Parent Vessel Diameters〉
1.5mm ~ 5.0mm

Basic Design

REVIVE® SE thrombectomy device



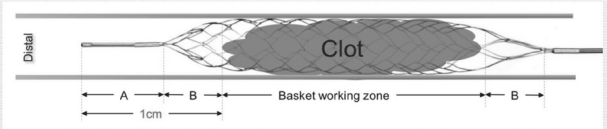
"A": Basket Working length

at MAXIMUM indicated vessel diameter (5.0mm): 22mm

at MINIMUM indicated vessel diameter (1.5mm): 28mm

Vessel Diameter	Working Length
4.5 mm & +	22 mm
4.0 mm	23 mm
3.5 mm	24 mm
3.0 mm	25 mm
2.5 mm	26 mm
2.0 mm	27 mm
1.5 mm	28 mm

How to use- Basket

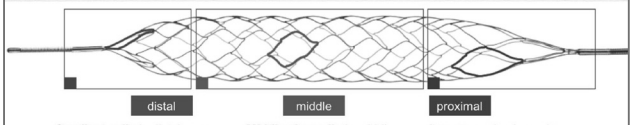


How
- Distal Tip 끝부분이 Clot에서 **최소 1cm 앞으로** Advance된 상태에서 Deploy 되어야함

Why
- Distal shoulder 부분(B)은 Clot을 Engage할 수 있는 Working zone이 아님

Part	Name	Length
A	Distal Tip	6mm
B	Shoulder	4mm
A+B Total Length		10mm (1cm)

Basic Design: Different Cell Pattern



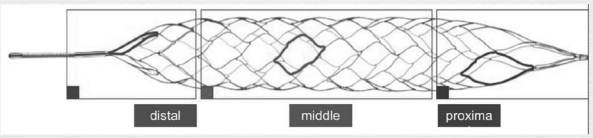
distal | middle | proximal

Smallest cells in distal serve to retain and retrieve more clots

Middle size cells in middle sections increase the number of contact points

Larger proximal openings to allow more blood flow

The Basket



Basket component

- Radial force optimized for gentle flow channel creation
- Large proximal openings to allow flow in
- Many "clot grabbing"n junctions along working length with nominal opening size
- Small distal openings to keep thrombus in

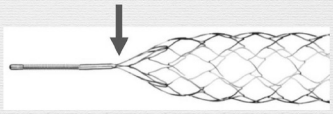
Basic Design: Closed Ended Basket

Tighter distal mesh coil

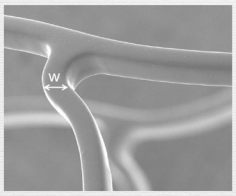
+

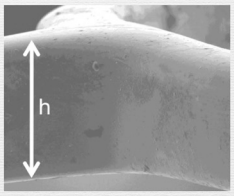
Closed Tip

Designed to
- Prevent clot fragments migration to distal
- Retain clot during extraction



Different Strut Dimensions

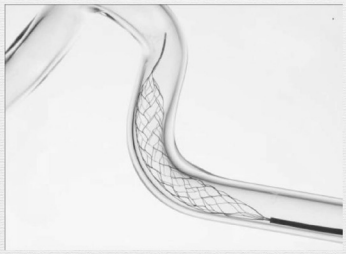




Test report on file at Micrus Endovascular

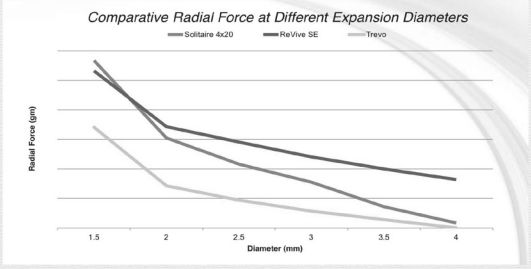
- Narrow strut width (W) is designed to better penetrate clot
- Taller strut height (h) is designed to increase surface area to engage more clot with the struts

Vessel Wall Conformability



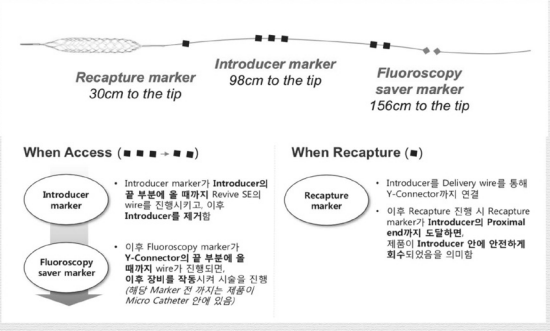
- Helical cell pattern, Hugh number of cells and consistent radial force provide superior conformability

Comparative Radial Force

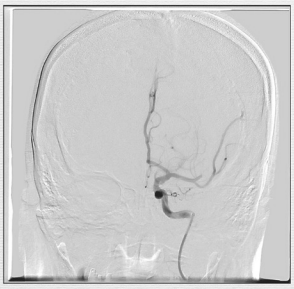


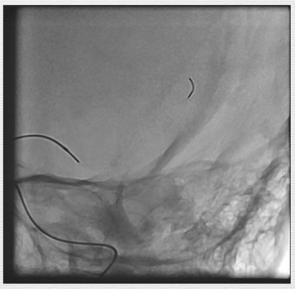
Test report on file at Micrus Endovascular

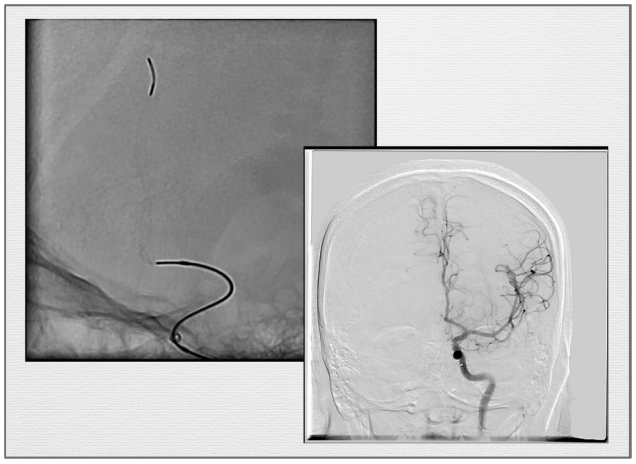
Delivery Wire Marker



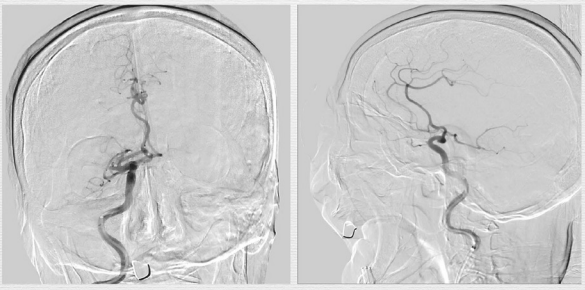
Case 1. 67Y.O./ F/ M2, Lt.

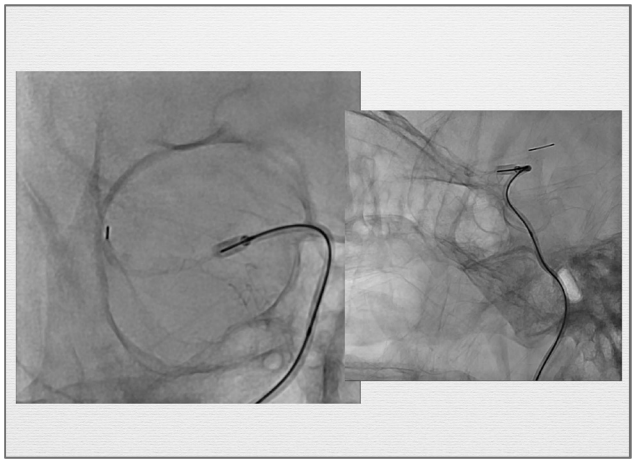


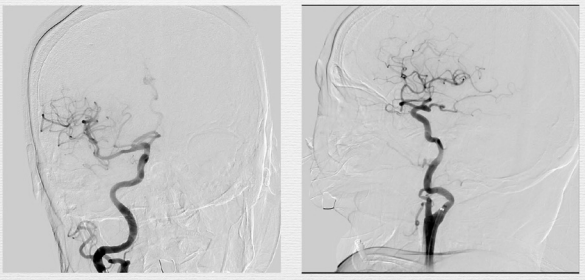




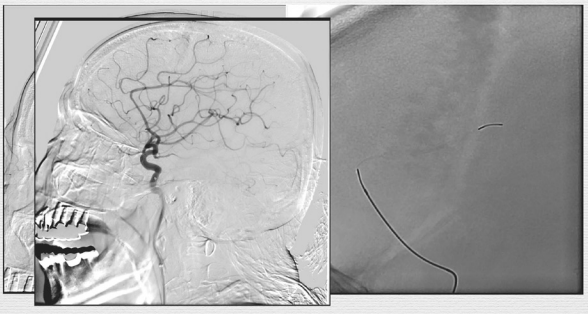
Case 2. 77Y.O./ F/ M1, Rt.



