Korean Society of Cerebrovascular Surgeons
대한뇌혈관외과학회

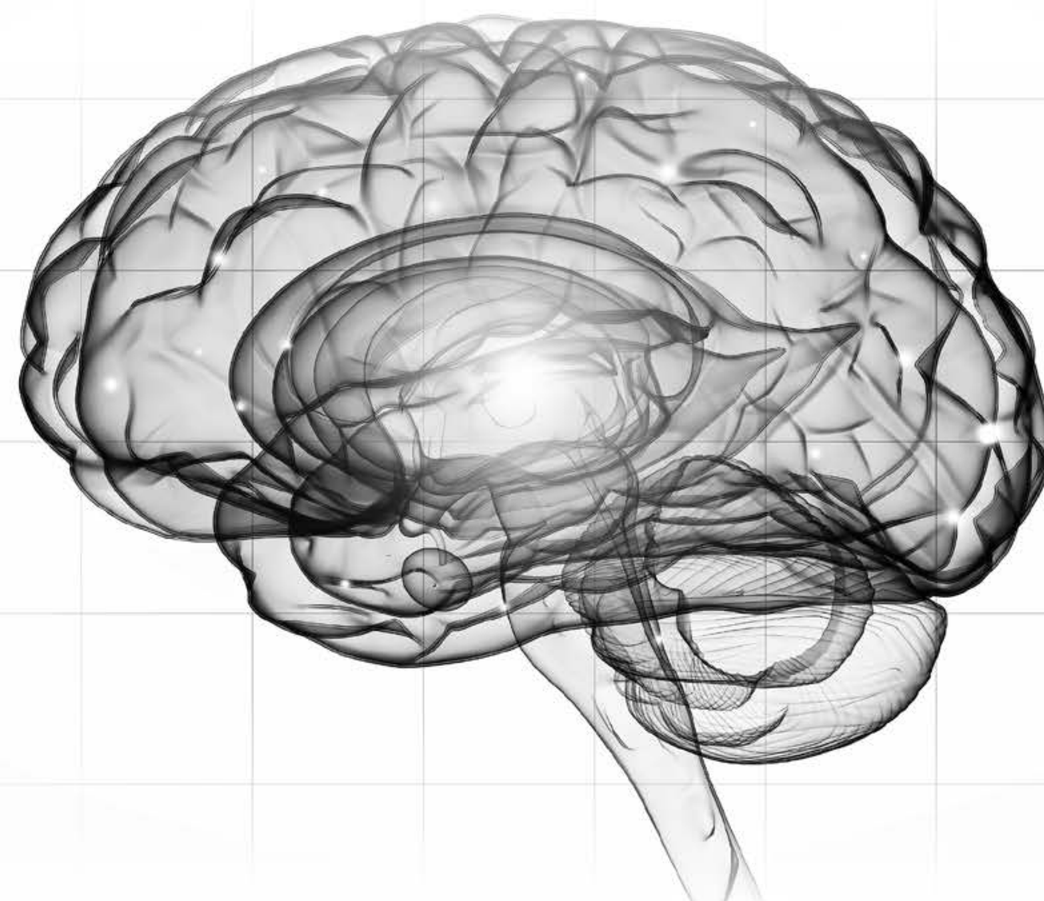
대한뇌혈관내치료의학회/ 대한뇌혈관외과학회 합동연수교육

(2021 대한뇌혈관내치료의학회 추계보수교육 및 ARCS)

일시 | **2021년 10월 1일**(금)

장소 | 판교 차바이오컴플렉스 지하 1층 대강당

평점 | 4점



주최 | 대한뇌혈관내치료의학회, 대한뇌혈관외과학회

주관 | 대한신경외과학연구재단

2020~2021 대한뇌혈관내치료의학회 임원진

명예회장

직위	성명	소속
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고현송	충남대병원
김태선	전남대병원
임동준	고려대 안산병원
박익성	가톨릭대 부천성모병원
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나형균	전)가톨릭의대

인사말

존경하는 대한뇌혈관내치료의학회 및 대한뇌혈관외과학회, 급성뇌경색치료연구회 회원 여러분!

기나긴 코로나 감염병의 터널 속에서 고군분투하고 계신 여러 회원님들께 경의를 표하며, 2021 KSCVS/KoNES 및 KoNES 추계보수교육 (ARCS)을 안내하고자 합니다. 최근 몇 년간 Ischemic stroke 환자의 증가와 새로운 연구내용이 발표되어 이에 대한 재정리를 하고 여러 회원님들과 공유하기 위해 이번 연수교육에서는 “Re-establishment of Ischemic Stroke” 라는 테마로 국내 유수병원의 각 분야 전문가들을 모시고 연수교육을 진행하고자 합니다.

이번 연수교육 통해 신경외과 의사로서 Ischemic stroke 에 접근하는 여러 방법을 공유하는 좋은 기회가 될 것으로 기대하고 있습니다.

아무쪼록 무더운 여름이 끝나고 선선한 바람이 부는 10월 1일 학회장에서 건강한 모습으로 뵙길 기대하면서, 2021 KCVS/KoNES 합동연수교육 및 KoNES 추계보수교육 (ARCS)에 여러 회원님들을 초대합니다.

감사합니다.

대한뇌혈관내치료의학회 회장 윤 석 만
급성뇌경색치료연구회 (ASTRO) 회장 신 승 훈

인사말

회원 여러분 안녕하셨습니까?

코로나 팬더믹으로 인한 거리두기의 수위가 점점 높아지고 비관적인 여론이 많음에도 불구하고, 이번 합동 연수교육을 준비해 주신 대한 뇌혈관내 치료의학회 윤석만 회장님을 비롯한 집행진분들께 먼저 감사를 드립니다. 아무리 코로나 팬더믹이더라도 저희의 학구열은 결코 줄어들지 않을 것입니다.

3개의 session으로 구성된 이번 합동연수교육은 허혈성 뇌혈관질환에 대하여 최신 지견 및 전문가들의 경험을 서로 공유하고 토론하는 좋은 장이 될 것 같습니다. 또 연자분들 중에는 능력있고 혈기넘치는 젊은 교수님들이 많이 보입니다. 저희 학회가 점점 젊어지고 자연스러운 세대교체의 좋은 징후라 생각됩니다.

아무쪼록 코로나 시기에 건강 조심하시고 자주 만나서 지식을 공유하고 토론하는 기회가 많이 있기를 바랍니다.

감사합니다.

대한뇌혈관외과학회 회장 김 태 선

프로그램

대한뇌혈관내치료의학회/ 대한뇌혈관외과학회 합동연수교육

(2021 대한뇌혈관내치료의학회 추계보수교육 및 ARCS)

일 시 | 2021년 10월 1일(금)
장 소 | 판교 차바이오컴플렉스 지하 1층 대강당

09:30-10:20	Registration		
10:20-10:30	Opening Remark	윤석만 (대한뇌혈관내치료의학회 회장) 김태선 (대한뇌혈관외과학회 회장)	
10:30-11:50	**Session 1. Ischemic stroke etiology**	좌장 : 고현송(충남대), 고준석(경희대)	
10:30-10:50	**TOAST classification and its connection to LVO / IAT**	곽동석 (경북대병원 신경과)	16
10:50-11:10	**AF and Cardioembolic stroke**	송여정 (해운대백병원 순환기내과)	26
11:10-11:30	**Cardioembolic stroke 1: Overview and intra-IAT / post-IAT care**	장준영 (서울아산병원 신경과)	32
11:30-11:50	**Cardioembolic stroke 2: IAT**	신동성 (순천향대 부천병원)	45
11:50-13:00	**Lunch break**		
13:00-14:15	**Session 2. Carotid revascularization strategy**	좌장 : 김태선(전남대), 윤석만(순천향대)	
13:00-13:25	**Carotid endarterectomy**	김용배 (연세대 세브란스병원)	50
13:25-13:50	**EC-IC Bypass**	윤원기 (고려대 구로병원)	59
13:50-14:15	**Carotid stenting**	이동훈 (가톨릭대 성빈센트병원)	60
14:15-14:30	**Coffee Break**		
14:30-16:00	**Session 3. Expert experience for special situations in LVO**	좌장 : 임동준(고려대), 장철훈(영남대)	
	Medium Vessel Occlusions		
14:30-14:45	**Medium vessel occlusions**	정영진 (영남대병원)	80
14:45-15:00	**Medium vessel occlusions**	하상우 (조선대병원)	90
	LVO with underlying Intracranial arterial stenosis		
15:00-15:15	**LVO with underlying Intracranial arterial stenosis**	홍대영 (에스포항병원)	95
15:15-15:30	**LVO with underlying Intracranial arterial stenosis**	양구현 (울산대 강릉아산병원)	114
	Acute tandem EC and IC occlusions		
15:30-15:45	**Acute tandem EC and IC occlusions**	박정현 (한림대 동탄성심병원)	115
15:45-16:00	**Acute tandem EC and IC occlusions**	조용환 (동아대병원)	118
16:00	**Closing Remark**	신승훈 (급성뇌경색치료연구회 회장)	

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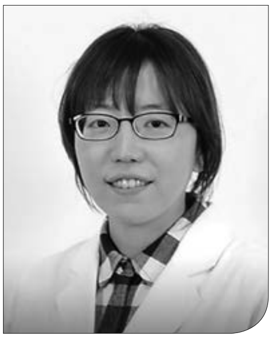
World stroke organization 회원



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Professional Experience

2005. 3 – 2006. 2	Intern, Seoul National University Hospital, Seoul, South Korea
2006. 3 – 2010. 2	Resident, Seoul National University Hospital (specialty: neurology)
2010. 3 – 2013. 4	Public Health Doctor (Obligation to male doctors in Korea) Department of Neurology, Chilgok Geriatric Hospital
2013. 5 – 2014. 2	Clinical Fellow, Department of Critical Care Medicine, Seoul National University BunDang Hospital (specialty: neurocritical care)
2014. 3 – 2015. 2	Clinical Fellow, Department of Neurosurgery, Seoul National University BunDang Hospital (specialty: neurointervention)
2015. 3 – 2016. 2	Clinical Fellow, Department of Neurology, Seoul National University BunDang Hospital (specialty: stroke)
2016. 3 – 2017. 8	Clinical Assistant Professor, Department of Neurology, Gyeongsang National University Changwon Hospital
2017. 9 – 2018. 2	Assistant Professor, Gyeongsang National University School of Medicine, Department of Neurology
2018. 3 – 2021. 2	Clinical Assistant Professor, Department of Neurology, Asan Medical Center
2021. 3 – Present	Associate Professor, Department of Neurology, Asan Medical Center, University of Ulsan, College of Medicine

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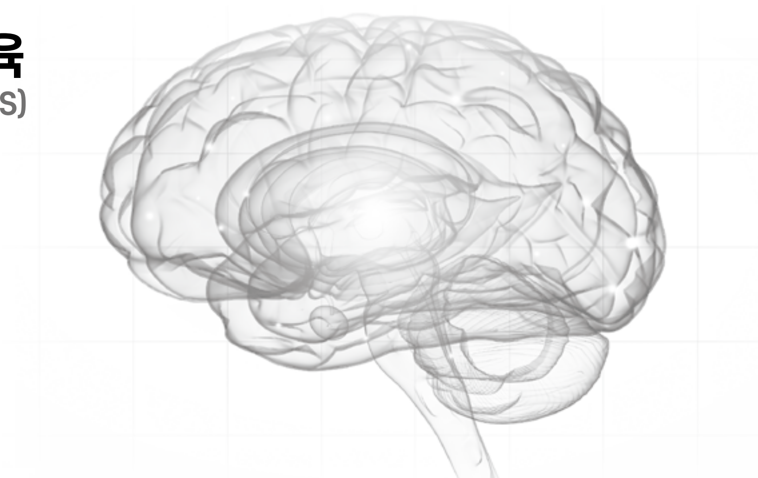
2006 –	Member of the Korean Neurological Association
2013 –	Member of the Korean Society of Critical Care Medicine
2013 –	Member of the Korean Neurocritical Care Society
2017 –	Member of Neurocritical Care Society
2017 –	Associate editor of the Journal of Neurocritical Care
2018 – 2019	A member of the academic committee of the Korean Stroke Society
2018 –	A Secretary of the general committee of the Korean Stroke Society

대한뇌혈관내치료의학회/
대한뇌혈관외과학회 합동연수교육

(2021 대한뇌혈관내치료의학회 추계보수교육 및 ARCS)



Session 1. Ischemic stroke etiology

좌장 : 고현송(충남대), 고준석(경희대)

1. TOAST classification and its connection to LVO / IAT
곽동석(경북대병원 신경과)

2. AF and Cardioembolic stroke
송여정(해운대백병원 순환기내과)

3. Cardioembolic stroke 1: Overview and intra-IAT / post-IAT care
장준영(서울아산병원 신경과)

4. Cardioembolic stroke 2: IAT
신동성(순천향대 부천병원)

TOAST classification and its connection to LVO / IAT

곽동석

경북대병원 신경과

Contents

- TOAST Classification
- Modifications of the TOAST classification
- Endovascular considerations for LVO
  - ICAD occlusion vs embolic occlusion

Classification of ischemic stroke

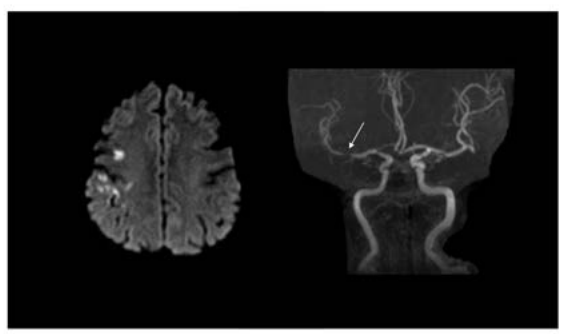
- Ischemic stroke is a heterogeneous neurological disorder.
- Its functional outcome, recurrence, and strategies for secondary prevention differ by subtype.
- To institute adequate treatment as rapidly as possible and to enable robust research in these areas, accurate classification of different stroke syndromes into homogenous subgroups is important.

TOAST Classification
(Trials of Org 10172 in Acute Stroke Treatment)

Subtype
Large-artery atherosclerosis (embolus/thrombosis)
Cardioembolism (high-risk / medium risk)
Small-vessel occlusion (lacune)
Stroke of other determined etiology
Stroke of undetermined etiology
a. Two or more causes identified
b. Negative evaluation
c. Incomplete evaluation

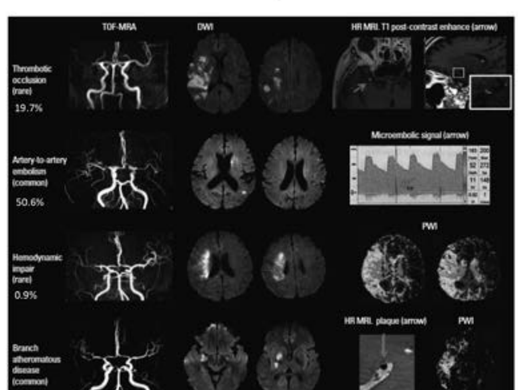
Stroke. 1993 Jan;24(1):35-4

Large-artery atherosclerosis



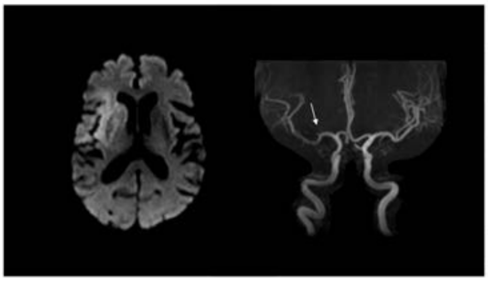
- Cortical/cerebellar lesions
- Brainstem/subcortical lesions > 1.5 cm
- Significant (>50%) stenosis or occlusion of relevant artery due to atherosclerosis
- Clinical findings
  - Cortical symptoms
  - Brainstem sign
  - Cerebellar dysfunction
  - Prior Hx of TIA
  - Carotid bruit
- Exclude sources of cardiogenic embolism

Stroke mechanisms in patients with LAA



J Stroke 2014;16:27.
Stroke 2012;43:3313.

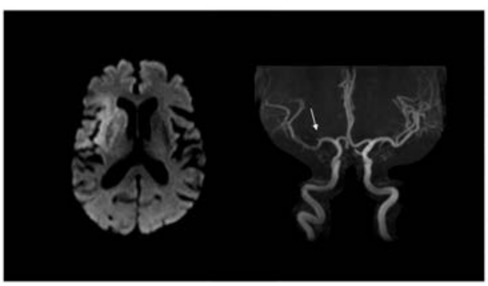
Cardioembolism



- Multiple vascular territory, h/o TIA, systemic embolism
- Embolic source w/u: EKG, TTE, 24h holter, etc.