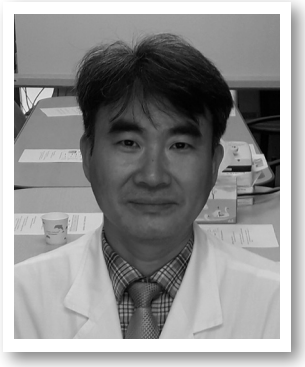




Case 3. 64Y.O./ M/ DACA, Lt.



김 병 철 동국의대 일산병원 신경외과



▶ 학력 및 경력

2000	한림대학교 졸업
2001–2005	강동성심신경외과 수련
2005	전문의취득
2008–2009	분당서울대 신경외과 fellowship
2009–현재	동국대일산병원 신경외과 교원

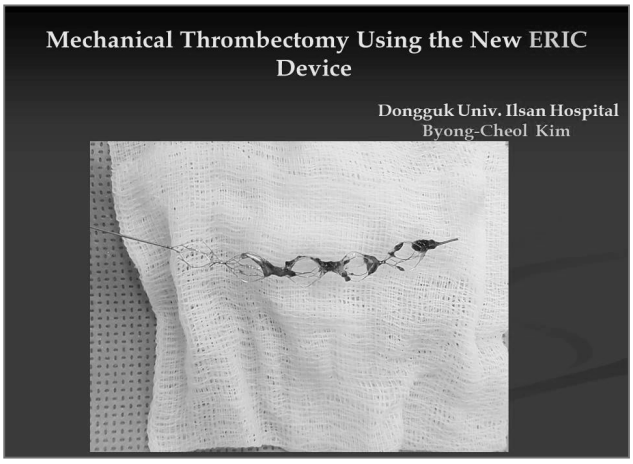
▶ 학회활동

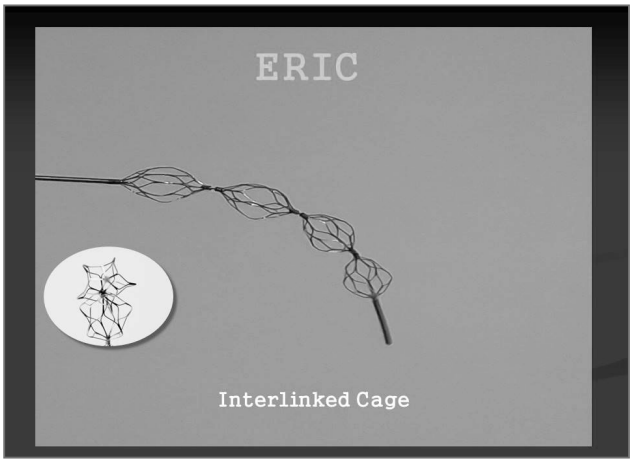
대한신경외과학회
대한뇌혈관내수술학회
대한신경중재치료의학회

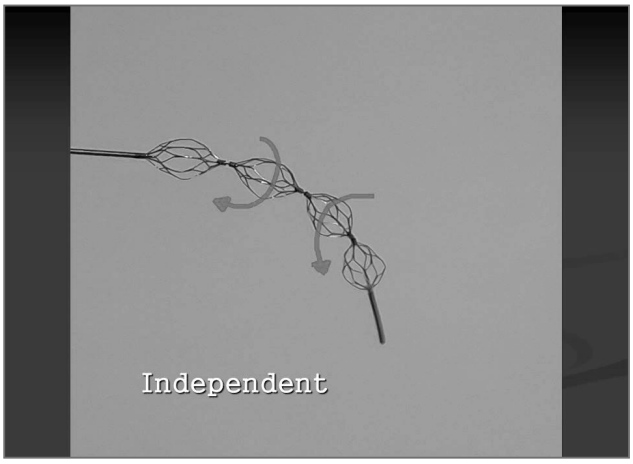
Eric®

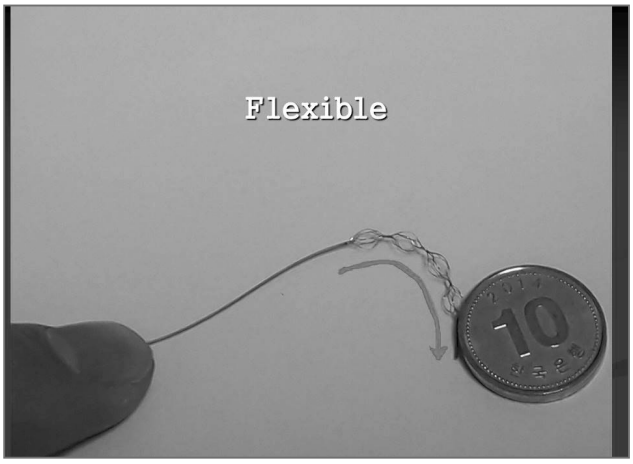
김 병 철

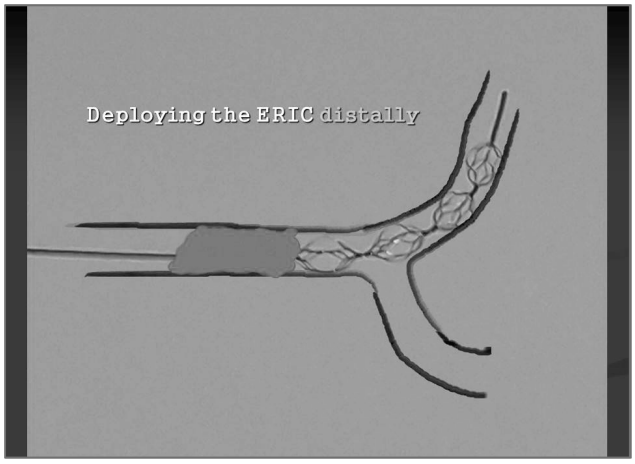
동국의대 일산백병원 신경외과

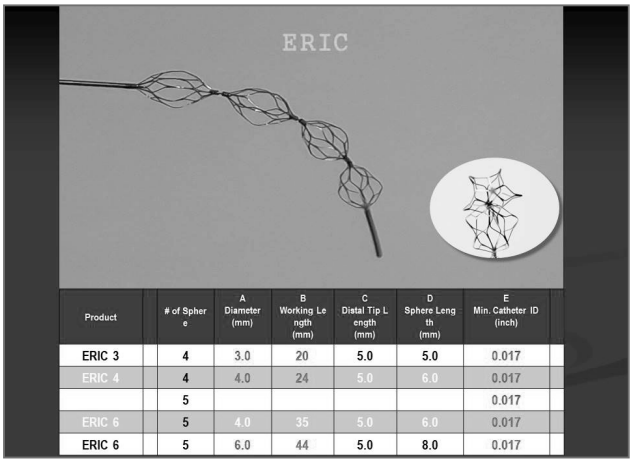








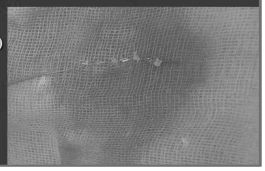




Product	# of Sphere	A Diameter (mm)	B Working Length (mm)	C Distal Tip Length (mm)	D Sphere Length (mm)	E Min. Catheter ID (inch)
ERIC 3	4	3.0	20	5.0	5.0	0.017
ERIC 4	4	4.0	24	5.0	6.0	0.017
	5					0.017
ERIC 6	5	4.0	35	5.0	6.0	0.017
ERIC 6	5	6.0	44	5.0	8.0	0.017

Cases (2016.06–2017.11)

- 18 cases
  - ICA-proximal M1: 2, Distal M1-M2: 11, M2-3: 4, BA: 1
- Age: mean 67 yrs (27-89)
- Initial NIHSS: mean 16 (4-30)
- Result
  - TICI 2b-3: 6, TICI 2a: 6, TICI 0-1: 6
  - ICA-proximal M1 (TICI 2b-3: 100%)
  - Distal M1-M2 (TICI 2b-3: 35%, TICI 2a: 35%, TICI 0-1: 30%)
  - M2-3 (TICI 2a: 25%,TICI 0-1:75%)
- Complication: none
  Unintended end of the procedure (1)



Mechanical Thrombectomy Using the New ERIC Retrieval Device Is Feasible, Efficient, and Safe in Acute Ischemic Stroke: A Swiss Stroke Center Experience

T. Kahles, C. Garcia-Esperon, S. Zeller, M. Hlavica, J. Afion, M. Diepers, K. Nedeltchev, and L. Remonda

ABSTRACT

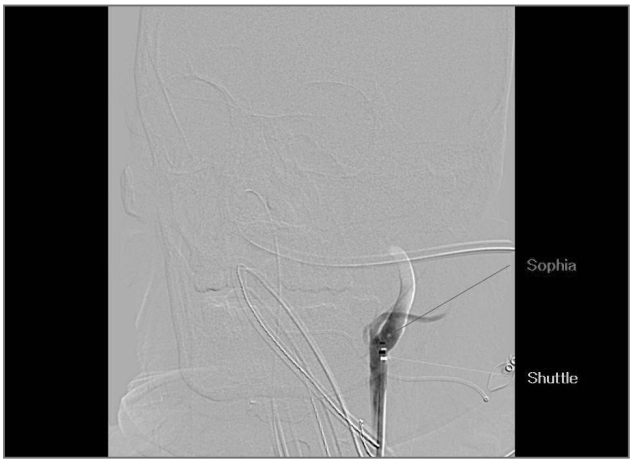
BACKGROUND AND PURPOSE: Intravenous thrombolysis and mechanical thrombectomy predominantly using stent retrievers have been shown to effectively restore cerebral blood flow and improve functional outcome in patients with acute ischemic stroke. We sought to determine the safety and feasibility of mechanical thrombectomy using the new ERIC retrieval device.

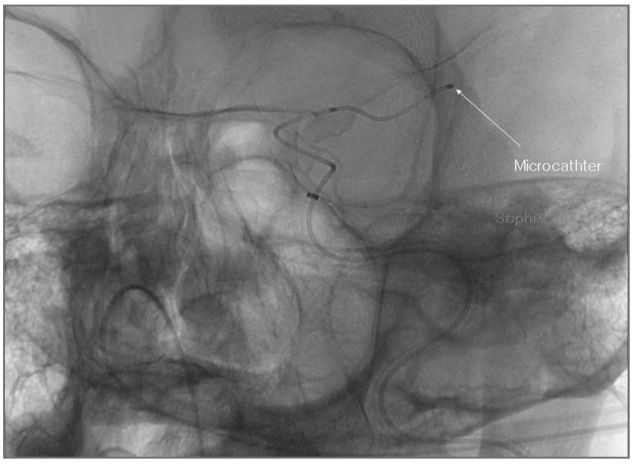
MATERIALS AND METHODS: We identified 36 consecutive patients from our Stroke Center registry with acute ischemic stroke who were treated with the new ERIC retriever from September 2013 to December 2014. Patients with ischemic stroke meeting the following criteria were eligible: onset-to-treatment time of ≤4.5 hours or wake-up stroke (n = 10) with relevant CT perfusion mismatch, NIHSS score of ≥4, and proof of large-vessel occlusion in the anterior circulation on CT angiography. We assessed the baseline characteristics including age, sex, comorbidities, stroke severity, site of vessel occlusion, presence of tissue at risk, and treatment-related parameters such as onset-to-treatment time, recanalization grade, and outcome.

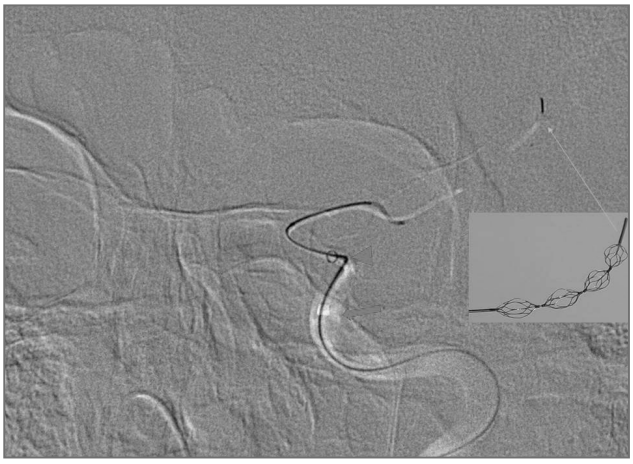
RESULTS: The mean age was 70 ± 13 years, and the median NIHSS score on admission was 18 (interquartile range, 10–20). Seventeen of 36 patients were on platelet inhibitors or anticoagulants before endovascular treatment (47.2%). 20 patients received intravenous thrombolysis (55.5%). The ERIC was used as the sole retriever in 28 patients (77.8%) and as a rescue device in 8. Excellent recanalization was achieved in 30/36 patients (83.3%) with TICI 3 in 19/36 and 2b in 11/36, respectively. Median procedural time in these patients was 90 minutes (interquartile range, 58–133 minutes). No intraprocedural complications occurred.

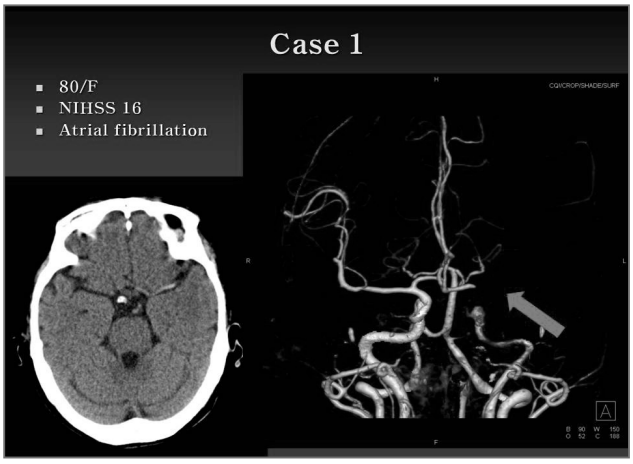
CONCLUSIONS: In this observational study, the new ERIC retrieval device was technically feasible, safe, and effective in acute ischemic stroke with large-vessel occlusion.

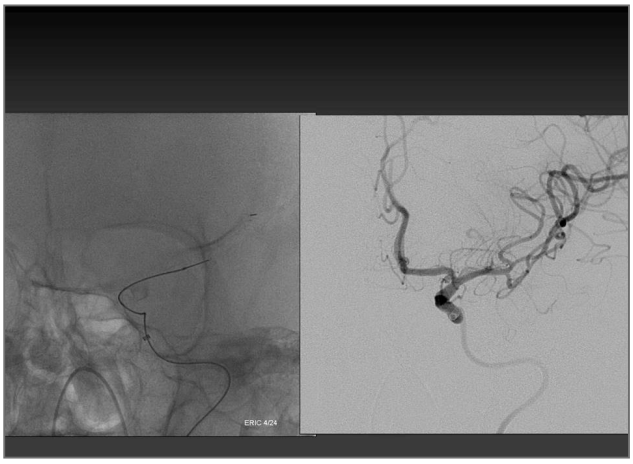
Kahles et al. AJNR 37 (1) (2016)