High-risk source	Medium-risk source
Mechanical prosthetic valve	Mitral valve prolapse
Mitral stenosis with AF	Mitral annulus calcification
AF (other than lone AF)	MS without AF
LAA thrombus	LA turbulence (smoke)
Sick sinus syndrome	Atrial septal aneurysm
Recent MI (<4 weeks)	PFO
LV thrombus	Atrial flutter
Dilated cardiomyopathy	Lone AF
Akinetic left ventricular segment	Bioprosthetic cardiac valve
Atrial myxoma	Nonbacterial thrombotic endocarditis
Infective endocarditis	Congestive heart failure
	Hypokinetic left ventricular segment
	MI >4 weeks, <6 months

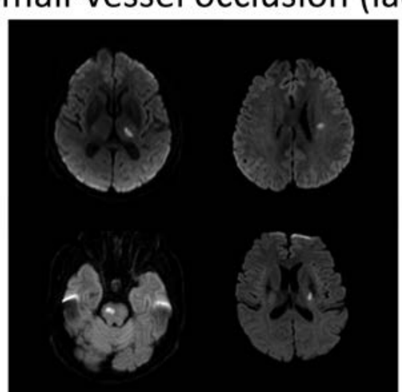
Cardioembolism: modified



High-risk source	Medium-risk source
Mechanical prosthetic valve	Mitral valve prolapse
Mitral stenosis with AF	Mitral annulus calcification
AF (other than lone AF)	~~MS without AF~~
LAA thrombus	LA turbulence (smoke)
Sick sinus syndrome	Atrial septal aneurysm
Recent MI (<4 weeks)	PFO
LV thrombus ←	Atrial flutter
Dilated cardiomyopathy ←	Bioprosthetic cardiac valve
Akinetic left ventricular segment ←	Nonbacterial thrombotic endocarditis
Atrial myxoma ←	Congestive heart failure, EF <30%
Infective endocarditis	Hypokinetic left ventricular segment
Papillary fibroelastoma ←	Chronic MI with EF <28%
Rheumatic mitral or aortic valve disease	Mitral annulus calcification
	Ventricular aneurysm without thrombus
	Complex atheroma in ascending or proximal aortic arch

Ann Neurol. 2005 Nov;58(5):68

Small-vessel occlusion (lacune)



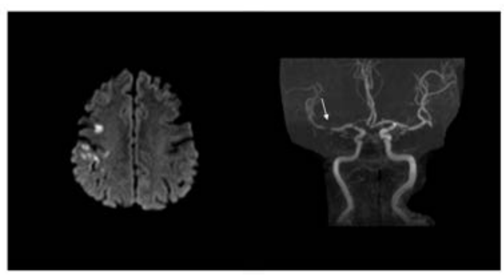
- Subcortical/brainstem lesions < 1.5 cm
- No cortical dysfunction
- Cardioembolic source (-) relevant artery stenosis (-)

Stroke of other determined etiology

Vasculopathy	Hematologic cause
a. Noninflammatory vasculopathy	a. Disorders of coagulation
arterial dissection	protein C / S deficiency
fibromuscular dysplasia	Antiphospholipid antibody syndrome
vasospasm	b. Red cell disorder
reversible cerebral vasoconstriction syndrome (RCVS)	sickle cell anemia
radiation-induced vasculopathy	polycythemia vera
Moyamoya disease	c. Platelet disorder
hereditary disease – homocysteinuria, Fabry disease, CADASIL, etc.	essential thrombocytosis
b. Inflammatory vasculopathy	
isolated angiitis of CNS	**Miscellaneous unusual cause**
gaint cell arteritis	MELAS (mitochondrial encephalopathy, lactic acidosis, and stroke-like episode)
collagen vascular disease – polyarteritis nodosa, Churg-Strauss syndrome, SLE	atypical embolism – fat, air, tumor, cholesterol
infectious arteriopathy – syphilis, Tbs, AIDS, bacterial/viral/fungal infection	cerebral venous thrombosis
toxic-related arteriopathy – amphetamine, cocaine, LSD, heroin	
neoplasm-related arteriopathy	

Stroke of undetermined etiology

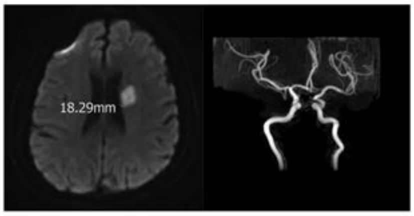
- Two or more causes identified

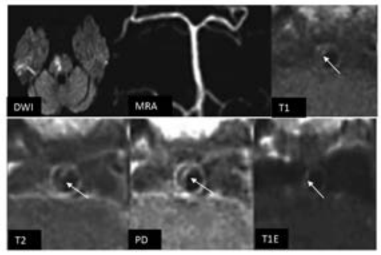


Stroke of undetermined etiology

- Negative evaluation
- Incomplete evaluation

Limitations of TOAST classification





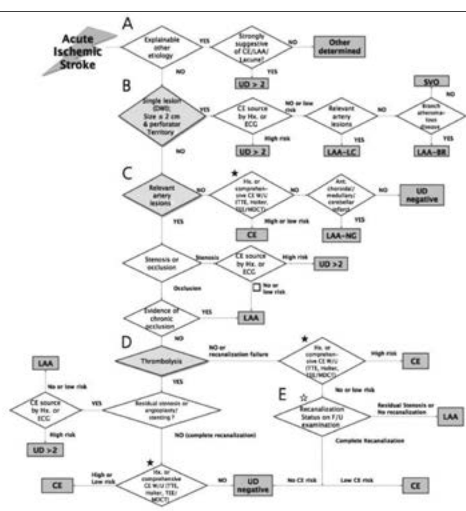
- Undetermined etiology ↑: 25-39%

Cerebrovasc Dis 2016;41:87–95
Cerebrovasc Dis 2009; 27:493-501

MRI-based Algorithm for classification

- Recanalization status after thrombolytic therapy
- Follow-up recanalization status without thrombolytic therapy
- SVO: a single lesion with the largest diameter of ≤20 mm
- Relevant artery stenosis or occlusion
  - **LAA-LC** (large artery atherosclerosis with lacune)
  - **LAA-BR** (large artery atherosclerosis – branch atheromatous disease)
  - **LAA-NG** (large artery atherosclerosis with normal angiography): AChA, single territory of cerebellum, medulla oblongata
  - Stenosis < 50% was also regarded as being relevant when clinical syndromes, lesions patterns on DWI, and new imaging techniques such as high-resolution wall imaging supported its relevance.

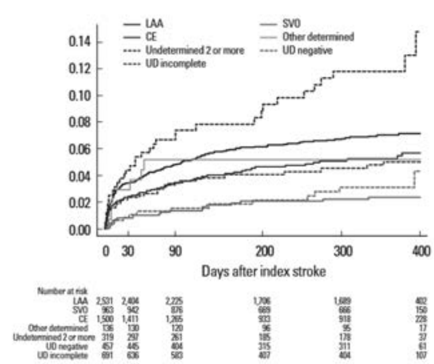
J Stroke. 2014 Sep;16(3):161-7



Stroke subtype: Baseline characteristics

	LAA	SVO	CE	OD	UD two or more	UD negative	UD incomplete	P-value
Number of patients	2,541 (38.3)	964 (14.6)	1,508 (22.8)	138 (2.1)	320 (4.8)	457 (6.9)	696 (10.5)	
Male	1,563 (61.5)	599 (62.1)	792 (52.5)	81 (58.7)	183 (57.2)	297 (65.0)	404 (58.0)	<0.001*
Age (years), mean ± SD	67.7 ± 12.2	64.0 ± 12.4	71.9 ± 11.6	52.4 ± 16.4	72.4 ± 11.0	65.2 ± 13.0	69.4 ± 12.6	<0.001†
FAT to arrival (h), median (IQR)	12 (3-43)	14 (4-41)	3 (1-11)	11 (1-48)	5 (1-25)	6 (1-36)	7 (2-33)	<0.001‡
Initial NIHSS, median (IQR)	4 (2-7)	2 (1-4)	8 (2-15)	2 (1-6)	5 (2-12)	3 (1-7)	5 (2-12)	<0.001‡
Previous mRS								<0.001*
0	1,998 (78.6)	808 (83.8)	1,159 (76.9)	110 (79.7)	245 (76.6)	389 (85.1)	513 (73.7)	
1-5	543 (21.4)	156 (16.2)	349 (23.1)	28 (20.3)	75 (23.4)	68 (14.9)	183 (26.3)	
History of stroke	575 (22.6)	152 (15.8)	355 (23.5)	31 (22.5)	87 (27.2)	77 (16.8)	127 (18.2)	<0.001*
Hypertension	1,790 (70.4)	628 (65.1)	1,034 (68.6)	69 (50.0)	248 (77.5)	266 (58.2)	428 (61.5)	<0.001*
Diabetes mellitus	975 (38.4)	322 (33.4)	439 (29.1)	22 (15.9)	105 (32.8)	111 (24.3)	196 (28.2)	<0.001*
Hyperlipidemia	865 (34.0)	307 (31.8)	419 (27.8)	26 (18.8)	87 (27.2)	163 (35.7)	160 (23.0)	<0.001*
Coronary artery disease	172 (6.8)	50 (5.2)	180 (11.9)	4 (2.9)	43 (13.4)	38 (8.3)	47 (6.8)	<0.001*
Current smoking	1,070 (42.1)	455 (47.2)	461 (30.6)	53 (38.4)	107 (33.4)	195 (42.7)	269 (38.6)	<0.001*
Atrial fibrillation	10 (0.4)	1 (0.1)	1175 (77.9)	1 (0.7)	265 (82.8)	0 (0)	20 (2.9)	<0.001*
Total cholesterol (mg/dL), mean ± SD	200.1 ± 131.5	191.4 ± 95.3	183.2 ± 127.1	221.5 ± 209.8	189.4 ± 127.9	192.0 ± 115.2	199.3 ± 141.0	<0.001†
FBS (mg/dL), mean ± SD	163.3 ± 190.9	149.6 ± 171.7	176.3 ± 217.7	178.0 ± 234.6	170.7 ± 207.0	147.6 ± 181.3	160.7 ± 171.2	0.014†
SBP (mmHg), mean ± SD	141.7 ± 31.5	154.8 ± 29.4	143.2 ± 34.2	139.3 ± 22.2	147.7 ± 28.1	144.6 ± 26.0	144.1 ± 41.5	<0.001†
DBP (mmHg), mean ± SD	85.2 ± 23.7	90.5 ± 17.2	84.5 ± 28.8	81.8 ± 13.5	85.6 ± 18.0	85.3 ± 15.1	84.6 ± 37.9	<0.001†
Thrombolysis								<0.001*
IV	188 (7.4)	49 (5.1)	241 (16.0)	8 (5.8)	47 (14.7)	46 (10.1)	67 (9.6)	
IA	64 (2.5)	0 (0)	81 (5.4)	1 (0.7)	11 (3.4)	15 (3.3)	11 (1.6)	
IV+IA	61 (2.4)	0 (0)	136 (9.0)	4 (2.9)	13 (4.1)	26 (5.7)	23 (3.3)	

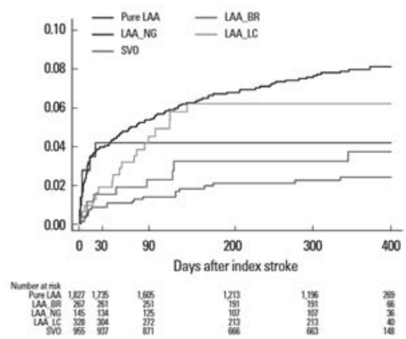
Stroke subtype: Recurrent stroke



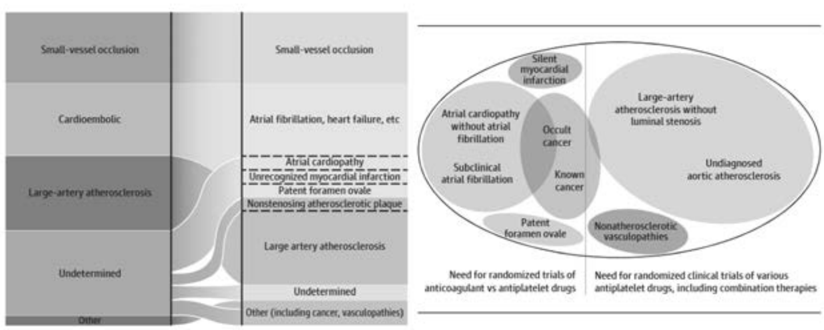
Special categories of MAGIC: Baseline characteristics

	Pure-LAA n = 1,837	LAA-LC n = 328	LAA-BR n = 267	LAA-NG n = 145	SVO n = 956	P-value
Male	1,158 (63.0)	183 (55.8)	134 (50.2)	109 (75.2)	594 (62.1)	<0.001*
Age (years), mean ± SD	68.2 ± 12.2	68.6 ± 12.2	67.0 ± 10.8	61.3 ± 12.7	63.9 ± 12.7	<0.001†
FAT to arrival (h), median (IQR)	10 (2-46)	15 (4-39)	17 (5-41)	15 (4-45)	14 (4-40)	<0.001‡
Initial NIHSS, median (IQR)	4 (2-8)	3 (1-5)	3 (2-5)	2 (1-4)	2 (1-4)	<0.001‡
History of stroke	428 (23.3)	81 (24.7)	52 (19.5)	19 (13.1)	150 (15.7)	<0.001*
Coronary artery disease	133 (7.2)	18 (5.5)	14 (5.2)	8 (5.5)	50 (5.2)	<0.001*
Hypertension	1278 (69.6)	254 (77.4)	187 (70.0)	95 (65.5)	624 (65.3)	<0.001*
Diabetes mellitus	668 (36.4)	140 (42.7)	120 (44.9)	57 (39.3)	321 (33.6)	<0.001*
Hyperlipidemia	640 (34.8)	107 (32.6)	84 (31.5)	42 (29.0)	305 (31.9)	<0.001*
Current smoking	809 (44.0)	115 (35.1)	86 (32.2)	74 (51.0)	452 (47.3)	<0.001*
Thrombolysis						<0.001*
IV	152 (8.3)	14 (4.3)	18 (6.7)	6 (4.1)	49 (5.1)	
IA	58 (3.2)	5 (1.5)	0 (0)	1 (0.7)	0 (0)	
IV+IA	60 (3.3)	5 (1.5)	0 (0)	0 (0)	0 (0)	

Special categories of MAGIC: Recurrent stroke



Reclassification based on emerging evidence



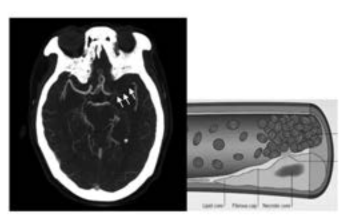
JAMA Neurol. 2019 Jul 1;76(7):855-

Endovascular considerations for LVO : Intracranial atherosclerosis vs Embolism

- Stent retriever or direct aspiration system – primarily designed for recanalization of the occluded artery by removing embolus.
- Recanalization may not be sufficiently achieved if a significant atherosclerotic stenosis is present at the occlusion site.

- ICAS occlusion: frequent in Asian countries

	MCA M1 occlusion (n=78)	ICA T occlusion (n=54)	Vertebrobasilar occlusion (n=25)
Atherosclerotic	18 (23)	3 (6)	10 (40)
Embolic	58 (74)	44 (81)	13 (52)
Dissection	1 (1)	1 (2)	1 (4)
Undetermined	1 (1)	6 (11)	1 (4)



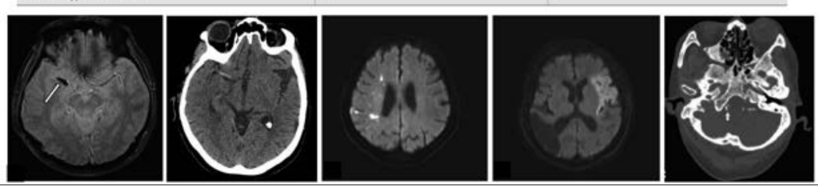
J Stroke. 2017;19(2):143-151.

Surrogate markers suggested of ICAD occlusion : Before starting IAT

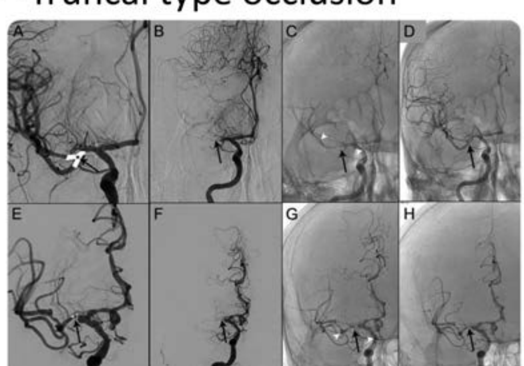
	ICAS-O	EMB-O
Clinical factors		
Younger age	++	+
Male gender	++	+
More severe initial severity	+	++
Relative frequency in vertebrobasilar bed	++	++
Relative frequency in MCA M1	+	+++
Relative frequency in ICA T	±	+++
Higher total cholesterol level	+	±
Smoking	++	+
Atrial fibrillation	±	++++

Surrogate markers suggested of ICAD occlusion : Before starting IAT

Imaging factors	ICAD-Occlusion	Embolic occlusion
Clot sign on GRE	+	+++
Hyperdense artery sign on CT	+	++
Smaller baseline DWI lesion volume	++	+
Large territorial infarct pattern	+	+++
Scattered/border-zone infarct pattern	+++	+
Vessel calcification in VB bed on CT	+++	+
Truncal type occlusion	++	+



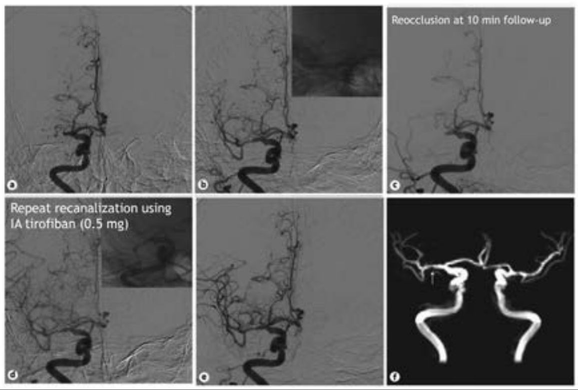
ICAD occlusion: During IAT – Truncal type occlusion



- Branching site occlusion
- Truncal type occlusion

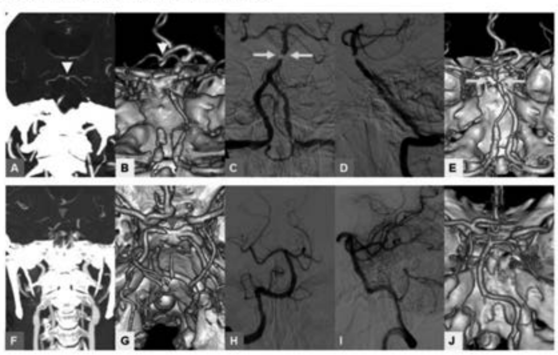
Neurology. 2016 Oct 11;87(15):1542-1550.

ICAD occlusion: During IAT – Interval angiographic change



Cerebrovasc Dis 2014;37:350–5.

ICAD occlusion: During IAT – Fixed focal stenosis



Front Neurol 2019;9:1195.

ICAD occlusion: Post-IAT

- Residual stenosis ≥ 50% at short-term follow-up angiography or image

Comparisons of ICAD occlusion identification methods

- Truncal type occlusion / Branching site occlusion
  - Identification before IAT using CTA.
  - Not applicable with CAT technique.
  - Risk of false identification

- Interval angiographic change / Fixed focal stenosis
  - Most explicit method
  - Not applicable before IAT.
  - Applicable with both SRT and CAT technique.