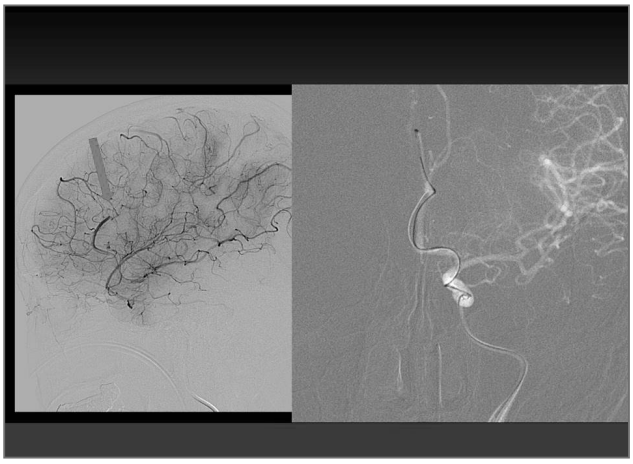


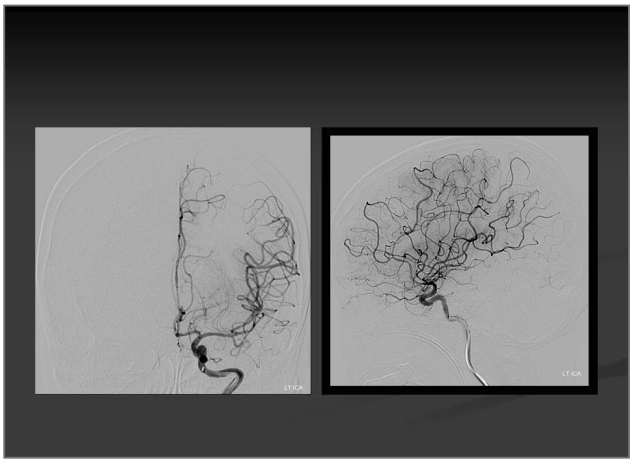


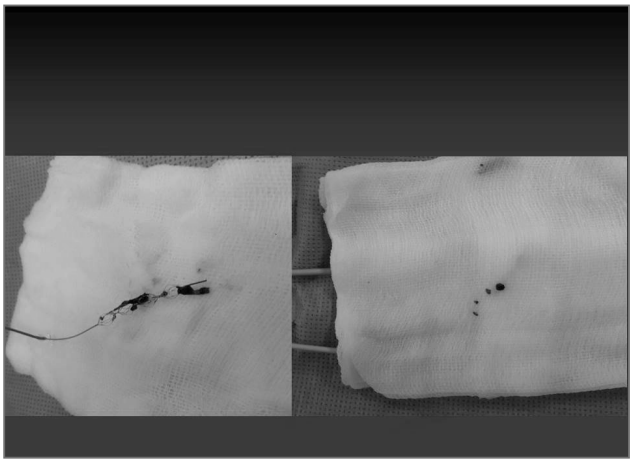


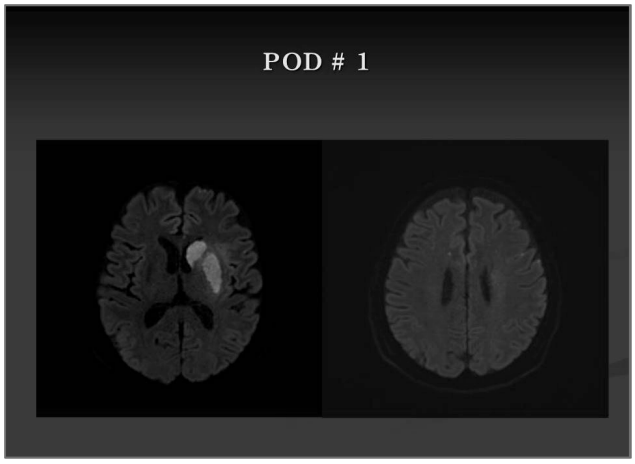

Case 1
80/F
NIHSS 16
Atrial fibrillation



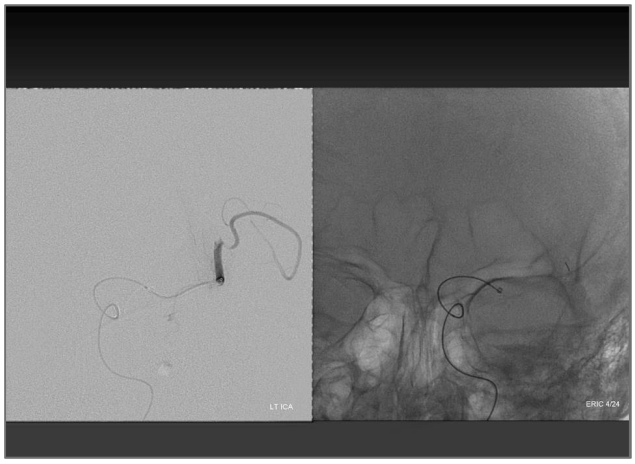


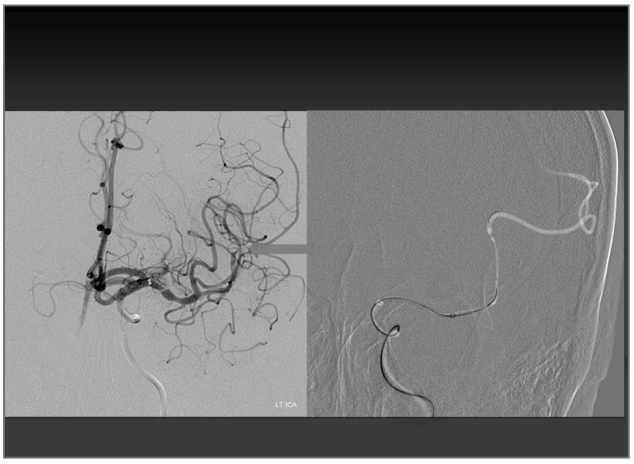


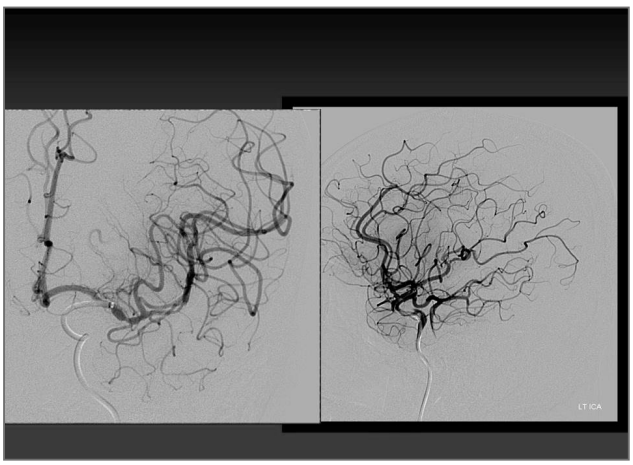


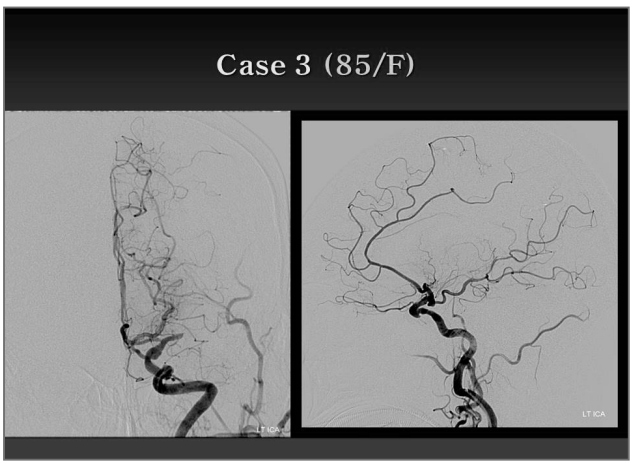

POD # 1

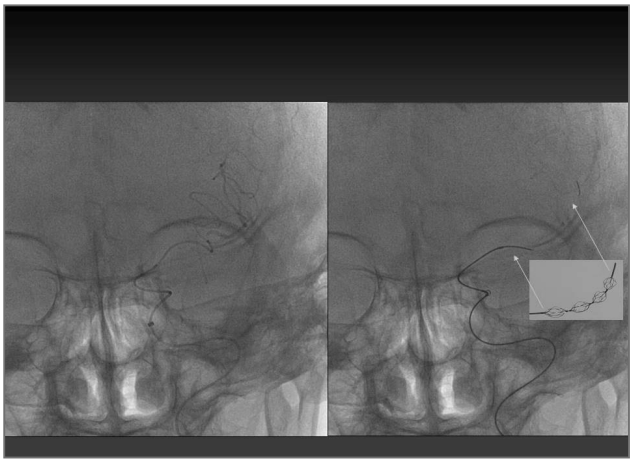

Case 2 (58/M)
CQ\CROP\SHADE\SURF
R
L
A

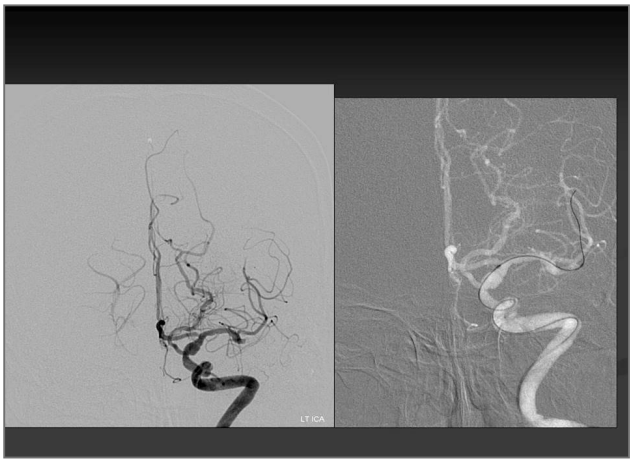

LT ICA
ERIC 4/24


LT ICA


LT ICA


Case 3 (85/F)
LT ICA

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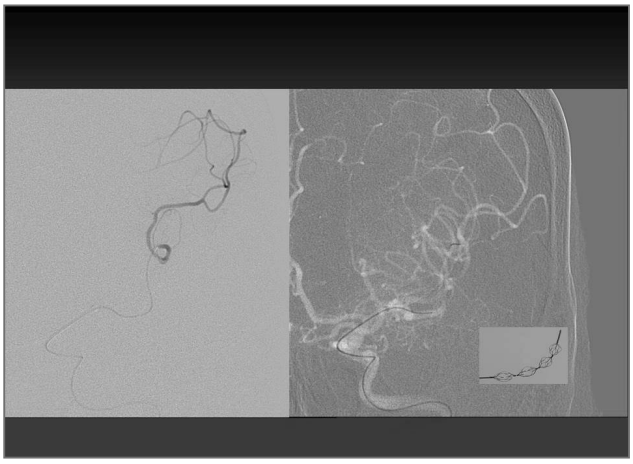
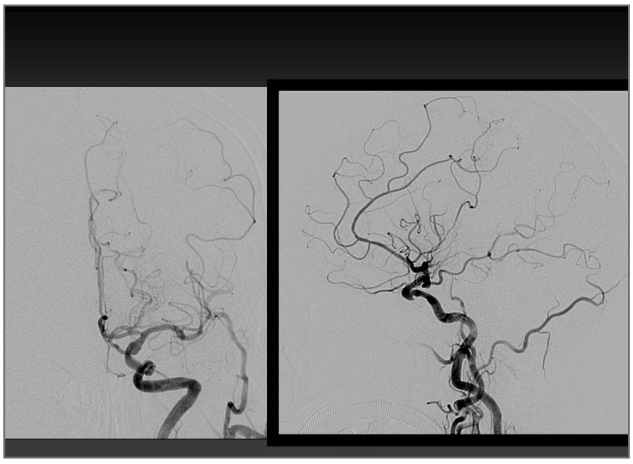
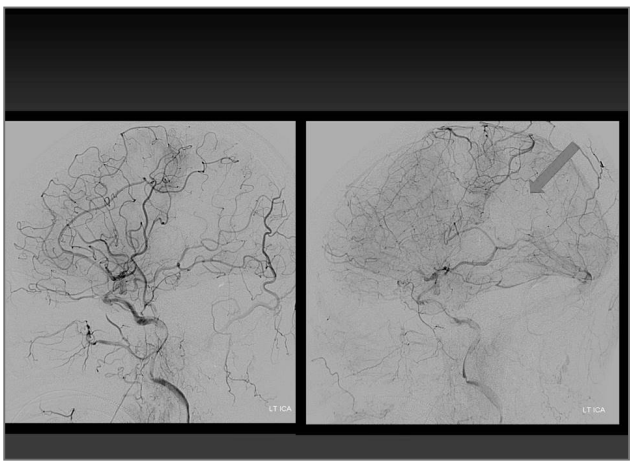
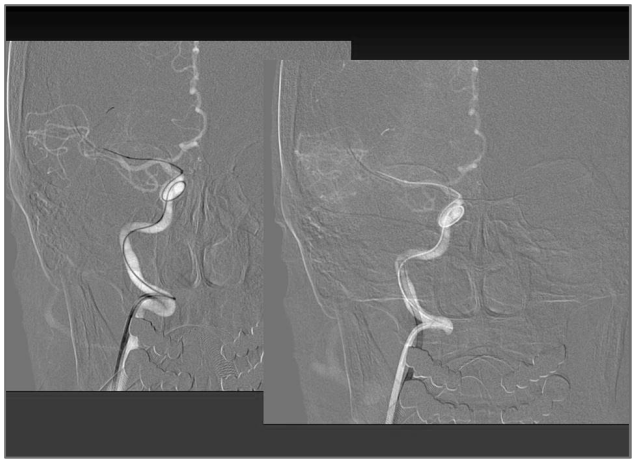
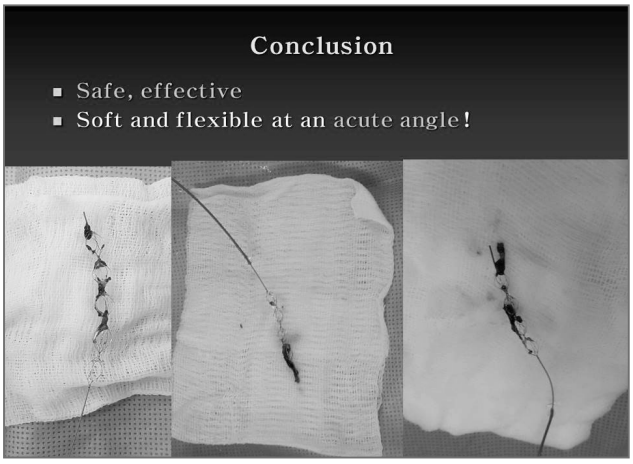