Take home messages

- Importance of stroke classification: functional outcome, recurrence, and strategies for secondary prevention differ by subtype.
- TOAST Classification
  - LAA / CE / SVO / OD /UE
  - Limitations of TOAST Classification: Lacune ≤15mm, LAA: stenosis ≥50%, UD etiology ↑
- Reclassification of stroke etiology
  - nonstenosing atherosclerotic plaque
  - potential embolic sources: atrial cardiopathy, subclinical AF, PFO, occult cancer, etc.
- LVO-IAT: ICAD-occlusion vs embolic occlusion
- Surrogate markers for ICAD-occlusion
  - Clinical: younger, men, smoking, AF(-), truncal type occlusion, scattered-border-zone infarct pattern
  - Angiographic: Truncal type occlusion, reocclusion tendency, fixed focal stenosis

AF and Cardioembolic stroke

송여정

해운대백병원 순환기내과

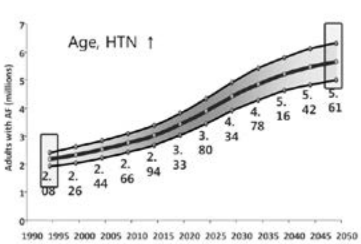
Contents

- Epidemiology of atrial fibrillation and stroke
- Management of thromboembolic risk
- In/Outpatient monitoring considerations
- Stroke risk based on atrial fibrillation burden
- Anticoagulation in AF

Epidemiology of Atrial Fibrillation and Stroke

Epidemiology of Atrial Fibrillation in the US: Rising Prevalence of the Disease

- As of 2010, 2.66 million Americans are estimated to have AF[1]
- Lifetime risk for developing AF is high[2]
  - 1 in 4 for men and women aged ≥40 years
- Prevalence increases rapidly with age[3]
  - 3.8% for persons ≥60 years old
  - 9% for persons ≥80 years old
- *AF prevalence is predicted to increase by 2.5 fold by 2050*

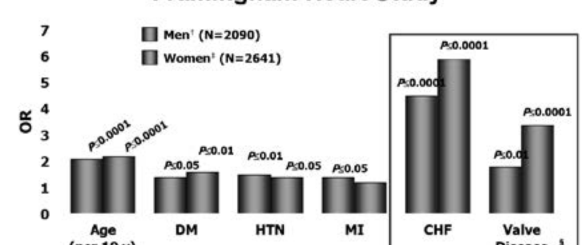


AF affects 1 in 25 adults aged >60 years and 1 in 10 adults >80 years[3]

Lloyd-Jones DM et al. Circulation. 2010;121:e1-e170.
2. Lloyd-Jones DM et al. Circulation. 2004;110:1042-1046.
3. Go AS et al. JAMA. 2001;285:2370-2375.

Go AS. et al. JAMA 2001;285:2370-2375.

Independent Risk Factors for Atrial Fibrillation * Framingham Heart Study



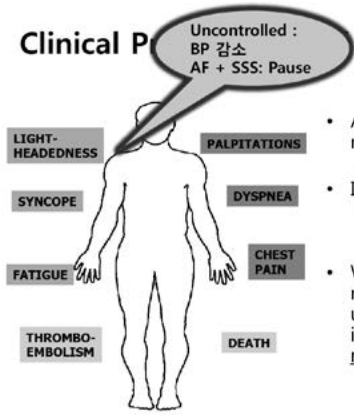
95% CI

	Age (per 10 y)	DM	HTN	MI	CHF	Valve Disease
Men	1.8-2.5	1.0-2.0	1.2-2.0	1.0-2.0	3.1-6.6	1.2-2.5
Women	1.9-2.6	1.1-1.2	1.1-1.8	0.8-1.8	4.2-8.4	2.5-4.5

LA remodeling ↑

DM = diabetes mellitus; HTN = hypertension; MI = myocardial infarction; CHF = congestive heart failure.
Benjamin EJ et al. JAMA. 1994;271:840-844.

Clinical P... Atrial Fibrillation



- AF presents with a wide range of symptoms[1]
  - May also be asymptomatic
- Impact of asymptomatic AF[2]
  - Potential for underlying electrical and structural damage to atrial myocardium
- While AF symptoms alone may not always be severe, untreated disease can result in significant morbidity and mortality[3]

1. Fuster V et al. *Circulation*. 2006;114:e257–e354.
2. Page RL et al. *Circulation*. 2003;107:1141–1146.
3. Stewart S et al. *Am J Med*. 2002;113:359–364.

Atrial Fibrillation and Cryptogenic Stroke
Why AF Matters

- **AF increases the risk of stroke five-folds**
  - AF related stroke are more severe (bedridden & death ↑)
- **After standard neurologic evaluation, 36% of stroke survivors are classified as cryptogenic**
  - AF/Atrial Flutter are intermittent in 30% of stroke patients
- **AF detection in cryptogenic stroke changes patient treatment**
  - Only indication for stroke patients to receive anticoagulation
  - Prevent future strokes by treatment of underlying cause
  - Interrupt natural history progression of atrial fibrillation

*** But difficult because of low detection of paroxysmal AF in real world practice.**

Management of Thromboembolic Risk

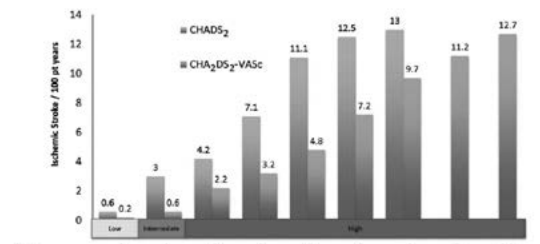
$CHADS_2VASc$ Scoring

	Risk factor	Score
C	Congestive heart failure/LV dysfunction	1
H	Hypertension	1
A	Age ≥65y	1
D	Diabetes mellitus	1
S_2	Stroke/TIA/TE	2
V	Vascular disease (prior myocardial infarction, peripheral artery disease, or aortic plaque)	1
A	Age 65-74y	1
Sc	Sex category (ie female gender)	1
	Maximum Score	9

Lip GY, et al., Chest 137, 263-272, 2010

$CHADS_2$-VASc score ≥ 2 (DOAC 보험)
=>stroke+AF만 있어도 보험됨!

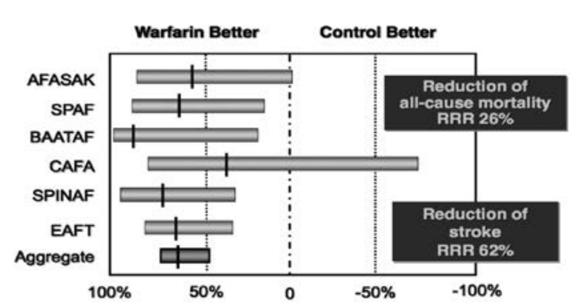
Comparison of Stroke Risk



Score		0	1	2	3	4	5	6	7	8-9
$CHADS_2$	% of cohort	14.7	25.5	28.5	17.2	9.7	3.7	0.9	---	---
CHA_2DS_2-VASc	% of cohort	5.9	7.5	12.4	19.5	21.1	16	10.6	4.9	2.0

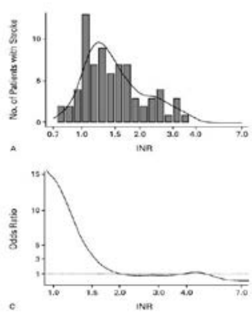
Friberg L. *Eur Heart J* 2012;33:1500-1510.

Anticoagulation for AF
: Stroke Risk Reduction



Hart et al. *Ann Intern Med.* 1999;131:492-501.

Distribution of INR Values in Patients with Stroke (Panel A) and Controls (Panel B) and Odds Ratios for Stroke According to INR Value (Panel C).

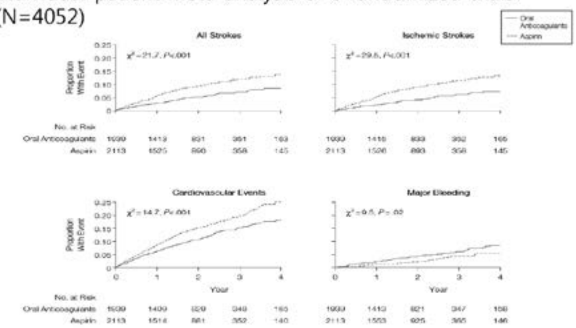


Target INR in AF : 2-3

Hylek EM et al. N Engl J Med 1996;335:540-546.

Oral anticoagulants vs. Aspirin for stroke prevention in AF

Individual patient meta-analysis of 6 randomized trials (N=4052)



Van Walraven C, et al. JAMA. 2002;288:2441-2448

In/Outpatient Monitoring Considerations

Cardiac Diagnostics Landscape

•24-Hour Holter

Event Recorder

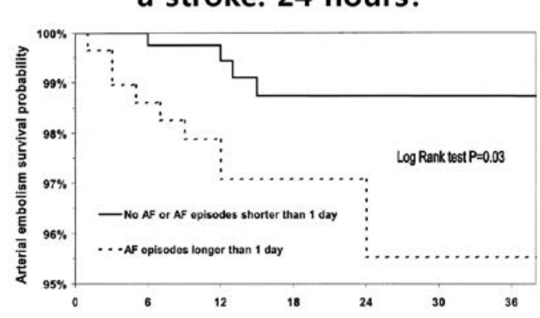
14-30 Day Mobile Cardiac Telemetry Monitor

Loop recorder

Source: Frost & Sullivan report. North American Cardiac Monitoring and Diagnostic Services Markets

Stroke Risk Based on Atrial Fibrillation Burden

How Much AF do you need to have a stroke: 24 hours?



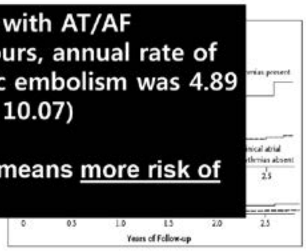
길면 길수록, 오래되면 오래될수록 risk ⬆

Capucci A. et al. JACC 2005; 46:1913

How Much AF for a Stroke
Assert Study

Results:

- 2580
- 10.1% episo... withi...
  - A... o... 7...
  - A... of Ischemic Stroke or Systemic Embolism (HR 2.49 [1.28-4.85]; p=0.007)-> figure



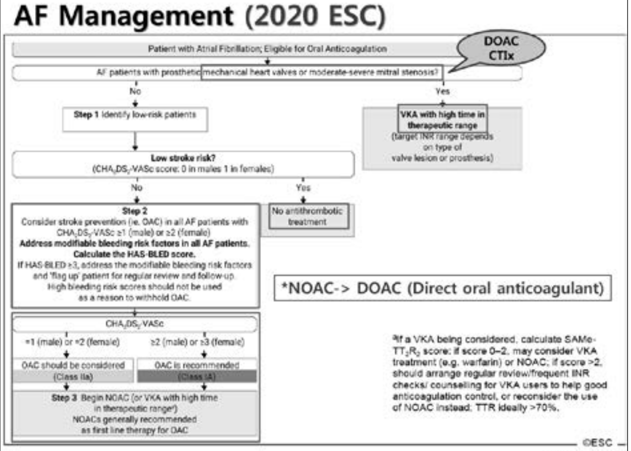
- Among patients with AT/AF episodes >17 hours, annual rate of stroke or systolic embolism was 4.89 (05% CI, 1.96 to 10.07)
- More time in AF means <u>more risk of stroke</u>

Even a little bit of AF matters

Healey JS et al. Subclinical Atrial Fibrillation and the Risk of Stroke. N Engl J Med 2012;366:120-129.

Anticoagulation in AF

AF Management (2020 ESC)



HAS-BLED score

Hypertension, Abnormal Liver or Renal Fxn, Stroke, Bleeding, Labile INR, Elderly, Drugs or Alcohol

HAS-BLED* score	Number of patients	Number of bleedings	Bleeds per 100 patient years
0	798	9	1.13
1	1286	13	1.02
2	744	14	1.88
3	187	7	3.74
4	46	4	8.70
5	8	1	12.50
6	2	0	0.0
7	---	---	---
8	---	---	---
9	---	---	---
Total	3,071	48	*P value for trend .007*

Chest. 2010 Nov;138(5):1093-100

DOAC Dosing recommendation

	Dabigatran	Rivaroxaban	Apixaban	Edoxaban
Standard Dosed	150mg bid	20mg qd	5mg bid	60mg qd
Reduced Dose	110mg bid	15mg qd	2.5mg bid	30mg qd
용량 감량 기준	- 기준 명확히 제시 X 단, 고령 (80세 이상) 시 110mg을 추천 (신장애 : 110mg 투여 고려, verapamil 감량 고려)	CrCl ≤ 50ml/min	다음 중 두 가지 이상에 해당시 - 체중 60kg 이하 - 나이 80세 이상 -S-Cr 1.5 mg/dl 이상	다음 중 한 가지 이상에 해당시 - 체중 60kg 이하 - CrCl ≤ 50ml/min - P-Gp 억제제 병용 , cyclosporine, dronedarone, erythromycin, ketoconazole...

Age
Body weight
Creatinine clearance
Drug, concomitant use

Clinical Outcomes DOACs vs Warfarin

Meta-analysis of Pivotal RCTs
42,411 patients: DOACs
29272 patients: warfarin

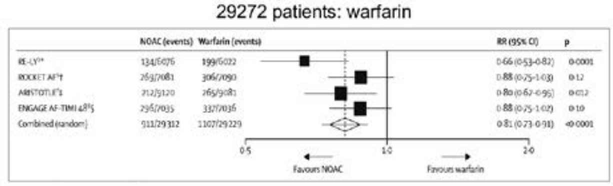


Figure 1: Stroke or systemic embolic events
Data are n/N, unless otherwise indicated. Heterogeneity: I²=47%; p=0·13. NOAC=new oral anticoagulant. RR=risk ratio. *Dabigatran 150 mg twice daily. †Rivaroxaban 20 mg once daily. ‡Apixaban 5 mg twice daily. §Edoxaban 60 mg once daily.

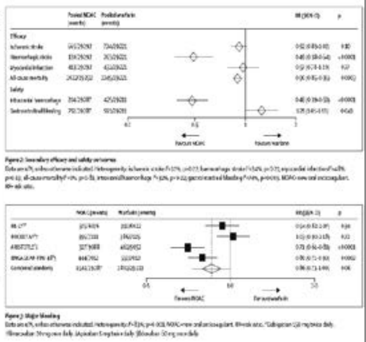
DOACs: 19% RR reduction in stroke of systemic embolic event

Ruff CT, Giugliano RP, Braunwald E, A meta-analysis of randomised trials. Lancet 2014; 383: 955-62

Clinical Outcomes DOACs vs Warfarin

Meta-analysis of Pivotal RCTs
42,411 patients: DOACs
29272 patients: warfarin

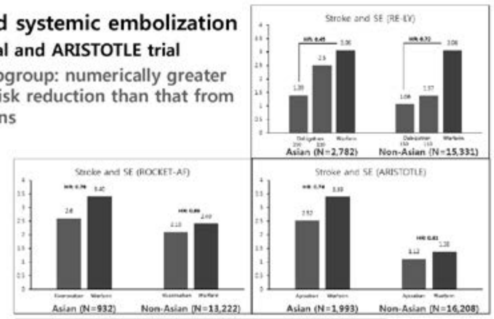
DOACs vs Warfarin
- Ischemic stroke: non-inferior
- Hemorrhagic stroke: 51% RR reduction
- All-cause mortality: 10% RR reduction
- Major Bleeding : similar to warfarin



Ruff CT, et al. A meta-analysis of randomised trials. Lancet 2014; 383: 955-62

Clinical Outcomes DOACs vs Warfarin: In Asian

Stroke and systemic embolization
- **RE-LY trial and ARISTOTLE trial**
- Asian subgroup: numerically greater relative risk reduction than that from non-Asians



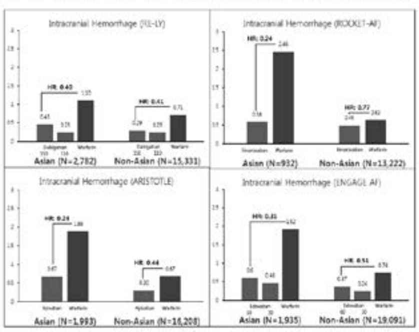
DOACs are preferentially indicated in Asians

Chiang CE et al. Thromb Haemost. 2014;111:789-797.
Yasaka M, et al. Circ J. 2014;78:2367-2372.

Clinical Outcomes DOACs vs Warfarin: In Asian

ICH
- Xa inhibitors
- **Asian subgroup:** numerically greater relative risk reduction than that from non-Asians

Major bleeding
- RE-LY trial and ARISTOTLE trial
- **Asian subgroup:** numerically greater relative risk reduction than that from non-Asians



DOACs are preferentially indicated in Asians

Chiang CE et al. Thromb Haemost. 2014;111:789-797.
Yasaka M. et al. Circ J. 2014;78:2367-2372.

Stable coronary disease + AF

- **1st Recommendation**
  - Single NOAC in stable coronary disease with AF (any kind of NOAC available)
- **2nd Recommendation**
  - Individualization-> Aspirin may be applied for long period in high risk patients or those with rapid plaque progression

Korean J Med. 2018;93(2):110-132

PTCA patient with AF

- **1st Recommendation**
  - 3제 요법: Warfarin (well controlled INR) or NOAC 다 가능
- **2nd Recommendation**
  - 3제 요법 for certain time (1-3개월) -> 2제 요법
- **3rd Recommendation**
  - NOAC을 2제(aspirin, clopidogrel)과 사용시 저용량 사용 권고.

Korean J Med. 2018;93(2):110-132

High risk of gastrointestinal bleeding

- **1st Recommendation**
  - **Apixaban 5mg bid** or **Dabigatran 110mg bid** in high risk of GI bleeding

Korean J Med. 2018;93(2):110-32
Yeh et al. Blood 2014;124 (7):1020-8

Renal impairment and on dialysis

- 1st Recommendation
  - Anticoagulation **not appropriate** in AF patient on dialysis
- 2nd Recommendation
  - CCr 15-50ml/min & CHA2DS2-VASc≥2: low dose NOAC (In case of Apixaban, cr ≥1.5mg/dL, age≥80 or weight≤60kg (2가지)-> 2.5mg bid)
  - CCr 15-50ml/min & CHA2DS2-VASc≥2: Warfarin
- Not Recommended
  - NOAC not recommended in patients with CCr<15ml/min –updated!