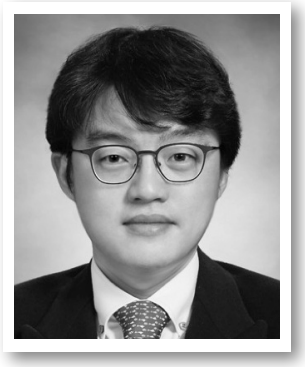

LT ICA
LT ICA


72/F: strong resistance




Conclusion
Safe, effective
Soft and flexible at an acute angle!

강 동 훈 경북대병원 신경외과/영상의학과



▶ 학력 및 경력

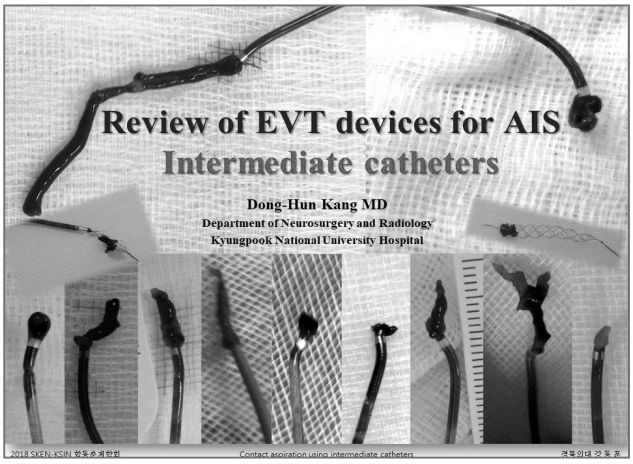
2005.2	신경외과 전문의 취득 (경북대학교병원)
2008.5–2010.2	경북대학교병원 신경외과/영상의학과 전임의/임상교수
2015.8–2016.8	미국 UCLA대학병원 (Los Angeles) 장기연수
2016.4–현재	경북대학교병원 신경외과/영상의학과 부교수

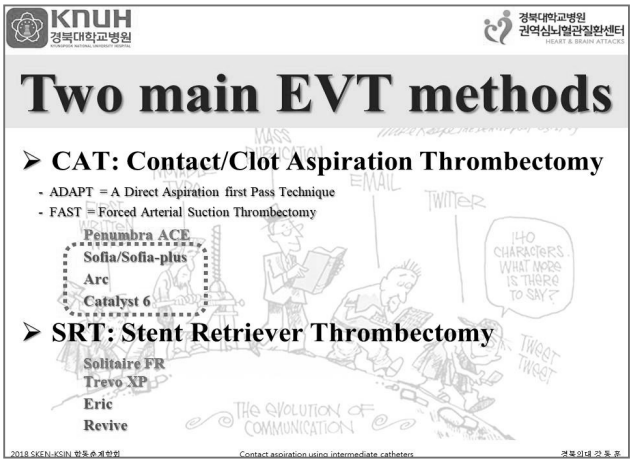
▶ 학회활동

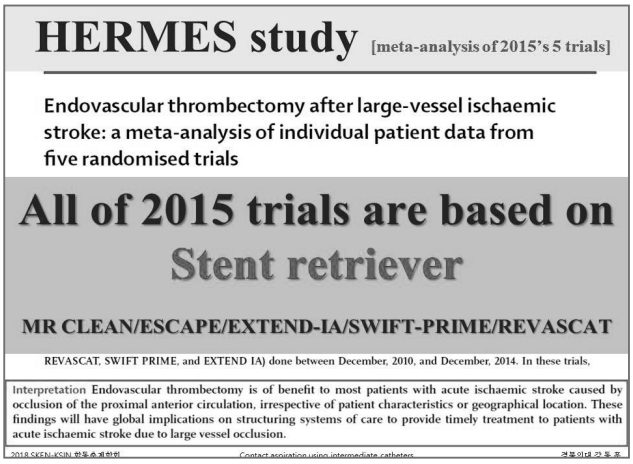
대한 신경중재치료의학회지 편집위원
대한 신경외과학회지 심사위원
대한 뇌혈관외과학회지 심사위원

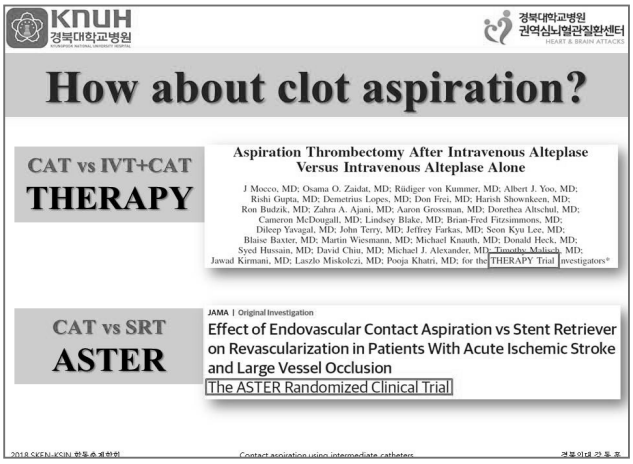
Intermediate catheters

강 동 훈
경북대병원 신경외과/영상의학과









Meta-Analysis

CAT and ADAPT
AJNR 2017 Oct

The Use and Utility of Aspiration Thrombectomy in Acute Ischemic Stroke: A Systematic Review and Meta-Analysis.

Wei D[1], Mascitelli JR[1], Nistal DA[1], Kellner CP[1], Fifi JT[1,2], Mocco JD[1], De Leacy RA[3,4].
Author information

Abstract
BACKGROUND: Thrombectomy trials are often specifically interpreted as evidence for the effectiveness of stent retrievers. The effectiveness of other thrombectomy techniques such as aspiration thrombectomy should be validated through further investigation and review.

PURPOSE: To evaluate published treatment times and clinical outcomes in patients treated with aspiration thrombectomy or ADAPT (A Direct Aspiration, First Pass Technique) for acute ischemic stroke.

DATA SOURCES: A systematic literature review was performed following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. MEDLINE, Scopus, and the Cochrane trial register were searched on November 8, 2016.

STUDY SELECTION: Twenty studies (n = 1523 patients) were included in this review and meta-analysis. One of these studies was prospective, and the rest were retrospective.

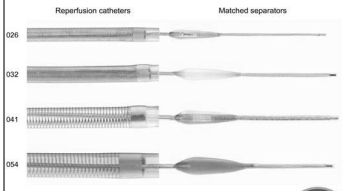
DATA ANALYSIS: Meta-analysis was performed by using a random effects model. Data and publication bias were visualized with forest plots and funnel plots.

DATA SYNTHESIS: Five studies investigated aspiration thrombectomy only, and 16 studies investigated ADAPT. Of the 16 studies on ADAPT, the rate of successful recanalization (TICI 2b/3) was 89.3% (95% CI, 85.4%-92.3%). The proportion of patients with good clinical outcome (90-day mRS ≤2) was 52.7% (95% CI, 48.0%-57.4%).

LIMITATIONS: Studies on ADAPT were retrospective, and there was heterogeneity between studies for successful recanalization (P < .001) and good clinical outcome (P < .001). There was evidence of publication bias for recanalization rates (P = .01), but not for clinical outcomes (P = .42).