Korean J Med. 2018;93(2):110-132

Elderly (age≥75)

- 1st Recommendation
  - Apixaban 5mg bid in patients with age≥75 (In case of Apixaban, cr ≥1.5mg/dL, age≥80 or weight≤60kg (2가지)-> 2.5mg bid)
- 2nd Recommendation
  - Dabigatran 110mg bid, Rivaroxaban 20mg qd, or Edoxaban 60mg qd in patients with age≥75

Apixaban showed superiority on bleeding in patients age≥75 (ARISTOTLE trial subgroup study)

Korean J Med. 2018;93(2):110-132

Take Home message

- **AF detection in stroke changes patient treatment & prognosis**
- **Anticoagulation: do not use underdose unless high bleeding condition: use recommended dose**
- **Beneficial DOAC over warfarin in patients with AF & stroke**
- **For rate control of AF, consultation to cardiologist**

Cardioembolic stroke 1: Overview and intra-IAT / post-IAT care

장준영

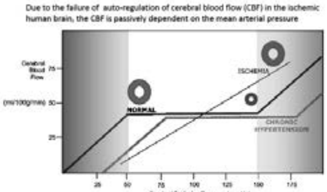
서울아산병원 신경과

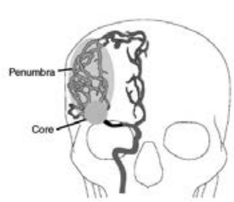
Contents

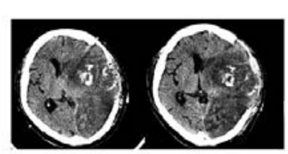
- Postprocedural management of blood pressure
- Postprocedural management of blood glucose
- Postprocedural management of antithrombotics : IVT, IAT, acute stenting
- END management: stroke progression, symptomatic hemorrhage, cerebral edema

The influence of BP on clinical outcomes in acute ischemic stroke

Due to the failure of auto-regulation of cerebral blood flow (CBF) in the ischemic human brain, the CBF is passively dependent on the mean arterial pressure







Rose J, et al Neurocrit Care. 2004

- Cerebral blood flow is passively dependent on the mean arterial pressure in the ischemic brain
- BP changes may result in hyper- or hypoperfusion in the ischemic penumbra
- BP ↑ → hemorrhagic transformation, cerebral edema
  BP ↓ → conversion of the ischemic tissue into infarct core

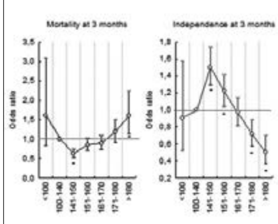
AJNR: 2006;27(4): 728-735
Korean J Crit Care Med 2014;May 29(2): 93-98

Blood pressure management of acute ischemic stroke: current guidelines

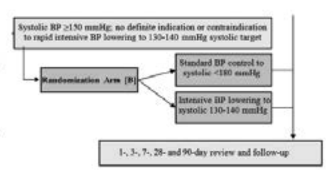
1. BP <220/120mm Hg who did not receive IVT or IAT and do not have a comorbid condition requiring acute antihypertensive treatment
2. Early treatment of hypertension is indicated when required by comorbid conditions (acute coronary event, acute HF, aortic dissection, postthrombolysis sICH, preeclamsia, etc.) Lowering BP initially by 15% is probably safe
3. <185/110 mmHg before IV fibrinolytic therapy, maintain <180/105 mmHg for 24 hours
4. Starting off restarting antihypertensive therapy during hospitalization in patients with BP >140/90 mmHg who are neurologically stable is safe and is reasonable

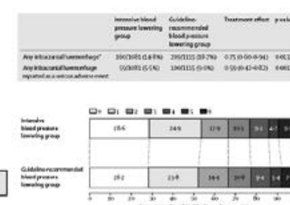
Stroke. 2018;49:e46-e99.

Blood pressure management after IVT



Stroke. 2009; 40: 2442-2449.





Lancet 2019; 393: 877-888.

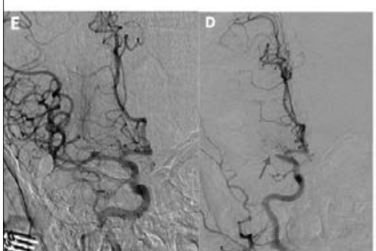
- Current guidelines: SBP <180, DBP <105 after IVT
- More research is needed to determine the optimal level of SBP after IVT (SBP 141–150 mmHg might be optimal after IVT)
- SBP 130–140 (144.3) vs. SBP <180 (149.8) after IVT: ICH ↓, no improvement in functional outcome

Options to treat arterial hypertension in patients with AIS who are candidates for acute reperfusion therapy

Patient eligible for acute reperfusion therapy except that BP is >185/110 mm Hg
Labetalol 10–20 mg IV over 1–2 minutes, may repeat 1 time; or
Nicardipine 5mg/h IV, titrated up by 2.5 mg/h every 5–15 minutes, maximum 15mg/h; when desired BP reached, adjust to maintain proper BP limits
If BP is not maintained at or below 185/110 mmHg, do not administer alteplase
Management of BP during and after rtPA or other acute reperfusion therapies to maintain BP at or below 180/105 mmHg
Monitor BP every 15 minutes for 2 hours from the start of rtPA therapy every 30 minutes for 6 hours, and then every hour for 16 hours
If systolic BP is >180–230 mm Hg or diastolic BP >105–200 mmHg
Labetalol 10 mg IV followed by continuous IV infusion 2–8 mg/min; or
Nicardipine 5 mg/h IV, titrated up to desired effect by 2.5 mg/h every 5-15 minutes, maximum 15 mg/h
If BP is not controlled or diastolic BP >140 mm Hg, consider IV sodium nitroprusside

Stroke. 2018;49:e46-e99.

Blood pressure management after IAT



1. If reperfusion is achieved, aim for moderate or normal BP goal of SBP <140 or 160 mmHg
2. In patients with tandem lesions who undergo adjunctive extracranial stenting, or in patients with intracranial lesions who undergo intracranial stenting, more intensive BP lowering may be warranted
3. In patients with incomplete reperfusion (TICI 2a or less), it is judicious to maintain an upper BP limit of <180/105 mmHg

Front. Neurol. 10:138.

Stroke. 2018;49:2801-2807

Blood pressure management after IAT

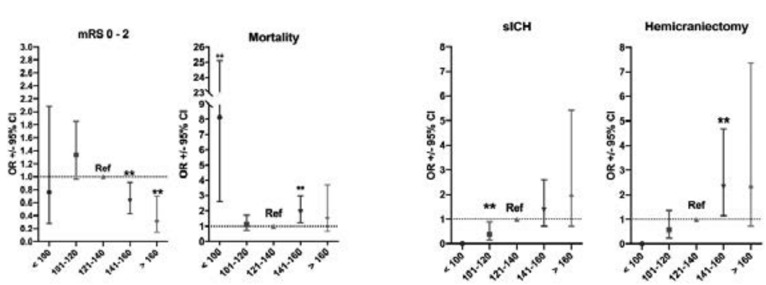
BP measure	Outcome	OR (95% CI)
Maximum SBP	Three-month functional independence (mRS 0-2)	0.70 (0.56-0.87)
Maximum SBP	Three-month mortality	1.49 (1.18-1.88)
Maximum DBP	Three-month functional independence (mRS 0-2)	0.83 (0.63-1.08)
Maximum DBP	Three-month mortality	1.26 (0.94-1.69)

Achieved BP goal	Outcome OR (95% CI)
Three-month functional independence (modified Rankin Scale score 0-2)	
Permissive hypertension[a]	1.00 (reference category)
Moderate BP control[b]	2.75 (0.73-10.35)
Intensive BP control[c]	1.26 (0.20-8.12)
Three-month mortality	
Permissive hypertension[a]	1.00 (reference category)
Moderate BP control[b]	0.08 (0.01-0.054)
Intensive BP control[c]	1.00 (0.99-1.01)

- 24 h following IAT
- Maximum SBP↑→ 3-month mortality ↑, functional independence↓
- Intensive (140/90 mmHg)
  Moderate (160/90 mmHg)
  Permissive hypertension (<220/110 or <180/105mmHg after IVT)
- Moderate BP control 3-month mortality ↓

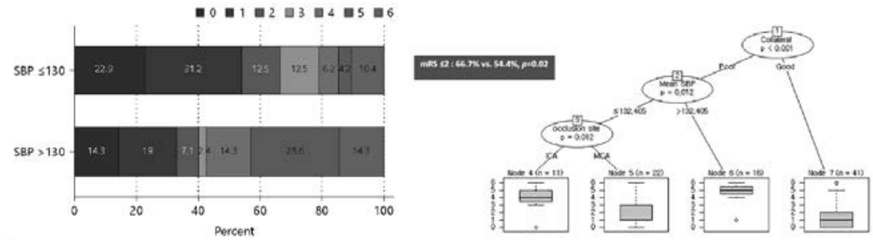
Neurology. 2017;89:540-547

Blood pressure management after IAT



Higher mean SBP within 24 hours of successful mechanical thrombectomy was associated with a higher likelihood of sICH, mortality, and requirement of hemicraniectomy

Stroke. 2019;50:2448-2454



	Unadjusted, OR (95% CI)	Model 1*, OR (95% CI)	Model 2†, OR (95% CI)	Model 3¶, OR (95% CI)
Mean SBP ≤130	Reference	Reference	Reference	Reference
Mean SBP >130	2.72 (1.27–5.82)	2.55 (1.18–5.52)	3.01 (1.36–6.64)	2.66 (1.11–6.41)
24-H mean SBP**	1.51 (1.09–2.09)	1.43 (1.02–2.01)	1.43 (1.01–2.03)	1.36 (0.93–1.98)
Percent reduction ≤15%	Reference			
Percent reduction >15%	0.98 (0.46–2.04)			
Initial SBP	1.01 (1.00–1.02)			

* Model 1: age (>60 vs. ≤60), initial NIHSS.
† Model 2: age (>60 vs. ≤60), initial NIHSS, occlusion site (MCA vs. ICA), baseline collateral status (good vs. poor).
¶ Model 3: age (>60 vs. ≤60), initial NIHSS, occlusion site (MCA vs. ICA), baseline collateral status (good vs. poor), recanalization degree (TICI 3 vs. 2b), TOAST (CE vs. nonCE), hemorrhagic transformation.

More intensive BP control during the first 24 hours after IAT may improve outcomes in patients with large vessel occlusion followed by successful recanalization

Eur Neurol. 2019;81:216-222

Blood pressure management after IAT: BP-TARGET trial

	Intensive SBP target group (n=158)	Standard SBP target group (n=160)	Mean difference (95% CI)	Adjusted odds ratio (95% CI)
Primary outcome (ICH at 24-36 h)				
Modified ITT*	65/154 (42%)	68/157 (43%)	..	0·96 (0·60 to 1·51)†
Imputation analysis‡	67/158 (42%)	69/160 (43%)	..	0·97 (0·61 to 1·53)
Secondary outcomes				
Favourable outcome (mRS score 0–2)	67/152 (44%)	69/153 (45%)	..	0·93 (0·58 to 1·48)
Excellent outcome (mRS score 0–1)	48/152 (32%)	42/153 (28%)	..	1·20 (0·72 to 1·97)
Change in NIHSS score at 24-36h	−4·1 (−5·5 to −2·7)	−4·4 (−5·8 to −3·0)	0·3 (−1·7 to 2·3)	..

	Intensive SBP target group (n=158)	Standard SBP target group (n=160)	Mean difference (95% CI)	Adjusted odds ratio (95% CI)
Safety outcomes				
Symptomatic ICH at 24 h-36h	17/154 (11%)	11/157 (7%)	..	1·68 (0·75 to 3·77)
Parenchymal haematoma type 2 at 24 h-36h	15/154 (10%)	12/157 (8%)	..	1·30 (0·58 to 2·89)
All-cause mortality at follow-up visit§	32/152 (21%)	24/153 (16%)	..	1·46 (0·80 to 2·63)
Hypotensive events	12/158 (8%)	5/160 (3%)	..	2·53 (0·86 to 7·41)

- **Acute ischemic stroke with LVO that was successfully treated with endovascular therapy**
- **Primary outcome: Radiographic intraparenchymal hemorrhage at 24-36 h**
- **Intensive SBP target group (100-129) vs. standard care SBP group (130-185) : 42% vs. 43%, no difference**

https://doi.org/10.1016/S1474-4422(20)30483-X

HbA1c goals

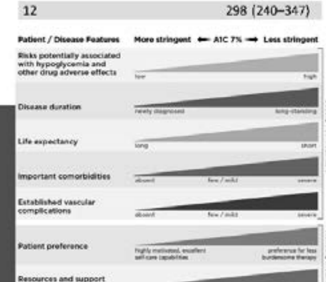
COR	LOE	Recommendations
1	A	1. In patients with an ischemic stroke or TIA who also have diabetes, the goal for glycemic control should be individualized based on the risk for adverse events, patient characteristics and preferences, and, for most patients, especially those <65 years of age and without life-limiting comorbid illness, achieving a goal of HbA1c ≤7% is recommended to reduce risk for microvascular complications.[299,300]

Stroke 2021;52:e364-e467

- Target HbA1c <7%
- Less stringent HbA1c goals (<8%)

✓ History of severe hypoglycemia
✓ Limited life expectancy
✓ Advanced microvascular or macrovascular complications
✓ Extensive comorbidities
✓ Long-standing DM

A1C (%)	mg/dL*
5	97 (76–120)
6	126 (100–152)
7	154 (123–185)
8	183 (147–217)
9	212 (170–249)
10	240 (193–282)
11	269 (217–314)
12	298 (240–347)



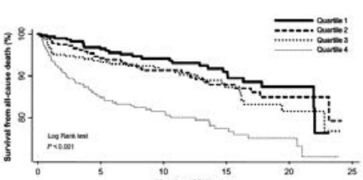
Diabetes Care. 2020;43(Suppl.1): S66-S76

Glycemic control in acute ischemic stroke: current guideline

4.6. Glucose	COR	LOE	New, Revised, or Unchanged
1. Hypoglycemia (blood glucose <60 mg/dL) should be treated in patients with AIS.	I	C-LD	Recommendation and COR unchanged from 2013 AIS Guidelines. LOE amended to conform with ACC/AHA 2015 Recommendation Classification System.
2. Evidence indicates that persistent in-hospital hyperglycemia during the first 24 hours after AIS is associated with worse outcomes than normoglycemia, and thus, it is reasonable to treat hyperglycemia to achieve blood glucose levels in a range of 140 to 180 mg/dL and to closely monitor to prevent hypoglycemia.	IIa	C-LD	Recommendation and COR unchanged from 2013 AIS Guidelines. LOE amended to conform with ACC/AHA 2015 Recommendation Classification System.

Stroke 2019;50:e344-e418

Poststroke hyperglycemia and outcome in acute ischemic stroke

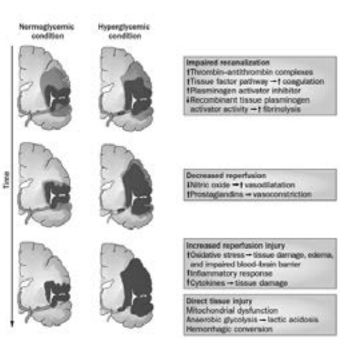


	Quartile of initial glucose level				
	Quartile 1	Quartile 2	Quartile 3	Quartile 4	P-trend
All-cause death					
Number of events	26	34	36	67	
Person-years (PYs)	303.5	316.4	294.5	290.0	
Incidence rate (per 1000 PYs)	85.7	107.5	122.2	231.0	
Model1*	1 (reference)	1.23 (0.74–2.04)	1.40 (0.84–2.31)	2.62 (1.67–4.12)	<0.001
Model2*	1 (reference)	1.17 (0.70–1.96)	1.34 (0.81–2.24)	2.32 (1.46–3.70)	0.002
Model3*	1 (reference)	1.18 (0.71–1.91)	1.39 (0.83–2.31)	2.18 (1.36–3.48)	0.02
Cardiovascular death					
Number of events	15	21	20	32	
Incidence rate (per 1000 PYs)	49.4	66.4	67.9	110.0	
Model1*	1 (reference)	1.32 (0.68–2.57)	1.35 (0.69–2.64)	2.17 (1.17–4.00)	0.02
Model2*	1 (reference)	1.25 (0.64–2.45)	1.31 (0.66–2.57)	1.93 (1.02–3.63)	0.1
Model3*	1 (reference)	1.26 (0.64–2.48)	1.29 (0.65–2.56)	1.91 (1.01–3.61)	0.15

Higher glucose levels in the ER were significantly associated with increased risk of all-cause mortality (HR; 2.18, 95% CI, 1.36–3.48) and cardiovascular death (HR, 1.91; 95% CI, 1.01–3.61)

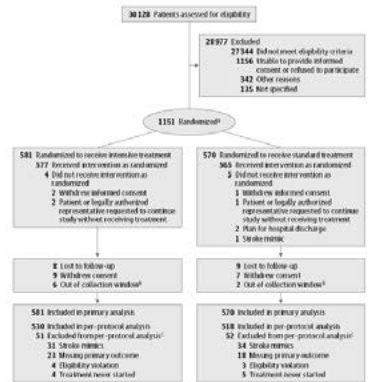
European Journal of Neurology 2012, 19:884-891

Hyperglycemia and infarct evolution



Nature Review Neurol. 2010;6: 145-155

Intensive vs. standard treatment of hyperglycemia and functional outcome of acute ischemic stroke: SHINE trial

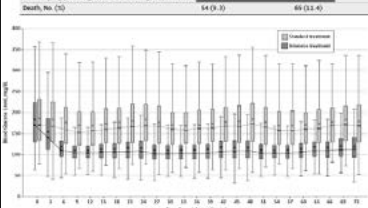


JAMA. 2019;322(4):326-335

- **Intensive glucose control (80–130 mg/dL) vs. Standard treatment (80–179 mg/dL) up to 72 hours**
- **Favorable outcome at 90 days : mRS 0 (NIHSS 3-7), mRS 0-1 (NIHSS 8-14), mRS 0-2 (NIHSS 15-22)**
- **Severe hypoglycemia (< 40mg/dL)**

Intensive vs. standard treatment of hyperglycemia and functional outcome of acute ischemic stroke: SHINE trial

	Treatment of Hyperglycemia		Unadjusted Risk Difference (95% CI), %	Relative Risk (95% CI)		P Value
	Intensive (n = 581)	Standard (n = 570)		Unadjusted	Adjusted	
Primary Outcome						
Favorable 90-d modified Rankin Scale score, No. (%)	119 (20.5)	123 (21.6)	−0.83 (−5.72 to 4.06)	0.96 (0.77 to 1.20)	0.97 (0.87 to 1.08)	.55
Secondary Outcomes						
Favorable 90-d NIHSS score, No./total No. (%)	152/348 (43.7)	166/371 (44.7)	−1.07 (−8.33 to 6.20)	0.98 (0.83 to 1.15)	1.00 (0.93 to 1.08)	.77
Favorable 90-d Barthel Index score, No./total No. (%)	271/491 (55.2)	261/477 (54.7)	0.48 (−5.79 to 6.75)	1.01 (0.90 to 1.13)	1.00 (0.95 to 1.06)	.88
90-d Stroke Specific Quality of Life score						
No. of patients	442	432				
Median (IQR)	3.75 (2.98 to 4.40)	3.69 (3.02 to 4.46)	0.06 (−0.13 to 0.25)			.74
Adverse Events						
Severe hypoglycemia (glucose level <40 mg/dL), No. (%)	15 (2.6)	0	2.58 (1.29 to 3.87)			<.001
Death, No. (%)	54 (9.3)	65 (11.4)	−2.11 (−5.63 to 1.41)	0.82 (0.58 to 1.15)		.24



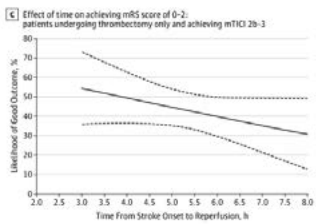
- **A favorable outcome occurred in 119/581 (20.5%) in the intensive treatment group and 123/570 (21.6%) in the standard group**
- **Severe hypoglycemia occurred only among patients in the intensive treatment group**

HbA_{1c} level	OR (95% CI)						Common OR (95% CI)		
	mRS 0–1 at 3 months			mRS 0–2 at 3 months			mRS at 3 months		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Quintile									
1st (≤6.1%)	0.58 (0.39, 0.86)	0.56 (0.37, 0.85)	0.59 (0.38, 0.91)	0.83 (0.59, 1.17)	0.83 (0.57, 1.21)	0.87 (0.58, 1.29)	0.86 (0.64, 1.14)	0.86 (0.64, 1.15)	0.91 (0.68, 1.23)
2nd (>6.1–6.6%)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
3rd (>6.6–7.1%)	0.90 (0.61, 1.33)	0.80 (0.52, 1.21)	0.84 (0.54, 1.31)	1.07 (0.75, 1.54)	0.97 (0.65, 1.43)	1.05 (0.69, 1.58)	1.05 (0.78, 1.42)	0.94 (0.69, 1.27)	0.99 (0.73, 1.35)
4th (>7.1–7.9%)	0.54 (0.36, 0.82)	0.40 (0.26, 0.63)	0.43 (0.27, 0.68)	0.95 (0.66, 1.35)	0.73 (0.49, 1.08)	0.81 (0.54, 1.22)	0.82 (0.61, 1.11)	0.63 (0.47, 0.85)	0.67 (0.49, 0.91)
5th (>7.9%)	0.62 (0.42, 0.94)	0.43 (0.28, 0.68)	0.47 (0.29, 0.75)	0.75 (0.52, 1.08)	0.49 (0.33, 0.73)	0.54 (0.35, 0.82)	0.79 (0.59, 1.06)	0.55 (0.41, 0.75)	0.59 (0.43, 0.80)
P value for overall effect	0.0069	<0.0001	0.0007	0.3159	0.0049	0.0218	0.2674	0.0002	0.0008
Cutoff									
≤7.0%	1 (Ref)	1(Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
>7.0%	0.68 (0.52, 0.90)	0.51 (0.38, 0.69)	0.53 (0.39, 0.72)	0.82 (0.65, 1.04)	0.60 (0.46, 0.77)	0.63 (0.48, 0.83)	0.82 (0.67, 0.99)	0.62 (0.51, 0.75)	0.63 (0.52, 0.78)
P value for overall effect	0.0063	<0.0001	<0.0001	0.0993	0.0001	0.0008	0.0361	<0.0001	<0.0001

Prestroke glucose control with a target HbA1c ≤ 7.0% may be beneficial for neurological recovery in patients with diabetes undergoing IAT for large vessel occlusive stroke

Diabetes care 2021;44:1-9

Postprocedural antiplatelet agent after IAT

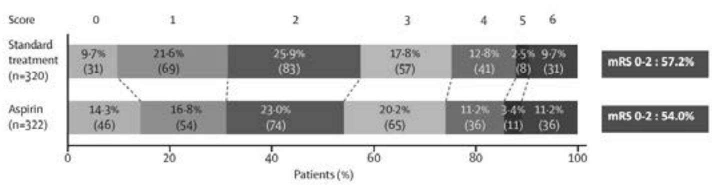


JAMA Neurology 2016; 73(2): 190-196

- Administration of aspirin (160 to 300mg) is recommended in patients with acute ischemic stroke within 24 to 48 hours after onset.
- Antiplatelet administration is generally delayed until 24 hours later
- But early administration might be considered in the presence of concomitant conditions for substantial benefit and risk

- Acute carotid or intracranial stenting
- Remnant severe stenosis of target vessel
- acute coronary syndrome, PCI within a year

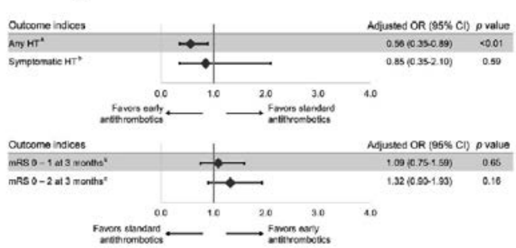
Antiplatelet agent within 24 hours after IVT



- IV aspirin 300mg within 90 min after IVT vs. standard treatment
- Early administration of intravenous aspirin does not improve outcome at 3 month
- The risk of SICH ↑ (4.3% vs. 1.6%, P=0.04)

Lancet 2012; 380: 731-737.

Antiplatelet agent within 24 hours after recanalization therapy



- Early initiation of antithrombotics was associated with decreased odds of having any hemorrhages (aOR 0.56; 95% CI 0.35-0.89)
- No differences on sICH (0.85; 0.35-2.10) and functional outcome (mRS 0-1 at 3months, 1.09; 0.75-159)

Neurology. 2016; 87: 996-1002.

Postprocedural (<24hr) antiplatelet use in patients with ischemic stroke who underwent IAT

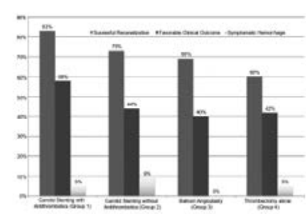
Study	sICH (%)	sICH, OR	Mortality	Mortality, OR	mRS ≤2	mRS ≤2, OR
Broeg-Morvay et al.	6%/6%	0.92 (0.24-3.46)	18%/23%	0.75 (0.34-1.67)	34%/16%	0.61 (0.32-1.17)
Ernst et al.	13%		33%		28%	
Memon et al.	14%		23%		60%	
Mulder et al.	17%/4%	4.80 (1.77-13.02)	33%/17%	2.46 (1.27-4.76)	23%/36%	0.54 (0.28-1.05)
Pandhi et al.	6%/7%	0.81 (0.25-2.68)	25%/26%	0.97 (0.50-1.85)	50%/48%	1.11 (0.63-1.97)
Sugiura et al.	13%/3%	5.43 (1.46-20.13)				

sICH 6-17%, mortality 18-33%, functional independence 23-60%

Front Neurol. 2018; 9: 238.

Optimal treatment strategy for tandem occlusive stroke

	Thrombectomy and Cervical ICA Stenting With Antithrombotic Agents (Group 1) (n = 256)	Thrombectomy and Cervical ICA Stenting Without Antithrombotic Agents (Group 2) (n = 66)	Thrombectomy and Cervical ICA Angioplasty (Group 3) (n = 52)	Thrombectomy Alone (Group 4) (n = 108)	p Value*	p Value†	p Value‡
Recanalization	213 (83)	48 (73)	36 (69)	65 (60)	<0.001	0.129	0.349
90-day favorable outcome	148 (58)	29 (44)	21 (40)	45 (42)	0.007	0.892	1
90-day mortality	24 (9)	12 (18)	6 (12)	18 (17)	0.07	0.96	0.539
Symptomatic hemorrhagic complications	14 (5)	6 (9)	0 (0)	5 (5)	0.944	0.336	0.175



- **Carotid stenting with acute antithrombotics : Highest rate of recanalization and favorable outcome, no difference in sICH**

J Am Coll Cardiol Intv 2018; 11: 1290-1299

Optimal treatment strategy for tandem occlusive stroke

	Thrombectomy and cervical ICA stenting: 1 antithrombotics (n=138)	Thrombectomy and cervical ICA stenting: At least 2 antithrombotics (n=118)	p value
Recanalization	112/138 (81%)	100/117 (85%)	0.45
Early neurological improvement	31/67 (46%)	32/68 (47%)	1
90-day favorable outcome	77/136 (57%)	70/118 (59%)	0.76
90-day mortality	10/136 (7%)	14/118 (12%)	0.31
Symptomatic hemorrhagic complications	5/137 (4%)	8/118 (7%)	0.40

- **Among patients with carotid stenting with antithrombotics, there was no significant differences in efficacy and safety outcomes by type of antithrombotics regimen used (1 vs. 2 antithrombotics agents)**

Postprocedural antiplatelet agent after IAT

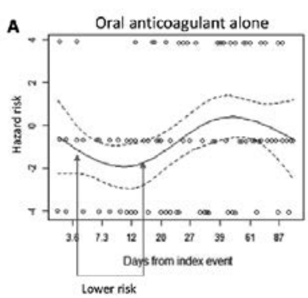
- **Acute carotid or intracranial stenting**

① DAPT

② IV tirofiban maintenance → DAPT

③ antiplatelet monotherapy : IVT , infarct size↑, postprocedural hemorrhagic transformation

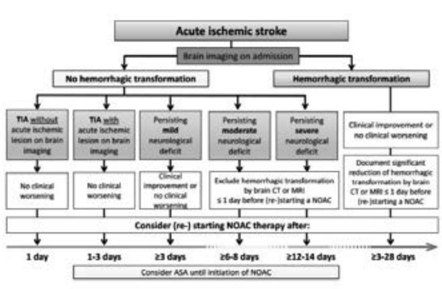
Postprocedural anticoagulation after recanalization therapy

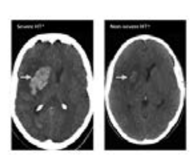


Initiating anticoagulation 4 to 14 days from stroke onset was associated with a significant reduction in primary outcome (stroke, TIA, symptomatic systemic embolization, symptomatic cerebral bleeding, and major extracranial bleeding) , compared with initiating before 4 or after 14 days

Stroke. 2015;46:2175-2182

Postprocedural anticoagulation after recanalization therapy





- **1 : TIA**
  1-3 : TIA with acute ischemic lesion
  ≥ 3: Mild neurological deficit
  ≥ 6-8: Moderate
  ≥ 12-14: Severe
- **≥3-28: Hemorrhagic transformation**

Europace (2021) 00.1-65

2a	C-EO	7. In patients with TIA in the setting of nonvalvular AF, it is reasonable to initiate anticoagulation immediately after the index event to reduce the risk of recurrent stroke.
2b	B-NR	9. In patients with stroke at low risk for hemorrhagic conversion in the setting of AF, it may be reasonable to initiate anticoagulation 2 to 14 days after the index event to reduce the risk of recurrent stroke.[428,429,437]
2a	B-NR	6. In patients with stroke at high risk of hemorrhagic conversion in the setting of AF, it is reasonable to delay initiation of oral anticoagulation beyond 14 days to reduce the risk of ICH.[428–431]

Stroke 2021;52:e364-e467

Postprocedural anticoagulation after recanalization therapy

- Neuroimaging at 24 hours to assess for hemorrhage and guide the timing of antithrombotics

✓ Small infarct volume (< 30 cc): initiate anticoagulation
✓ Moderate infarct volume (30-70 cc): 2 to 4 weeks
✓ Large infarct volume (> 70 cc): 4 to 6 weeks

Stroke. 2018;49:2801-2807

Management of early neurological deterioration

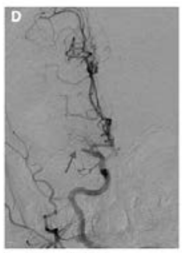
- Early neurological deterioration: NIHSS ≥ 2 within during 24hr – 7 days after hospitalization

✓ Ischemia progression or recurrence: volume expansion, induced hypertension , timely administration of antithrombotics
→ large artery atherosclerosis

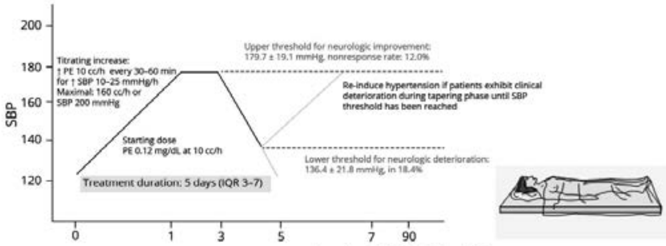
✓ Symptomatic hemorrhage: blood pressure, glucose, tPA reversal
✓ Cerebral edema : osmotherapy, hypothermia, decompression, CSF diversion
→ high NIHSS after ERT, failed recanalization

Neurology 2019;93: e1955-e1963

Induced hypertension therapy



Front. Neurol. 10:138.



Neurology 2019;93: e1955-e1963

- Noncardioembolic stroke who were ineligible for revascularization therapy, progressive stroke
- CBF, oxygen delivery, removal of metabolic waste ↑ , collateral channels ↑
- Exclusion: intracranial hemorrhage, congestive heart failure, active coronary ischemia (changes on ECG or

tPA reversal for bleeding complications

ECASS-II hemorrhage grade*	Imaging criteria
Hemorrhagic infarction type 1 (HI1)	Small punctate petechial change around margins of infarct bed
Hemorrhagic infarction type 2 (HI2)	Confluent petechial within the infarct bed, but no mass effect
Parenchymal hematoma type 1 (PH1)	Hematoma (homogenous hyperdensity) ≤30% of infarct bed, mild mass effect
Parenchymal hematoma type 2 (PH2)	Hematoma (homogenous hyperdensity) >30% of infarct with significant mass effect, or hemorrhage beyond the infarct borders

- Symptomatic hemorrhage or parenchymal hematoma (PH1, PH2) within 24 hours after administration IV tPA

✓ Cryoprecipitate (includes factor VIII): 10 U infused over 10-30 min (onset 1h, peaks in 12 h), administer additional dose for fibrinogen level of < 150 mg/dL
✓ Fresh frozen plasma (10-15ml/kg)
✓ Tranexamic acid 1000mg IV over 10 min
✓ aminocaproic acid 4-5g over 1 h, followed by 1g IV until bleeding is controlled

Stroke 2019;50: e344-e418

Malignant cerebral edema

- The greatest risk of cerebral edema within 48-72 hours (30% within 24 hours), and subsequent swelling as late as 8 days
- Decompensation: abrupt – hemorrhagic transformation, gradual- progressive loss of ischemic penumbra
- Younger age, proximal occlusion, NIHSS ≥ 15 (nondominant) or ≥ 20 (dominant)
  Hypodensity in one-third of the MCA territory, DWI infarct volume > 80 mL, midline shift within 6 hours

Korean J Crit Care Med 2014 May 29(2): 93-98
J Neurointervent Surg 2017;9:1258-1266

Causes specific IICP management in malignant cerebral edema

① Brain swelling (cytotoxic, vasogenic edema)

→ Decompressive craniectomy, osmotherapy, TTM

② Cerebral artery dilation and CBV increase

→ Hyperventilation and cerebral vasoconstriction

③ Venous outflow obstruction

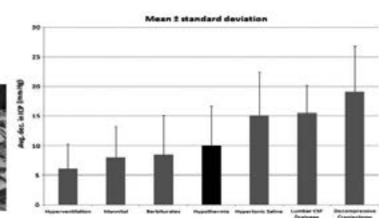
→ Head elevation 30 degree, neutral neck position, loosening neck tie, avoidance of jugular venous catheter

④ Acute hydrocephalus due to CSF outflow obstruction

→ CSF drainage via EVD

Journal of Stroke 2014;16(3): 146-160

Malignant cerebral edema



- Osmotic therapy : hypertonic saline, mannitol (0.5-1g/kg every 4-6 hours)
- Hypothermia: 33℃ for 48-72 hours (till midline shifting halted)
- Hyperventilation : target PCO_2 of 30 mm Hg (short lived 1-3 hours)
- Head elevation: 30-45
- Decompressive surgery: age ≤ 60 – both survival and functional benefit, age > 60 – survival benefit

Neurocrit Care 2009;11(3): 427-436
J Neurointervent Surg 2017;9:1258-1266

Summary

- Acute BP management

✓ <220/120, (re)start anti-HT during hospitalization if neurologically stable
✓ IVT: <185/110 before IVT, <180/105 for 24 h after IVT by current guideline, SBP 140-150 may be optimal
✓ IAT: <140-160 after successful recanalization, <180/105 if recanalization failed, personalized BP management

- Target blood glucose level in acute ischemic stroke: 140 to 180mg/dL

Summary

- **Postprocedural antithrombotics**

- ✓ **Antiplatelet administration is generally delayed until 24 hours later**
- ✓ **Early administration of antiplatelet might be considered in the presence of concomitant conditions for substantial benefit : acute intra or extracranial stenting, remnant severe stenosis of target vessel, acute coronary syndrome or recent PCI**
- ✓ **Anticoagulant: mild- 1~3, moderate- 6~12, severe- 2~3 weeks**

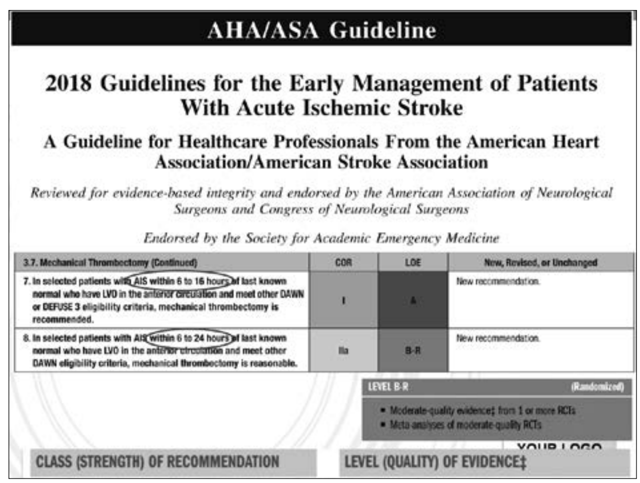
- **END management:**

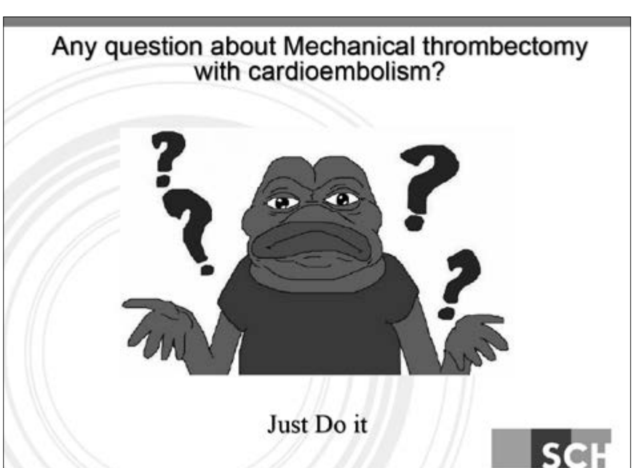
- ✓ **Ischemic progression: induced hypertension**
- ✓ **Symptomatic hemorrhage: tPA reversal, BP control**
- ✓ **Cerebral edema: osmotic therapy, hypothermia, CSF diversion, decompression**

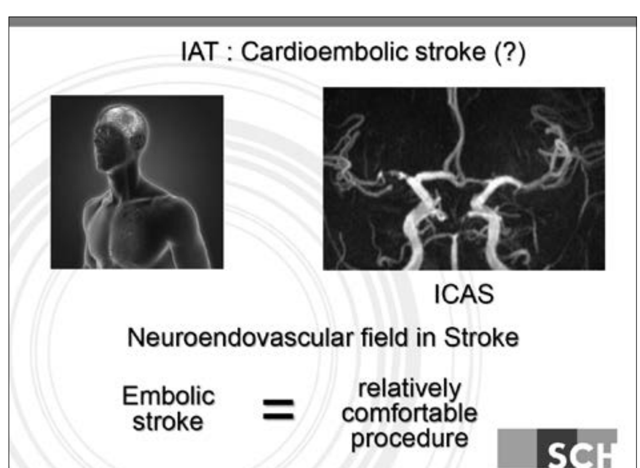
Cardioembolic stroke 2: IAT

신동성

순천향대 부천병원







Differentiation of Cardioembolic Stroke

- **Cerebral Embolism Task Force(1986)**
  - Sudden, Severe Neurologic deficit
  - Cause of embolus (Heart disease)
  - Involvement of Various vascular territory
- **TOAST classification**
  - Arterial occlusions due to an embolus arising in the heart
- **Evidence-based causative classification system**
  - Probable or evident cardio-embolism

?????