CONCLUSIONS: ADAPT and aspiration thrombectomy are effective approaches to thrombectomy, with high recanalization rates and excellent clinical outcomes reported in the literature. Aspiration thrombectomy is a promising neurointervention, but large prospective randomized studies are needed to validate its utility.

The era of "Clot Aspiration Thrombectomy" began with the Penumbra Catheters <FAST & ADAPT>



Penumbra

From 2009
Five generation of Penumbra Catheters

1G: 041/032/054 family
2G: 4Max/3Max/5Max
3G: 5MaxAce
4G: Ace64
5G: Ace68

} 3Max as a coaxial system

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Intermediate catheters for CAT ?

Specifications

Penumbra catheter vs Intermediate catheter

Product name	Length (cm)	Proximal OD (inches)	Proximal ID (inches)	Distal OD (inches)	Distal ID (inches)
Penumbra 5 Max	132	0.080	0.064	0.065	0.054
Penumbra ACE 64	132	0.080	0.068	0.075	0.064
Penumbra ACE 68	132	0.080	0.068	0.080	0.068
ARC (Medtronic)	132	0.080	0.069	0.069	0.061
Catalyst 6 (Stryker)	132	0.079	0.060	0.071	0.060
Sofia (Microvention)	125	0.068	0.055	0.068	0.055
Sofia Plus (Microvention)	125/131	0.083	0.070	0.082	0.070
Revive IC 044 (Codman)	136	0.053	0.044	0.053	0.044
Revive IC 056 (Codman)	121	0.065	0.056	0.065	0.056

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My institute KNUH
CAT using intermediate catheter from 2016-9

Neurointervention 2017;12:45-49
https://doi.org/10.5469/neuroint.2017.12.1.45
ISSN (Print): 2093-9043 ISSN (Online): 2233-6273

Forced Arterial Suction Thrombectomy Using Distal Access Catheter in Acute Ischemic Stroke

Ho-Cheol Lee, MD[1], Dong-Hun Kang, MD[1,2], Yang-Ha Hwang, MD[1], Yong-Sun Kim, MD[1], Yong-Won Kim, MD[1,2]

Historical innovations in mechanical thrombectomy devices and strategies for ischemic stroke have resulted in improved angiographic outcomes and better clinical outcomes. Various devices have been used, but the two most common approaches are aspiration thrombectomy and stent-retrieval thrombectomy. Aspiration thrombectomy has advanced from the traditional Penumbra system to forced arterial suction thrombectomy and a direct aspiration first-pass technique. Newer generation aspiration catheters with flexible distal tips and a larger bore have demonstrated faster and better recanalization relative to older devices. Recently, several species of distal access catheters have similar structural characteristics to the Penumbra reperfusion catheter. Therefore, we used the distal access catheter for forced

IAT Protocol in KNUH

- Primary CAT based switching -

Period 1 ~2009.4.	Period 2 ~2010.11	Period 3 ~2016. 8	Period 4 2016.9~
MCD	***CAT*** Penumbra catheter (1G) No BGC → BGC	***CAT to SRT*** CAT using Penumbra catheter → SRT [Solitaire FR / Trevo XP]	***CAT to m-Solumbra*** CAT using any aspiration cath [Penumbra/Sofia/Catalyst/Arc] → m-Solumbra [Trevo XP/Solitaire FR/ERIC through the aspiration catheter]

Steps to Reperfusion

ICA and proximal M1: Penumbra ACE68/ Sofia 6 (Catalyst 6/Arc) + Prowler selector plus 45 (2.3F) + 016/014 wire

Distal M1/M2 segment: Sofia 5/ Penumbra 4Max + Excelsior 1018 45 (2.0F) + 014 wire

BA [6F Chaperon]: Sofia 5 + Excelsior 1018 + 014 wire (Previously Penumbra 3Max)

CAT using ARC

ARC can be used for clot aspiration and simultaneously for distal access during stent retriever thrombectomy (SRT)

Very Good

STROKE PRODUCT PORTFOLIO

STENT RETRIEVERS
- Solitaire™ FR

SUPPORT CATHETER
- Cello™ Balloon Guiding

The Arc™ support catheter's infinity zone shaft design provides a more navigable device compared to the Penumbra ACE™ catheter for improved M1 access.

The Arc™ support catheter unique 100% nitinol reinforcement provides more kink resistance and lumen patency throughout.

Arc™ Catheter 5MAX ACE™

 # ID larger than Penumbra 5 Max
 # For ICA & prox M1 occlusion

Product name	Length (cm)	Proximal OD (inches)	Proximal ID (inches)	Distal OD (inches)	Distal ID (inches)
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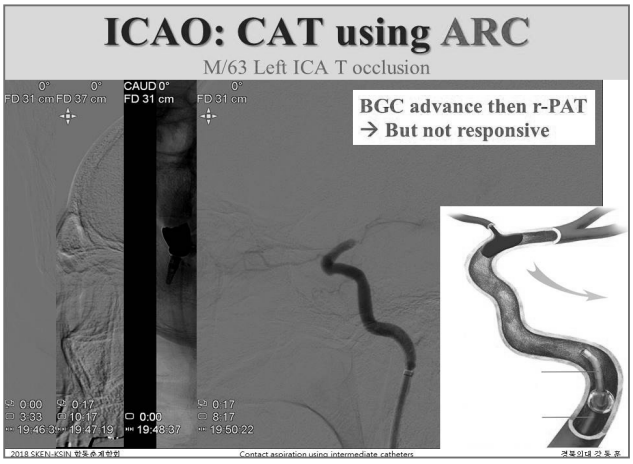

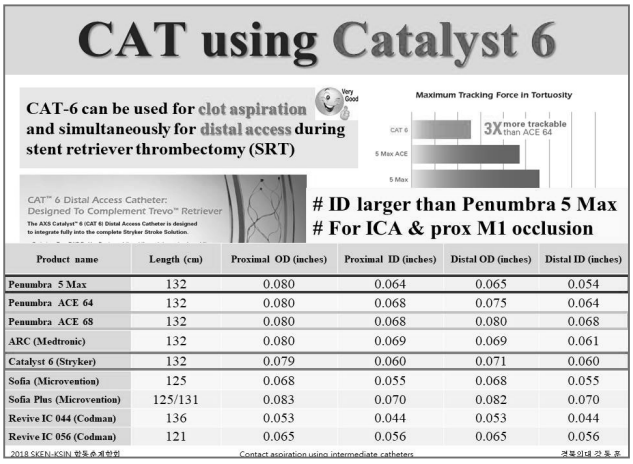

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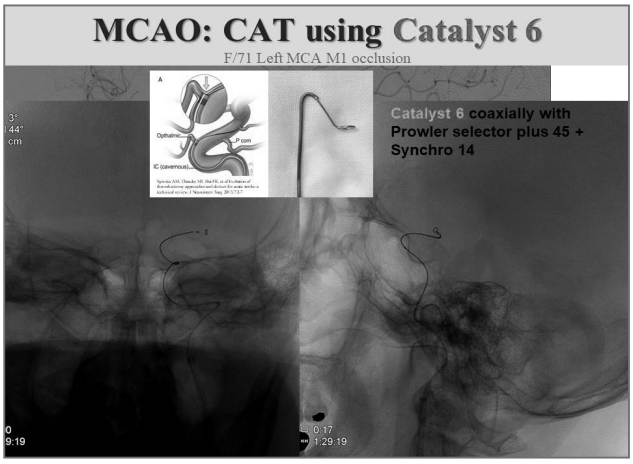

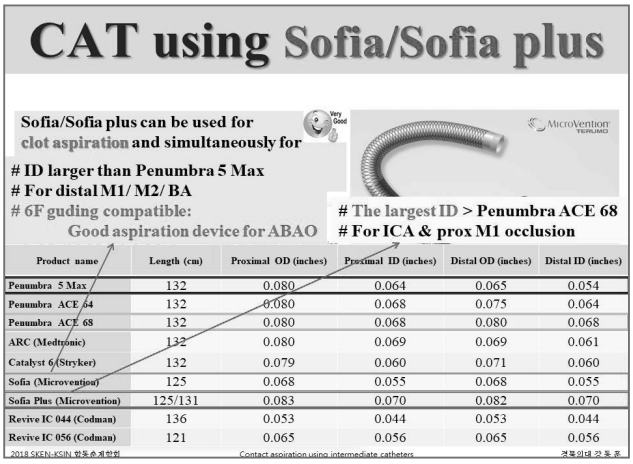

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KNUH IAT data [2016 Sep ~ 2017 Aug]

CAT based switching: Sofia 5/6

- Inclusion criteria

1. Acute ischemic stroke **within 8 hours** from symptom onset
2. Intracranial arterial occlusion **(intracranial ICA, MCA M1/M2, Basilar artery)**
3. Established with CTA or MRA
4. Endovascular treatment by **frontline CAT using Sofia catheter**

	N=67
Age, median (IQR)	73 (62-81)
Female, n (%)	30 (44.8%)
Intravenous rtPA, n (%)	13 (19.4%)
Baseline NIHSS, median (IQR)	16 (13-21)
Occluded site, n (%)	
Intracranial ICA	3 (4.5%)
Intracranial ICA/MCA	8 (11.9%)
Terminal ICA	22 (32.8%)
MCA M1	20 (29.9%)
MCA M2	4 (6.0%)
Basilar artery	9 (13.4%)
Multiple occlusion	1 (1.5%)
Time from onset to door, median (IQR)	165 (50.75-236.5)

KNUH 경북대학교병원

ORIGINAL RESEARCH Möhlenbruch M

Multicenter experience with catheter as a primary local a for acute stroke thrombecton

M A Möhlenbruch,[1] C Kabbasch,[2] A Kowoll,[3] M Müller,[6] M Wiesmann,[6] J Trenkler,[5] M Kille A Mpotsaris,[2] M Bendszus,[1] S Stampfl[1]

ABSTRACT

Introduction The direct aspiration first pass tecl (ADAPT) has been introduced as a rapid and safe endovascular treatment strategy in patients with is stroke.