Can't diagnosed in emergent situation

- **Co-mobidities**
  - Proximal carotid stenosis
  - ICAS
- **Lacuna infarction with AF (heart risk factor)**
  - Arterial occlusions due to an embolus arising in the heart
- **Cardio embolic presentation without cardioembolic risk**

SCH

Cardioembolic infarction

Stroke. 1996 Oct;27(10):1765-9. doi: 10.1161/01.str.27.10.1765.

Acute stroke with atrial fibrillation. The Copenhagen Stroke Study

- **1185 patients**
  - AF: 217(18%)
- **Stroke with AF**
  - Old age
  - More severe
  - Higher mortality
  - Longer hospital stays
  - Lower discharge rate
  - Poor functional outcome

- **1996 (IV thrombolysis)**
- **2021 (IAT)**

Poor prognosis

Aggressive treatment

Page • 7

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Why Cardioembolic infarction have poor outcome?

Journal of the Neurological Sciences

IV t-PA therapy in acute stroke patients with atrial fibrillation

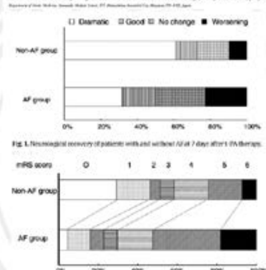

Fig. 1. Neurological recovery of patients with and without AF at 7 days after t-PA therapy.

Fig. 2. Modified Rankin scale of patients with and without AF at 3 months after t-PA.

- **AF**
  - Independent factor of Non-recanalization after tPA
- **Clot dissolution after tPA**
  - Clot size
  - Site of occlusion
  - Clot composition
  - The surface area of clot exposed to blood flow
  - Penetration of tPA into the clot structure

SCH

Why Cardioembolic infarction have poor outcome?

Journal of the Neurological Sciences

IV t-PA therapy in acute stroke patients with atrial fibrillation

- **AF**
  - Fresh and old clot mixed in cardiac cavity
  - Large thrombi formation in LA(TEE)
  - Old and large thrombi may be more resistant to thrombolysis
  - Stroke with AF are resistant to tPA

- **Increased risk of death, 4weeks (stroke with AF)**
  - Sudden occlusion of large cerebral artery
  - Insufficiency of collateral flow
  - More severe stroke
- **ICA occlusion (poor Px factor)**
  - Poor tPA response factor (proximal occlusion)
  - ICA occlusion rate (no different)
  - But, stroke with AF more frequently occluded ICA on initial MRA
  - More worsening and poor outcome

How about IAT effect?

Page • 9

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Effectiveness of IAT on Cardioembolic infarction

Endovascular thrombectomy in patients with acute ischaemic stroke and atrial fibrillation: a MR CLEAN subgroup analysis

EuroIntervention 2017;13:996-1002 published online ahead of print June 2017

- **NO significant different (AF/ no AF)**
  - AF group trend to small treatment effect
  - However, not prove that EVT was less effective in AF stroke

- **Why?**
  - AF group treated anticoagulant before stroke (tPA contraindication)
  - AF group was older, worse functional condition pre-stroke (poor prognosis at baseline)
  - 12 years difference (difficult statistical adjustment)
  - Exclude small and lacunar infarction by embolus
  - Reduction infarct volume was smaller (relatively large infarct volume at initial period)

Page • 10

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Effectiveness of IAT on Cardioembolic infarction

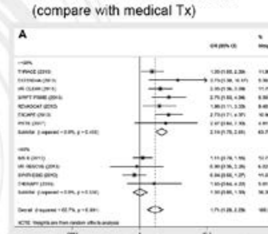
Oncotarget, 2017, Vol. 8, (No. 42), pp: 72072-72084

Impact of hyperlipidemia and atrial fibrillation on the efficacy of endovascular treatment for acute ischemic stroke: a meta-analysis

Table 1: Characteristics of studies included in the meta-analysis

- **Pooled 11 RCT for efficacy and safety of EVT on AIS**

- **Subgroup analysis**
  - Use rate of Solitaire FR
  - High-rate use(>60%) of Solitaire FR had favorable functional outcome (compare with medical Tx)



Page • 11

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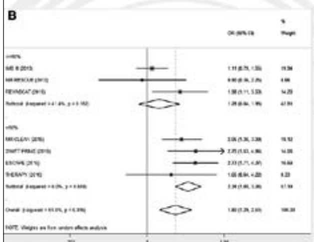
Effectiveness of IAT on Cardioembolic infarction

- Subgroup analysis
  - Low percentage of hyperlipidemia(<50%)
  - EVT Tx had favorable functional outcome (compare with medical Tx)
- Subgroup analysis
  - High percentage of AF(>35%)
  - EVT Tx had favorable functional outcome (compare with medical Tx)

B



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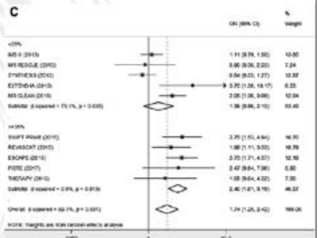
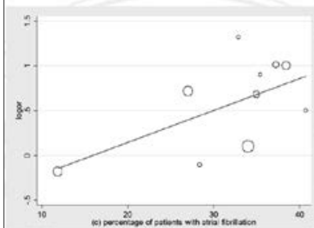


Page • 12

Effectiveness of IAT on Cardioembolic infarction



- Embolus type may be a potential influence factor affecting the recanalization rate and functional outcome
  - Cardioembolic stroke can hardly gain benefits from tPA
  - Cardioembolic stroke can gain benefits from EVT

- Similar result in another study

Page • 13

Compare AF stroke with non-AF stroke (IAT)

Better endovascular mechanical thrombectomy outcome in atrial fibrillation patients with acute ischemic stroke: A single-center experience

Table 3

Outcomes in patients with and without AF

	AF (n=43)	Non-AF (n=40)	P
mTICI 2b-3, % (n)	72.1 (31)	55.0 (22)	0.12
sICH, % (n)	7.0 (3)	10.0 (4)	0.71
Mortality, % (n)	9.3 (4)	15.0 (6)	0.51
90-d mRS 0–2, % (n)	55.8 (24)	17.5 (7)	<0.01*

- 3 interventionist
- General/Local anesthesia
- Solumbra Tech.
- AF: 51%
- Overall substantial reperfusion rate: 63.9%

- TOAST classification
  - Cardiombolic etiology were significantly more probable to have a good outcome (90D) than non-cardioeombolic etiology (49.0% vs 18.8%, p<0.01)

Table 4

Predictors of good 90-day clinical outcome (mRS 0–2) in multivariate logistic regression model

Cox and Snell R^2 = 0.41 Nagelkerke R^2 = 0.56	Significance (p)	95% CI
Age < 70	<0.01*	0.02–0.39
NIHSS > 25	0.27	0.01–6.89
Prior IVT	0.19	0.11–1.57
Door to puncture time <120 min	0.29	0.14–1.80
Onset to puncture time <360 min	0.25	0.31–6.90
TICI 2B-3 (reperfusion)	<0.01*	0.02–0.53
AF	<0.01*	0.02–0.46
Constant	0.01	

- Poor outcome predictor (stroke with AF)
  - Turned to be a good outcome predictor in EVT

Page • 14

Compare AF stroke with atherosclerotic stroke

Collateral Circulation and Outcome in Atherosclerotic Versus Cardioembolic Cerebral Large Vessel Occlusion

Stroke. 2019;50:3360-3368.

Table 1. Baseline Characteristics

	Cervical Carotid Atherosclerosis (N=190)	Cardioembolism (N=476)	P Value
Median age, y (IQR)	69 (62–77)	76 (56–83)	<0.001
Men, n (%)	127/190 (67)	223/426 (42)	<0.001
Medical history			
Diabetes mellitus, n/N (%)	27/186 (15)	89/474 (19)	0.196
Hypertension, n/N (%)	83/187 (44)	290/473 (61)	<0.001
Ischemic stroke, n/N (%)	25/187 (13)	89/475 (19)	0.10
Medication			
DOAC, n/N (%)	0/186 (0)	27/465 (6)	0.001
Vitamin K antagonist, n/N (%)	4/186 (2)	150/471 (32)	<0.001
Antiplatelets, n/N (%)	63/189 (33)	146/468 (31)	0.594
IV r-tPA before EVT, n (%)	166/190 (87)	291/476 (61)	<0.001
Prestroke mRS, n/N (%)			<0.001
0	147/187 (79)	282/471 (60)	
1	23/187 (12)	77/471 (16)	
2	10/187 (5)	40/471 (9)	
≥3	7/187 (4)	72/471 (12)	

- Sudden occlusion without collateral flow
  - poor outcome predictor of Cardioembolic stroke
  - Atherosclerosis = collateral socre high(?)
  - Embolic = collateral score low (?)
- MR-CLEAN registry
  - Collateral circulation
  - Outcomes
  - Thrombus perviousness
- Cardioembolism
  - elder
  - Medication(NOAC,warfarin)
  - rtPA (no)
  - Prestroke mRS(high)

Compare AF stroke with atherosclerotic stroke

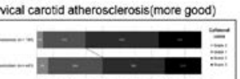
Collateral Circulation and Outcome in Atherosclerotic Versus Cardioembolic Cerebral Large Vessel Occlusion

Stroke. 2019;50:3360-3368.

Table 1. Baseline Characteristics

	Cervical Carotid Atherosclerosis (N=190)	Cardioembolism (N=476)	P Value
Clinical characteristics			
Median NIHSS (IQR)*	16 (12–19)	18 (12–20)	0.358
Median systolic blood pressure, mmHg (IQR)†	156 (142–173)	150 (131–167)	0.003
Median diastolic blood pressure, mmHg (IQR)‡	80 (71–90)	80 (70–89)	0.806
Median onset-to-groin in minutes (IQR)	207 (165–273)	215 (160–270)	0.962
Laboratory investigations			
Median serum glucose (IQR)§	6.5 (5.8–7.8)	6.6 (6–8.1)	0.095
Median platelet count (IQR)‖	226 (200–280)	221 (187–267)	0.232
Median INR (IQR)¶	1 (1–1)	1 (1–1.5)	<0.001
Imaging characteristics			
Median ASPECTS (IQR)#	8 (7–10)	9 (7–10)	0.158
Occlusion location on CT angiography, n/N (%)			<0.001
ICA	20/190 (10)	6/430 (1)	
ICA-T	63/190 (33)	81/430 (19)	
Proximal M1	53/190 (28)	119/430 (28)	
Distal M1	36/190 (19)	171/430 (38)	
M2	8/190 (4)	68/430 (1)	
Hyperdense artery sign, n/N (%)	128/183 (73)	229/450 (51)	<0.001
Median TAI in Hounsfield units (IQR)**	6.9 (5.7–15.7)	3.9 (1.6–11.1)	0.068
Clot length, mm (IQR)††	20.5 (14.2–23.3)	12.3 (6.0–15.9)	<0.001

- Collateral score
  - Cervical carotid atherosclerosis(more good)



- Cardioembolism
  - MCA occlusion

Compare AF stroke with atherosclerotic stroke

Table 2. Clinical, Radiological, and Procedural Outcomes

	Cervical Carotid Atherosclerosis (N=190)	Cardioembolism (N=476)	Adjusted Common OR† (95% CI)
Clinical outcomes			
Median ΔNIHSS (IQR)*	4 (0–9)	3 (0–9)	0.51 (−0.36–2.60)
Median mRS at 90 d (IQR)†	3 (1–5)	4 (2–6)	1.45 (1.03–2.05)
mRS score of 0–2 at 90 d, n/N (%)	82/175 (46)	150/427 (35)	1.39 (0.89–2.07)
Mortality, n/N (%)	40/175 (23)	142/431 (33)	0.80 (0.48–1.34)
Symptomatic intracranial hemorrhage, n/N (%)‡	13/180 (7)	22/476 (5)	1.42 (0.70–2.85)
Radiological outcomes, n/N (%)			
Post-EVT eTICI score ≥2B	95/186 (52)	261/470 (56)	0.85 (0.58–1.22)
Post-EVT eTICI score ≥2C	66/186 (36)	189/470 (43)	0.77 (0.51–1.14)
Procedural outcomes			
First-pass effect,§ n/N (%)	14/128 (10)	76/367 (21)	0.43 (0.23–0.80)
Median number of passes with stent retriever (IQR)‖	2 (1–3)	2 (1–3)	0.21 (−0.02–1.40)
Median procedure duration in minutes (IQR)¶	73 (56–102)	68 (40–90)	13.05 (4.64–16.96)

- mRS score(0-2)
- Mortality
  - No statistical difference
- Cardioembolic stroke associated with better procedural outcome
  - Shorter procedural time (easy access)
  - Collateral score may not main deciding factor of outcome
  - Post EVT eTICI, first pass are better
- Why?
  - Cardioembolic group treated anticoagulant before stroke (tPA contraindication)
  - cardioembolic group was older, worse functional condition pre-stroke (poor prognosis at baseline)
- Using Non-EVT data
  - Cardioembolic group present more severe deficit than other etiology
  - Cardioembolic stroke is usually associated with relatively large thrombi resulting more often in LVO .
  - Using LVO cases in this study, Cardioembolic group and atherosclerosis group didn't different

Technical success rate for AF stroke

Clinical Article

Mechanical Thrombectomy with Solitaire Stent Retrieval for Acute Cardioembolic Stroke

- 20 patients with Solitaire retrieval stent
- Cardio-embolism
  - Contralateral ICA morphology
  - Arrhythmia
  - Comorbid heart disease

M : F	10 :10
tPA	12
medication	
warfarin	3
aspirin	7
Aspirin+cilostazol	1
TICI 2b, 3	16/20(80%)
Reperfusion hemorrhage	2/20 (10%)
Recanalization failure	4/20(20%)

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Page • 18

AF after acute stroke

Atrial Fibrillation After Acute Stroke

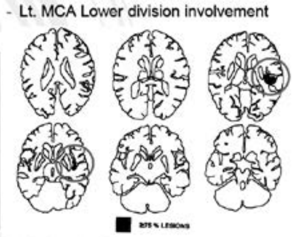
F. Vingerhoets, MD; J. Bogousslavsky, MD; F. Regli, MD; and G. Van Melle, PhD

Stroke Vol 24, No 1 January 1993

- 2/3 of ischemic stroke may be secondary to AF
- Cardiac arrhythmias and ECG change have been reported after ischemic stroke
  - ICH, brain tumor, head trauma, epilepsy, multiple sclerosis, basilar artery migraine

- First ever stroke
- 24hour ECG monitoring after admission
- 1661 patients included
  - 144(8.7%): known AF
  - 41(2.5%): recent AF
- Recent AF: sinus rhythm on ECG at admission, AF discover after admission on ECG

- Recent AF
  - Superficial MCA territory (M/C), 59%
    - Parietoinsular region(32%)
      - MCA lower division
  - Brain stem, 11%
  - Distribution of infarction
    - Statistical difference(p<0.05) recent AF with cardioembolic stroke
  - Left sided infarction 61%
  - Lt. MCA Lower division involvement



Page • 19

AF after acute stroke

Atrial Fibrillation After Acute Stroke

F. Vingerhoets, MD; J. Bogousslavsky, MD; F. Regli, MD; and G. Van Melle, PhD

Stroke Vol 24, No 1 January 1993

- Recent AF (AF may be not cause of stroke)
  - Developed clearly after stroke
  - No longer than a few days
  - Uncommon recurrence
  - Preponderance of ICH 9.8%
    - cardioembolic stroke 0.9%
    - ICH cannot be cause by AF
  - Echo fail to find source of recent AF
    - Echo found source of embolism at Know AF, cardioembolic stroke patients

- Topographical distribution of infarction
  - Recent AF, known AF, cardioembolism

- Recent AF
- **Brain stem**
  - Stem may be arrhythmogenic
  - Directly involved in cardiac regulation
    - Nucleus tractus solitarius
    - Dorsolateral nucleus of vagus nerve
    - Nucleus ambiguous
- **Parietoinsular predominance**
  - Difficult to explain
  - May be insula associated with a higher risk of developing AF after acute stroke

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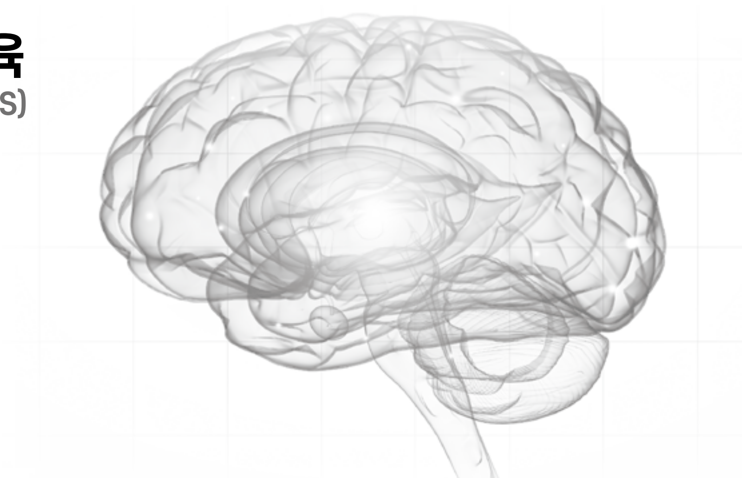
Page • 20



Session 2. Carotid revascularization strategy

좌장 : 김태선(전남대), 윤석만(순천향대)

1. Carotid endarterectomy
김용배(연세대 세브란스병원)

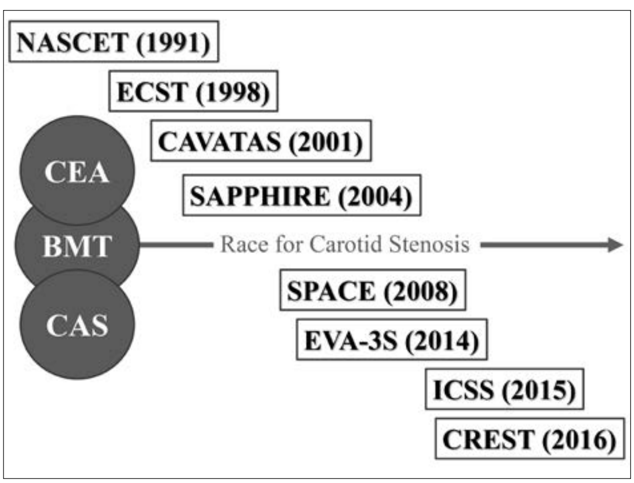
2. EC-IC Bypass
윤원기(고려대 구로병원)

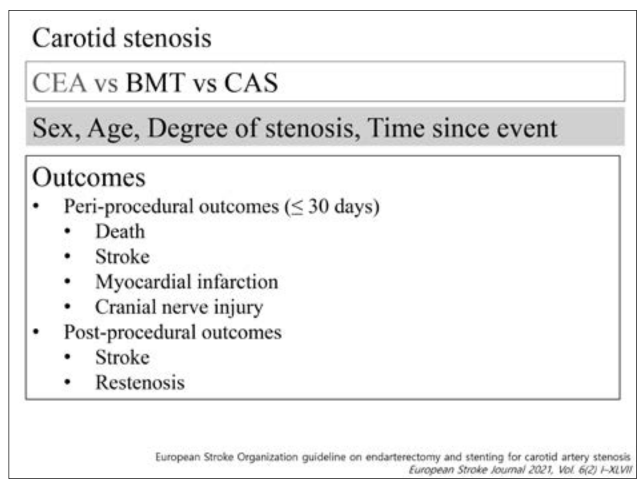
3. Carotid stenting
이동훈(가톨릭대 성빈센트병원)

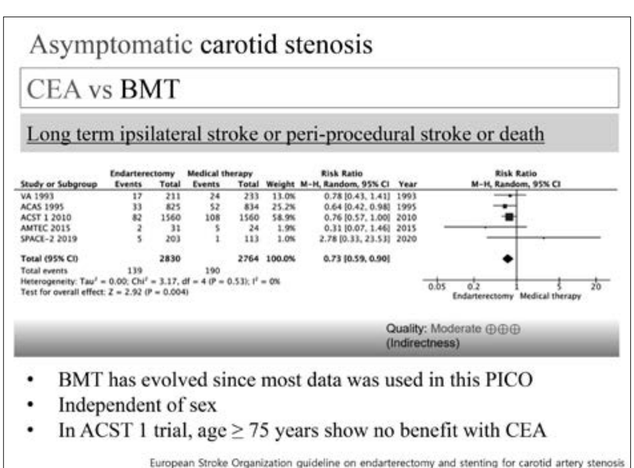
Carotid endarterectomy

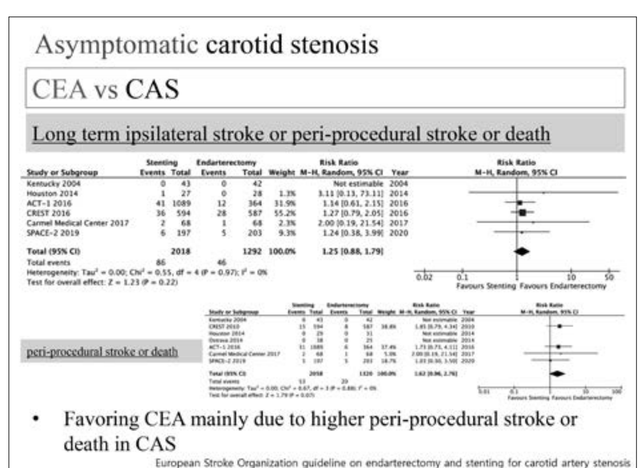
김용배

연세대 세브란스병원









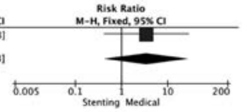
Asymptomatic carotid stenosis

CAS vs BMT

Long term ipsilateral stroke or peri-procedural stroke or death

Study or Subgroup	Stenting Events	Stenting Total	Medical Events	Medical Total	Weight	Risk Ratio M-H, Fixed, 95% CI
SPACE-2 2019	6	197	1	113	100.0%	3.44 [0.42, 28.23]
Total (95% CI)		**197**		**113**	**100.0%**	**3.44 [0.42, 28.23]**
Total events	6		1			

Heterogeneity: Not applicable
Test for overall effect: Z = 1.15 (P = 0.25)



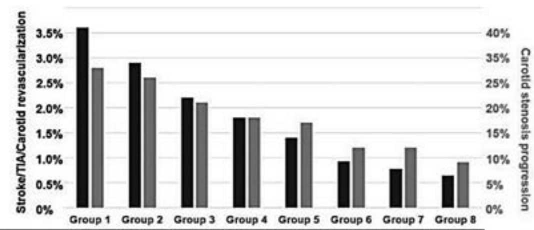
Quality: Very low ⊕
(Bias, Indirectness, Imprecision)

- Evidence-based recommendation indicated against CAS as a routine alternative to BMT alone

European Stroke Organization guideline on endarterectomy and stenting for carotid artery stenosis
European Stroke Journal 2021, Vol. 6(2) I–XLVII

Asymptomatic carotid stenosis

BMT



	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Smoking	YES	YES	YES	YES	YES	YES	YES	NO
BP≥140/90 mmHg	YES	NO	YES	YES	NO	YES	NO	NO
LDL>100 mg/dl	YES	YES	YES	NO	NO	NO	NO	NO
No/low dose statins	YES	YES	NO	YES	YES	NO	NO	NO

Management of carotid stenosis for primary and secondary prevention of stroke: state-of-the-art 2020: a critical review
European Heart Journal Supplements (2020) 22, M35–M42

Perioperative mortality & morbidity

Improving operative stroke/death rates in major randomized trials

Trial	Publication Year	CEA*	CAS*
Symptomatic			
NASCET	1991, 1998	6.7%	
ECST	2003	7.5%	
EVA-3S	2008	3.9%	9.6%
SPACE	2008	6.6%	7.4%
ICSS	2010	3.4%	7.4%
CREST	2010, 2016	3.2%	6.0%
Asymptomatic			
ACAS	1995	2.3%	
ACST	2004	2.8%	
CREST	2010, 2016	1.4%	2.5%
ACT I	2016	1.7%	2.9%

*30-day any operative stroke/death

"History and Major Trials in Carotid Revascularization" Supplemental Tables I & II
Stroke, 2018

Asymptomatic carotid stenosis

Expert consensus statement

in selected patients 75 years of age or older with ≥ 60% asymptomatic carotid artery stenosis and an expected survival of at least five years, who are considered to be at an increased risk of stroke on best medical therapy alone, carotid endarterectomy is suggested after careful consideration of the risks and benefits at a multi-disciplinary team meeting.
> Risk of in-hospital stroke or death following endarterectomy or stenting for asymptomatic carotid stenosis should be as low as possible, ideally below 2%

European Stroke Organization guideline on endarterectomy and stenting for carotid artery stenosis
European Stroke Journal 2021, Vol. 6(2) I–XLVII

Asymptomatic carotid stenosis

Increased stroke risk

- Silent infarction on neuroimaging
- High degree or progression of stenosis
- Echolucent plaque on ultrasound
- Intra-plaque haemorrhage on MRI
- Micro-emboli on TCD
- Reduced cerebrovascular reserve on TCD

European Stroke Organization guideline on endarterectomy and stenting for carotid artery stenosis
European Stroke Journal 2021, Vol. 6(2) I–XLVII

Asymptomatic carotid stenosis

Practical Real World Statement

- **< 50% stenosis : MILD**
  - Risk factor control with lifestyle change and medication
  - Annual carotid duplex surveillance
- **50-69% stenosis : MODERATE**
  - Intensive medical therapy
  - Tight imaging surveillance
- **> 70% : SEVERE**
  - Consider carotid revascularization with BMT
  - Many surgeon adopt more conservative policy until >80% stenosis

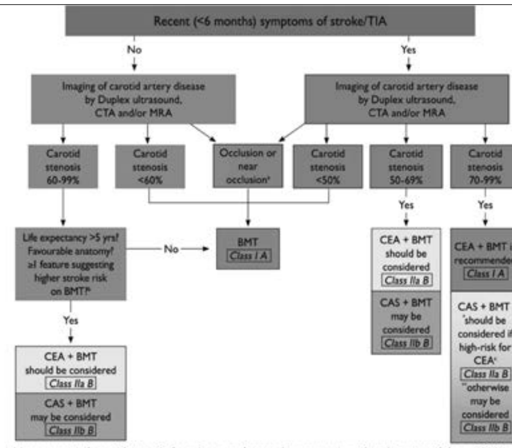
Management of asymptomatic extracranial carotid atherosclerotic disease
UpToDate, 2021

Symptomatic carotid stenosis

CEA vs CAS from meta analysis ICSS, CREST, EVA-3S, SPACE

- In CAS, risk increase with age, if >80 yrs, then OR 4.15 for procedural stroke/death, not in CEA
- The age effect become apparent in 60-65 yrs
- CEA superior to CAS in aged >70 yrs
- CEA reduce stroke with moderate (50-69%) and severe (70-99%) stenosis, except for 'near occlusion'

Management of carotid stenosis for primary and secondary prevention of stroke: state-of-the-art 2020: a critical review
European Heart Journal Supplements (2020) 22, M35–M42



Management of carotid stenosis for primary and secondary prevention of stroke: state-of-the-art 2020: a critical review
European Heart Journal Supplements (2020) 22, M35–M42

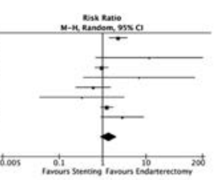
Asymptomatic or Symptomatic carotid stenosis

CEA vs BMT

Severe restenosis

Study or Subgroup	Stenting Events	Stenting Total	Endarterectomy Events	Endarterectomy Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
SPACE 2008	54	607	23	589	21.4%	2.28 [1.42, 3.66]	2008
BACASS 2008	0	8	0	9		Not estimable	2008
Regensburg 2008	6	32	0	29	2.1%	11.82 [0.69, 200.99]	2008
CREST 2012	58	1086	62	1105	24.3%	0.95 [0.67, 1.35]	2012
Kentucky 2014	3	95	0	94	2.0%	6.93 [0.36, 132.29]	2014
EVA-3S 2014	7	247	12	257	12.5%	0.61 [0.24, 1.52]	2014
Carmel Medical Center 2017	1	68	3	68	3.3%	0.33 [0.04, 3.13]	2017
ICSS 2018	72	737	62	793	24.8%	1.25 [0.90, 1.73]	2018
SPACE-2 2019	11	197	4	203	9.7%	2.83 [0.92, 8.75]	2020
Total (95% CI)		**3077**		**3147**	**100.0%**	**1.37 [0.89, 2.10]**	
Total events	212		166				

Heterogeneity: $Tau^2 = 0.17$; $Chi^2 = 18.03$, $df = 7$ ($P = 0.01$); $I^2 = 61\%$
Test for overall effect: $Z = 1.43$ ($P = 0.15$)



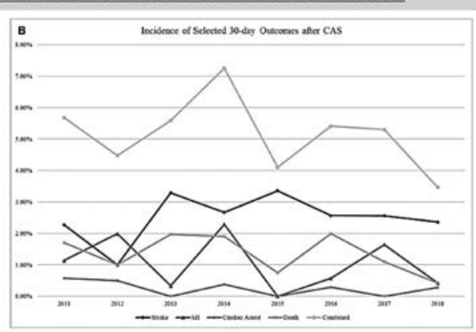
Quality: Very low ⊕
(Inconsistency, Indirectness, Imprecision)

- Low quality of evidence favoring CEA

European Stroke Organization guideline on endarterectomy and stenting for carotid artery stenosis
European Stroke Journal 2021, Vol. 6(2) I–XLVII

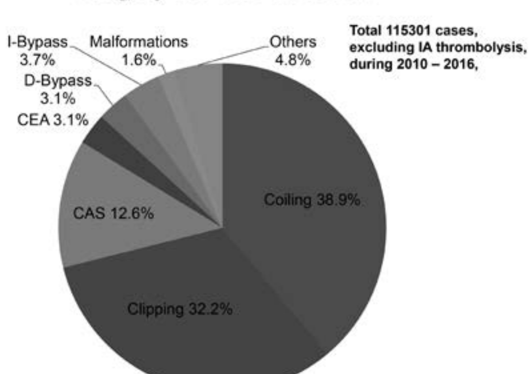
CEA vs CAS

Early outcomes in real US nationwide data since 2011



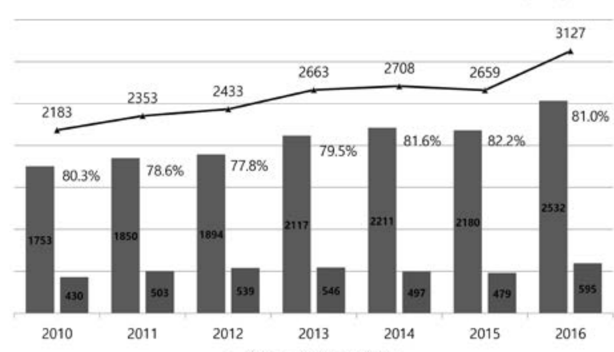
- Peri-procedural stroke after CAS is not decreasing over time

Early Outcomes After Carotid Endarterectomy and Carotid Artery Stenting: A Propensity-Matched Cohort Analysis
Neurosurgery 0:1–11, 2021



Nation-wide trends in Korea

SOURCE : Korean National Health Insurance Review & Assessment (HIRA) Service



Biased Practice Trends in KOREA

- Lack of interest in performing CEA
- Wider popularity of endovascular surgeon
- Tends to prefer non-invasive modality

⬇

- Need qualified candidate for each intervention
- Candid evaluation for institutional outcome
- Foster competent surgical option

Protocol for Carotid Artery Stenosis

PROCESS

1. **Consensus**
   by Neurology, Neurosurgery, Neuroradiology
2. **Review (192 articles)**
   RCTs, well-designed case-control (IF ≥ 6)
3. **Qualifying the proper candidate**

Protocol for Carotid Artery Stenosis

Treatment Indications

Symptomatic stenosis ≥ 50%
Asymptomatic stenosis ≥ 80% or
≥ 50% with contralateral occlusion

Timing

≤ 2 weeks for symptomatic stenosis

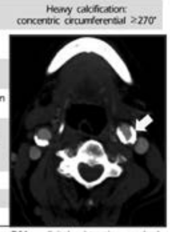
Protocol for Carotid Artery Stenosis

Four categories : based on the selected factors

1. Anatomic approach to carotid artery
   High bifurcation, Previous neck dissection, Radiation,
2. Endovascular accessibility
   Vascular access, Allergy to contrast, Renal dysfunction, Type III aorta
3. Characteristics of stenosis & plaque
   Calcification, Ulceration, Length, Collaterals, Tandem lesion, Contralateral occlusion
4. Cardiopulmonary function
   Heart failure, Myocardial infarction, Pulmonary dysfunction

Absolute : 3 points, Favorable : 1 point

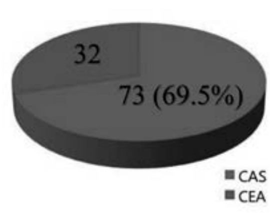
Table 1. Protocol for selection of a proper surgical treatment option for carotid artery stenosis

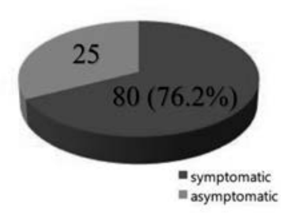
Absolute CAS	Favorable CAS	Favorable CEA	Absolute CEA
Heart failure (TEE, ejection fraction ≤ 30%)	Stable angina including a history of coronary stenting with 30% < ejection fraction ≤ 40%	Renal failure without hemodialysis	Failure of DSA
Myocardial infarction within 4 weeks	Poor collateral flow of anterior communicating artery	Complicated atheroma on the ascending aortic arch	Severe vascular disease of femoral access
Need for open heart surgery within 6 weeks	Carotid artery tandem lesions	Type 3 aortic arch	Allergic reaction to contrast
Pulmonary dysfunction (PFT, FEV1 or DLCO ≤ 50%)	Emergency	String sign	Heavy calcification: concentric circumferential ≥270°
Contralateral carotid artery occlusion		Ulcerated lesion	
Contralateral laryngeal paralysis		The length of the lesion ≥ 30 mm	
High stenosis above C2 or low stenosis below clavicle		Thrombus-containing stenosis on DSA	
Previous radiation of the neck		Moderate calcification (90° ≤ circumference < 270°) with calcification thickness ≥ 3 mm	
Previous radical neck surgery			
Restenosis after CEA			
Former tracheostomy			

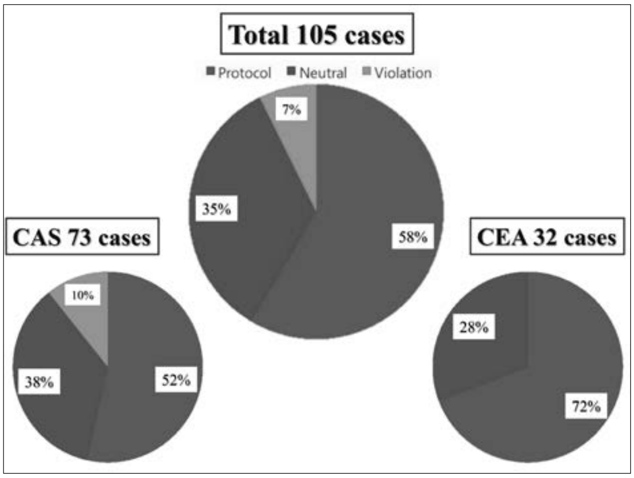
CAS = carotid artery stenting; CEA = carotid endarterectomy; TEE = transesophageal echocardiogram; DSA = digital subtraction cerebral angiography; PFT = pulmonary function test; FEV1 = forced expiratory volume in 1 second; DLCO = diffusion capacity of the lung for carbon monoxide