Objective To determine the technical feasibility, and functional outcome with ADAPT using the ne large-bore 6F SOFIA Plus catheter.

Methods A retrospective analysis of prospectivel collected data from six university hospitals was performed. The following parameters of all acute s procedures (June 2015– January 2016) using the Plus catheter were analyzed: accessibility of the thrombus with the catheter, recanalization success (Thrombolysis in Cerebral Infarction >2b), time to

WORLD NEUROSURGERY

Contact Aspiration with the New ARC Catheter Stroke: Single-Center Results

Benjamin Gory and Francis Turjman

BACKGROUND/OBJECTIVE: Contact aspiratio gained growing acceptance in endovascular stro apy. The safety and efficacy data of the novel ARC (Medtronic, Irvine, California, USA) used for int thrombectomy have been poorly evaluated thus far. We report our preliminary results with the ARC with regard to angiographic reperfusion, duration of thrombectomy, safety, and clinical outcome at 90 days.

METHODS: In a single-center series including 20 large-vessel occlusion stroke patients who were collected pro-spectively, we retrospectively evaluated the safety and efficacy profiles of the ARC intracranial catheter for first-line contact aspiration. Successful reperfusion was defined as modified Thrombolysis in Cerebrovascular Infarction (mTICI) scores 2b–3 at final angiogram and functional independence as modified Rankin Scale score

경북대학교병원

New devices

ORIGINAL RESEARCH

Sallustio F, et al. J Neurointervent Surg 2018;

Mechanical thrombectomy of acute ischemic stroke with a new intermediate aspiration catheter: preliminary results

Fabrizio Sallustio,[1,2] Enrico Pampana,[3] Alessandro Davoli,[1] Stefano Merolla,[3] Giacomo Koch,[1,2] Fana Alemseged,[1] Marta Panella,[1] Vittoria Carla D'Agostino,[1] Francesco Mori,[1] Daniele Morosetti,[1] Daniel Konda,[1] Sebastiano Fabiano,[3] Marina Diomedi,[1] Roberto Gandini[1]

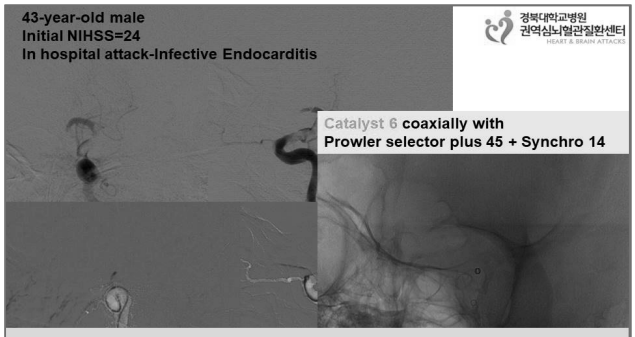
Conclusions Endovascular treatment with AXS Catalyst 6 proved to be safe, technically feasible, and effective.

ABSTRACT

Background and purpose To report clinical and procedural outcomes of acute ischemic stroke patients after endovascular treatment with the new thromboaspiration catheter AXS Catalyst 6.

Methods Patients with anterior and posterior circulation stroke were selected. Successful reperfusion defined as a Thrombolysis in Cerebral Infarction (TICI) score ≥2b and 3-month functional independence defined as a modified Rankin Scale (mRS) ≤2 were the main efficacy outcomes. Symptomatic intracranial hemorrhage and mortality were the main safety outcomes.

For the refractory cases…



CAT to m-Solumbra

FAST using Catalyst 6

→ modified Solumbra (Trevo XP through the Catalyst 6)

Conclusions

- **Intermediate catheters seems safe and effective for contact or clot aspiration thrombectomy (CAT)**
- **Based on preliminary results, primary CAT using intermediate catheters was successful (mTICI 2b-3) in 64.7% to 76.6% cases**
- **For the refractory cases, we can deliver any stent retriever through the intermediate catheters (m-Solumbra)**
- **Further prospective investigation seems necessary**

제2회 대한뇌혈관내수술학회 I 대한신경중재치료의학회

SKEN-KSIN

합동춘계학술대회

Session V. Acute Ischemic Stroke Case II

좌장 : 서울의대 **강현승**, 가톨릭의대 **김범수**

Mechanical thrombectomy within 22 hours after symptom onset in ischemic stroke	인제의대 **유민욱**
Y-stent-retrieval technique in endovascular treatment of bifurcated cerebral artery	한림의대 **박정현**
Correlation with pial arterial filling score of multiphase CT angiography and clinical outcome in patients with acute ischemic stroke treated with intra-arterial treatment: Case report	순천향의대 **우호걸**
Salvageable penumbral tissue is valuable parameter compared with the time window: 2 cases	순천향의대 **박종현**
Retrograde stent-graft insertion via surgically-exposed CCA in a patient with acute cerebral infarction due to the left CCA narrowing after total aortic arch replacement in aortic dissection with Marfan's syndrome	중앙의대 **남택균**
Ischemic stroke due to occlusion of the same site occurring at intervals of two months	영남의대 **김종훈**
Acute thrombectomy **후 발생한** complication	울산의대 **송윤선**
Dural venous sinus thrombosis in straight sinus and vein of Galen: Multistep endovascular treatment and stenting	연세의대 **백성현**

1. Mechanical thrombectomy within 22 hours after symptom onset in ischemic stroke

Minwook Yoo, Jung-Soo Kim, Sung-Chul Jin

Department of Neurosurgery, Inje University Haeundae Paik Hospital

Objective : Although ischemic stroke therapy with mechanical thrombectomy has become an increasingly important treatment modality, there is still much debate about the therapeutic effect in patients who arrive late in the emergency room after a symptom onset. We report the treatment of mechanical thrombectomy in a patient who visited in our clinic 22 hours after the onset of symptoms.

Methods : A 64-year-old man developed dysarthria, gait disturbance, and drowsy mentality, which occurred 22 hours before he was hospitalized. On arrival, brain MRI showed that Rt. infarction of MCA territory was confirmed, and CT angiography showed Rt. ICA occlusion. At mechanical thrombectomy, direct aspiration with Catalyst 6 was performed and the dark bloody clot was removed. Complete recanalization was confirmed in trans-femoral catheter angiography.

Result : After mechanical thrombectomy, the patient's condition did not deteriorate and he was admitted to the ICU for treatment. Lt. facial palsy and dysarthria were observed and the mental state was found to be drowsy similar to that before the procedure. He is scheduled to be discharged after active rehabilitation and intensive medication.

Conclusion : This is the case that mechanical thrombectomy performed 22 hours after the symptom can be safe and beneficial. More discussion about active mechanical thrombectomy will be needed.

2. Y-stent-retrieval technique in endovascular treatment of bifurcated cerebral artery

Jung Hyun Park

Department of Neurosurgery, Dongtan Sacred Heart Hospital

Objective : Stroke is a major public health problem worldwide. The introduction of stent retriever was a major advancement; however, despite their high recanalization rate, up to 89%, they are not still perfect and interventionists sometimes encounter thrombi not-retrievable.

Methods : We introduce two cases – one case was occlusion of ICA bifurcation, and the other was Basilar tip. After conventional try of stent retrieval technique, attempted Y-stent retrieval technique.

Result : Y-stent retriever technique would be successful and rescue the failure of conventional stent retrieval technique.

Conclusion : We propose Y-stent retriever as an innovative potential option when conventional attempts are unsuccessful.

3. Correlation with pial arterial filling score of multiphase CT angiography and clinical outcome in patients with acute ischemic stroke treated with intra-arterial treatment : Case report

Ho Geol Woo[1], Leonard Sunwoo[2], Seunguk Jung[4], Yun Jung Bae[2], Byung Se Choi[2], Jae Hyoung Kim[2], Beom Joon Kim[3], Moon-Ku Han[3], Hee-Joon Bae[3], Sang-Hoon Cha[5], Cheolkyu Jung[2]

[1]Department of Neurology, Soonchunhyang University Cheonon Hospital, South Korea, [2]Department of Radiology, [3]Department of Neurology, Seoul National University Bundang Hospital, South Korea, [4]Department of Neurology, Gyeongsang National University Changwon Hospital, Changwon, South Korea, [5]Department of Radiology, Chungbuk National University College of Medicine, South Korea

Case A 52-year-old male patient was admitted to our hospital with left hemiparesis and neglect syndrome. Onset to arrival time was 45 min. He had no prior medical history of hypertension, diabetes, or atrial fibrillation. The initial neurologic examination demonstrated a drowsy state, left hemiparesis, left facial palsy, dysarthria, and neglect syndrome with a NIHSS score of 18. Non-enhanced brain CT revealed no hemorrhagic density. However, perfusion CT showed small CBV/MTT mismatch in right MCA territory. Multiphase CTA (mCTA) showed an occlusion in the right proximal cervical ICA and poor pial collateral score (score 2). Intravenous tPA was administrated. Then, endovascular mechanical thrombectomy was performed on a biplane angiography machine. We used a 9-French balloon guiding catheter. A 0.021-inch microcatheter and a 0.014-inch microguidewire were advanced to the proximal end of the occluded segment. Then, mechanical thrombectomy with the stent retriever was performed. A large thrombus wedged within stent retriever was shown, and complete reperfusion was achieved (mTICI 3). Procedure time was 22 min and onset to reperfusion time was 120 min. One-day follow-up with brain CT revealed no hemorrhagic complications with a NIHSS score of 5. One weak follow up with brain MRI revealed a high signal in the right frontoparietal cortex, insular cortex, caudate and basal ganglia. At discharge, mRS was 2. Favorable outcome was shown at 90 days (mRS 0). Discussion Menon et al demonstrated that mCTA (〉3 versus ≤3) was more sensitive imaging modality to discriminate clinical outcome at 90 days within 12 hours of stroke symptom onset than other image modalities. However, we need validation study for cut-off score of mCTA in which the collateral status using mCTA would be more predictable to determine clinical outcome in the setting of IAT for patients with acute ischemic stroke within the 4.5 hours from symptom onset.

4. Salvageable penumbral tissue is valuable parameter compared with the time window: 2 cases

Jong-Hyun Park, Dong-Sung Shin, Bum-Tae Kim

Department of Neurosurgery, Soonchunhyang University Bucheon Hospital

Objective : Recently, the results of the DAWN (DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo) trial show outcomes for disability were better with thrombectomy plus standard medical care than with standard medical care alone among patients with acute stroke who received treatment 6 to 24 hours after they had last been known to be well and who had a mismatch between the severity of the clinical deficit and the infarct volume. However, safety profile for thrombectomy is still argument

Methods : First case, 72-year-old female with a history of hypertension presented with mental deterioration with left sided hemiparesis. She presented first to a community hospital and was transferred to our center 24 h after onset. MRI demonstrated more extensive restricted diffusion involving right posterior temporoparietal lobe on local institute right occipital lobe comparing with initial MR diffusion scan. Second case, previously healthy 58-year-old male presented with right sided hemiparesis. He presented first to our center 24 h after onset. On arrival at our facility his Initial National Institutes of Health stroke scale (NIHSS) score was 6. Stroke protocol MRI demonstrated Multifocal diffusion restriction in the left frontal cortex, PVWM and insula and Multifocal decreased CBF in the left F-T-P lobes, MCA territory on perfusion image. MR angiography and CT angiography confirmed complete occlusion of left proximal ICA.

Result : Mechanical thrombectomy was performed in 2 patients over at least 36 hours from onset by simultaneously uses both the stent retriever and the large-bore aspiration catheter at once to enhance the efficacy of recanalization. Both patients had excellent angiographic results with recannlization after thrombectomy. Follow-up MR scan showed no change in 1 patient and hemorrhagic transformation after thrombectomy occurred in the other. However, these were no mass effect. Both patients had excellent clinical outcome with no or mild neurological deficits.

Conclusion : Our cases show salvageable penumbral tissue is valuable parameter for making decision to perform thrombectomy in patients with acute ischemic strokes instead of on a pre-specified time window.

5. Retrograde stent-graft insertion via surgically-exposed CCA in a patient with acute cerebral infarction due to the left CCA narrowing after total aortic arch replacement in aortic dissection with Marfan's syndrome

Taek Kyun Nam[1], Hyun Ho Choi[1], Jun Soo Byun[2]

Department of Neurosurgery[1], and Neuroradiology[2], Chung-Ang University Hospital

Objective : A 31-year-old female patient visited the ER with chest discomfort, palpitation, and dyspnea 2 days before. She had a family history of Marfan's syndrome. A chest CT scan revealed Stanford type A aortic dissection involving from ascending aorta to bilateral common iliac arteries, and dilatation of the aortic root (up to 4 cm, R/O underlying Marfan's syndrome). Cardiac Surgeon performed emergency surgery (total aortic arch replacement). At 2 days after the operation, mental decrease (stupor) and right hemiplegia (Gr. 0) developed. Diffusion MRI showed small areas of hyperacute infarction in the left parietal cortex/subcortex and centrum semiovale. Head & neck CT angiography revealed severe luminal narrowing of left proximal CCA (1cm form OS), probably periaortic hematoma with false lumen thrombus.

Methods : Under general anesthesia, distal CCA was exposed by carotid dissection with 5 cm vertical incision. With 8F sheath, 5F KMP catheter and 035 guidewire inserted into the aorta through the luminal narrowing site. Unfortunately, the first Seal bifurcated stent-graft (10/40 mm) was deployed at the aorta. But, the second Seal bifurcated stent-graft (10/60 mm) was deployed at the narrowing site and angioplasty was done with Mustang balloon (7/40 mm). Finally, the first stent graft in the aorta was removed with a Snare (25 mm).

Result : At 6 days after the procedure, she was transferred from ICU into the general ward. Her consciousness and motor weakness improved (Gr. IV).

Conclusion : We have experienced a rare case of acute cerebral infarction and have helped the patient to recover through successful treatment using retrograde stent-graft insertion via surgically-exposed CCA.

6. Ischemic stroke due to occlusion of the same site occurring at intervals of two months

Jong-Hoon Kim, Kyung-Sik Choi, Young-Jin Jung, Chul-Hoon Chang

Department of Neurosurgery, Yeungnam University Medical Center

Objective : We report a rare case of ischemic stroke due to occlusion of the same site occurring at intervals of two months.

Methods : In November 2016, a 70-year-old male patient with the chief complaint of stuporous conscious level arrived at the emergency department. The patient began to show symptoms one hour before arrival at hospital. The patient initial National Institute of Health Stroke Scale(NIHSS) score was 17. Brain CTA and digital subtraction angiography(DSA) showed a distal basilar artery and left posterior cerebral artery occlusion. Perfusion MR showed severe decrease in perfusion in the left thalamus and PCA territory.

Result : Intra-arterial(IA) thrombectomy was performed via Rt. radial artery, because we could not access both femoral arteries. The occluded site was fully recanalized (modified Thrombolysis in Cerebral Infarction Grade 3). The patient was improved and underwent active rehabilitation. However, after two months, the patient visited the emergency department again and was diagnosed with the same site occlusion and received the same operation as two months ago. The patient was improved again, and underwent active rehabilitation.

Conclusion : We assume that intracranial atherosclerosis(ICAS) is the cause, but we still do not know exactly why the occlusion of the same site occurred at intervals of two months.

7. Acute thrombectomy 후 발생한 complication

송윤선, 이덕희

서울아산병원 영상의학과

CASE1 stent-retreiver를 이용한 thrombectomy 중 microguidewire에 의한 tiny cortical vessel perforation에 대해 coil을 이용해 parent artery를 embolization 했던 케이스

*포인트 "cortical artery perforation에 대한 대처방법 논의"

CASE2 distal access catheter를 이용해 direct aspiration thrombectomy 직후 BG에 contrast leakage 관찰되었으며 DynaCT에서 large hematoma 관찰되었던 케이스

*포인트 "thrombectomy후 직후 바로 leak를 보이는 경험 문의, 예방법 논의"

8. Dural venous sinus thrombosis in straight sinus and vein of Galen: Multistep endovascular treatment and stenting

Sung Hyun Baik, Hyung Jong Park, Dong Joon Kim, Byung Moon Kim

Department of Radiology, Severance Hospital, Yonsei University College of Medicine

Objective : We present a case with rapidly progressive neurologic decline in the setting of cerebral hemorrhage and edema due to dural venous sinus thrombosis (DVST) from Lt sigmoid sinus to vein of Galen despite intravenous heparin administration. We report our experience using multistep endovascular treatment with balloon angioplasty and stenting for DVST in straight sinus and vein of Galen.

Methods : A 65-year old woman with DVST were treated using mechanical thrombectomy and multistep balloon angioplasty and stentings in left sigmoid, transverse, straight sinus and vein of Galen.

Result : Successful mechanical thrombectomy, balloon angioplasty and stenting were achieved in left sigmoid, transverse, straight sinus and vein of Galen. Flow restoration in occluded sinuses was noted on final venogram. No complications were encountered during the procedure and no postprocedural complications were attributable to the endovascular treatment. Follow-up imaging documented continued sinus patency and reversed DWI abnormalities and decreased edema. Neurologic improvement was seen one day after procedure. The patient eventually had an excellent recovery and discharged from hospital 2 weeks after procedure.

Conclusion : This case report presents the possibility of endovascular treatment with multistep mechanical thrombectomy, balloon angioplasty and stenting for DVST in straight sinus and vein of Galen.

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