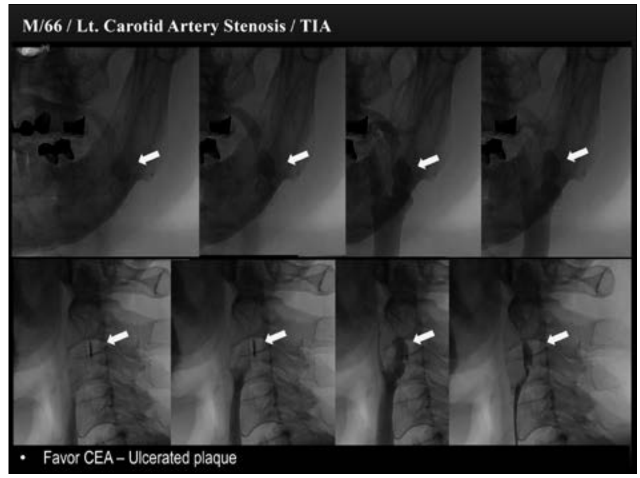
Protocol-based Practice

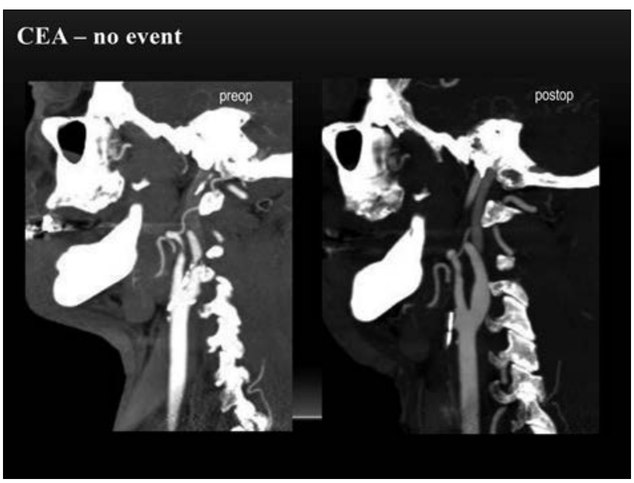
From Oct. 2013 to May 2018
the protocol applied to total **105 consecutive** pts

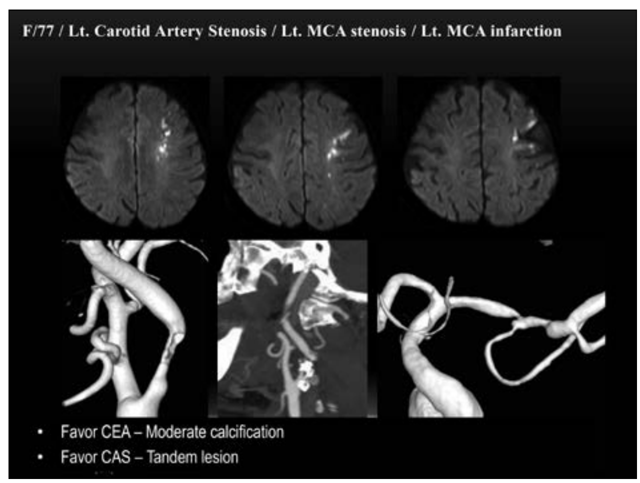


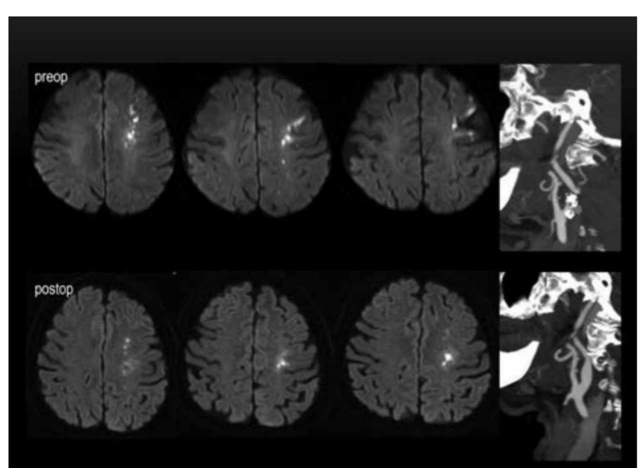



Total 105 cases
Protocol
Neutral
Violation
7%
35%
58%
CAS 73 cases
10%
38%
52%
CEA 32 cases
28%
72%


M/66 / Lt. Carotid Artery Stenosis / TIA
Favor CEA – Ulcerated plaque


CEA – no event
preop
postop

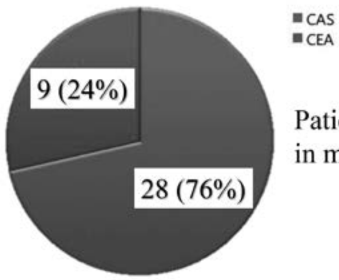

F/77 / Lt. Carotid Artery Stenosis / Lt. MCA stenosis / Lt. MCA infarction
Favor CEA – Moderate calcification
Favor CAS – Tandem lesion


preop
postop

Neutral 37 (35.2%) cases

no score in 27, equal score in 10

✦CAS in 28 pts / CEA in 9 pts



Patient's preference in majority

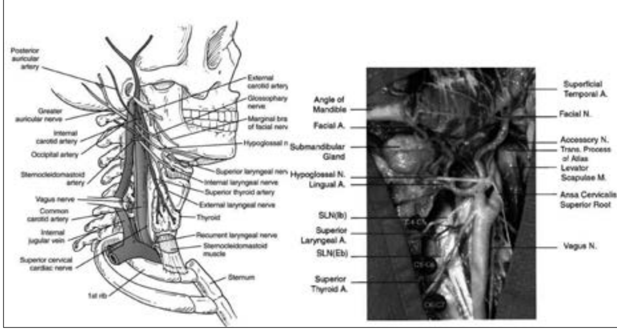
Protocol-Based Decision

- About 60% of the patients can be followed by the protocol
- Neutral 76% of the patients tend to select CAS
- Individual indication can contribute to improve overall outcome
- There should be "BOTH" options for carotid stenosis
- Protocol can be a reasonable solution to correct the inherent bias in clinical practice

Technique

Anatomy

- 4 structures crossing over ICA
  - Hypoglossal N / Occipital A / Facial V / Ansa Cervicalis



Technique

as for Neurosurgeon

- Neurological surgery has yielded favorable outcomes
  ① use of the operating microscope
  ② intraoperative monitoring of cerebral function
- Safety
  - ~~< 3% in the asymptomatic patient~~
  - ~~< 5-6% in the symptomatic patient~~
  - **< 2% in the asymptomatic patient**
  - **< 4% in the symptomatic patient**
- The choice of the CEA technique : depend on the experience and familiarity of the individual surgeon

Technique - Anesthesia

General vs Local

Lancet 2008; 372: 2132-2142.
Meta-analysis, Hajibandeh S et al. Anesthesia, 2018; 73: 1280-1289

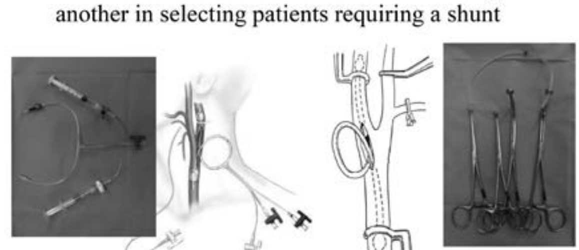
- Both General and Local anesthesia are safe
- Surgeon, Anesthetist, Patient – individual base
- **Local anesthesia might have some benefit of lower morbidity and mortality**
- **Local anesthesia may reduce use of shunts**

LA ≧ GA

Technique - shunt

Use of Shunts

- No evidence for the routine use of shunt
- Little evidence to use one form of monitoring over another in selecting patients requiring a shunt



Pruitt-Inahara carotid shunt   USCI Javid carotid bypass shunt

Technique - repair

Primary Repair vs Patch Angioplasty

Meta-analysis, Texakalidis P et al. J Vasc Surg, 2018;1241-1256

- **Patch angioplasty may reduces the risk of occlusion and re-stenosis, and risk of stroke / death**
- Synthetic / Bovine pericardium / Venous
- Longer cross-clamping time

Primary ≦ Patch

Technique - repair

Primary Repair vs Patch Angioplasty

(Continued from previous page)

Conclusions: This systematic review showed no conclusive evidence of a difference between carotid endarterectomy with patch angioplasty versus primary closure of the arterial wall on all-cause mortality, < 30 days mortality, < 30 days stroke, or any other serious adverse events. These conclusions are based on data from 15 to 35 years ago, obtained in trials with very low certainty according to GRADE, and should be interpreted cautiously. Therefore, we suggest conducting new randomized clinical trials patch angioplasty versus primary closure in carotid endarterectomy in symptomatic patients with an internal carotid artery stenosis of 50% or more. Such trials ought to be designed according to the Standard Protocol Items: Recommendations for Interventional Trials statement (Chan et al., Ann Intern Med 1:200–7, 2013) and reported according to the Consolidated Standards of Reporting Trials statement (Schulz et al., 7, 2010). Until conclusive evidence is obtained, the standard of care according to guidelines should not be abandoned.

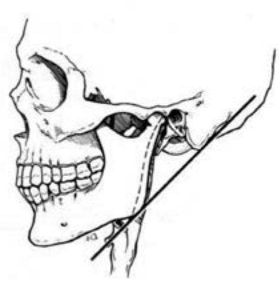
Systematic review registration: PROSPERO CRD42014013416. Review protocol publication 2019 DOI: https://doi.org/10.1136/bmjopen-2018-026419.

Keywords: Carotid stenosis, Carotid endarterectomy, Patch, Systematic review, Primary closure, Trial sequential analysis, GRADE

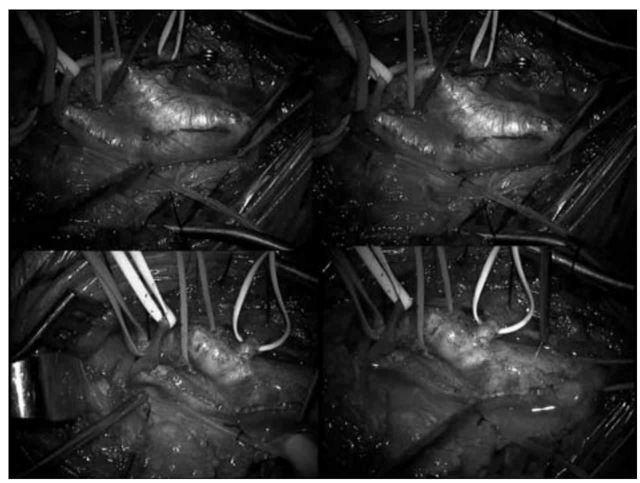
Carotid endarterectomy with patch angioplasty versus primary closure in patients with symptomatic and significant stenosis: a systematic review with metaanalyses and trial sequential analysis of randomized clinical trials
Marsman et al. Systematic Reviews (2021) 10:139

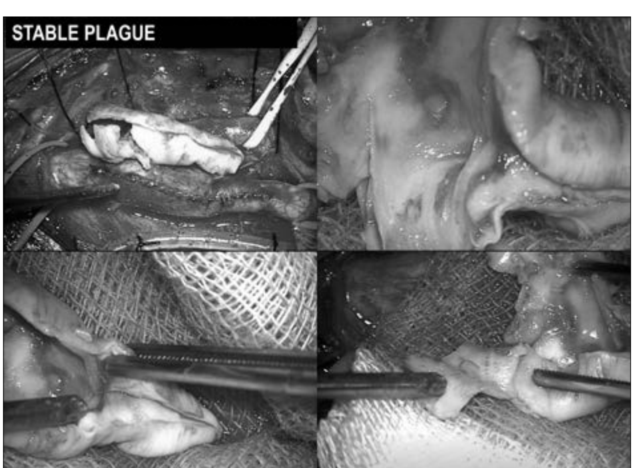
Technique

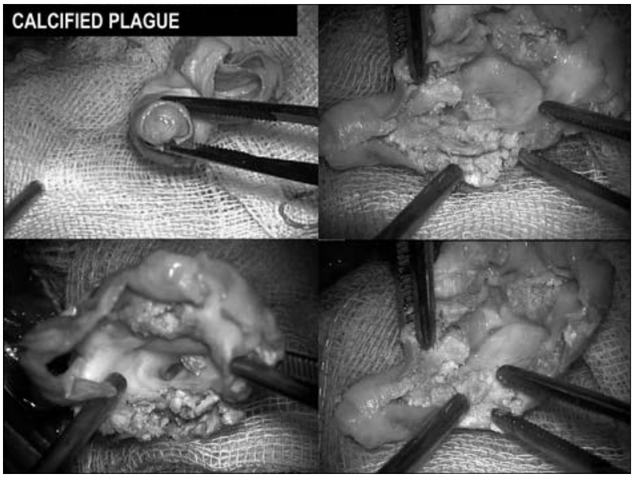
Higher exposure

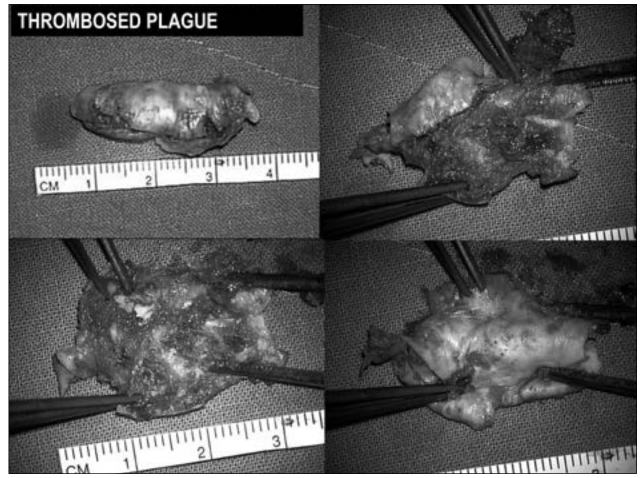


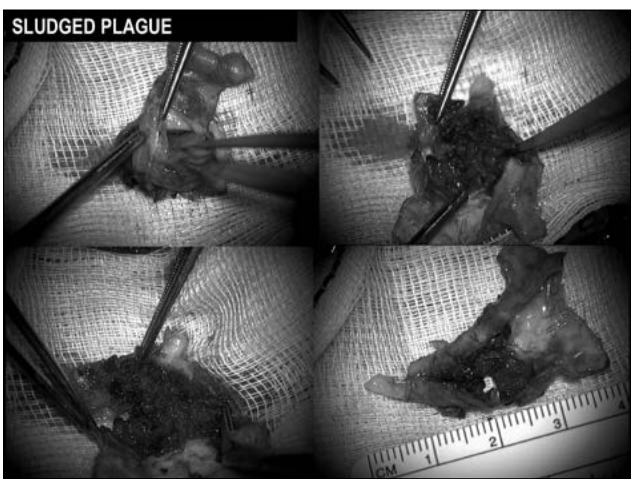
Blaisdell's line
: tip of mastoid process - angle of mandible

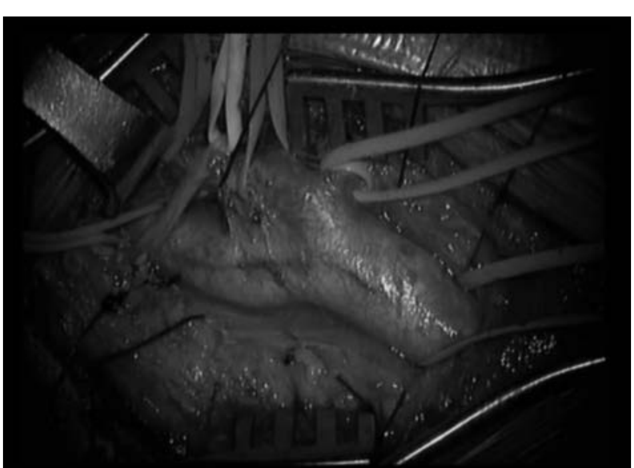


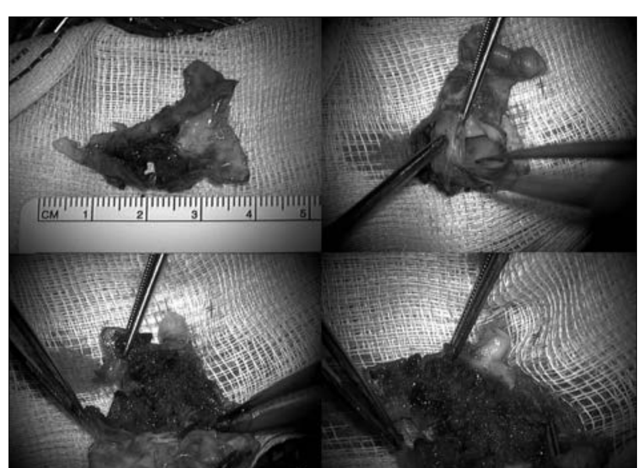


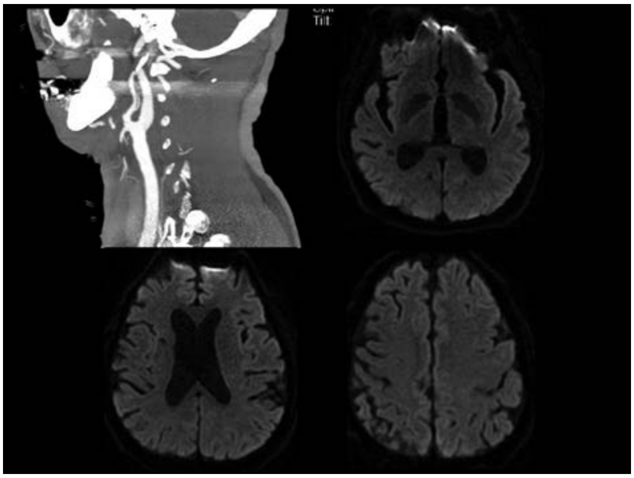

CALCIFIED PLAGUE

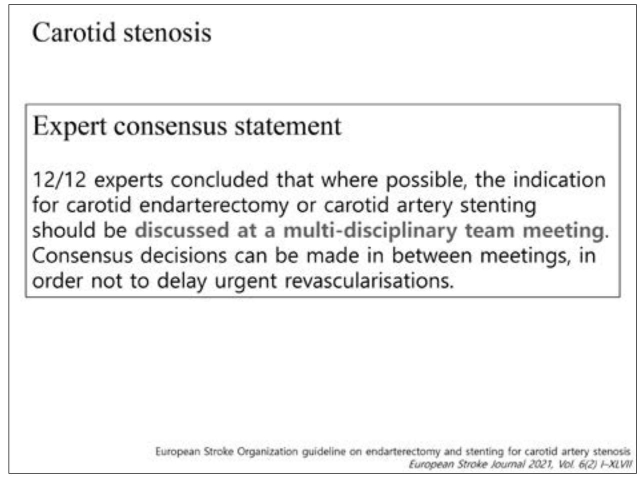

THROMBOSED PLAGUE


SLUDGED PLAGUE








Carotid stenosis
Expert consensus statement
12/12 experts concluded that where possible, the indication for carotid endarterectomy or carotid artery stenting should be **discussed at a multi-disciplinary team meeting**. Consensus decisions can be made in between meetings, in order not to delay urgent revascularisations.
European Stroke Organization guideline on endarterectomy and stenting for carotid artery stenosis
European Stroke Journal 2021, Vol. 6(2) I–XLVII

EC-IC Bypass

윤원기

고려대 구로병원

Role of Bypass Surgery for Acute Ischemic Stroke in the Era of EVT

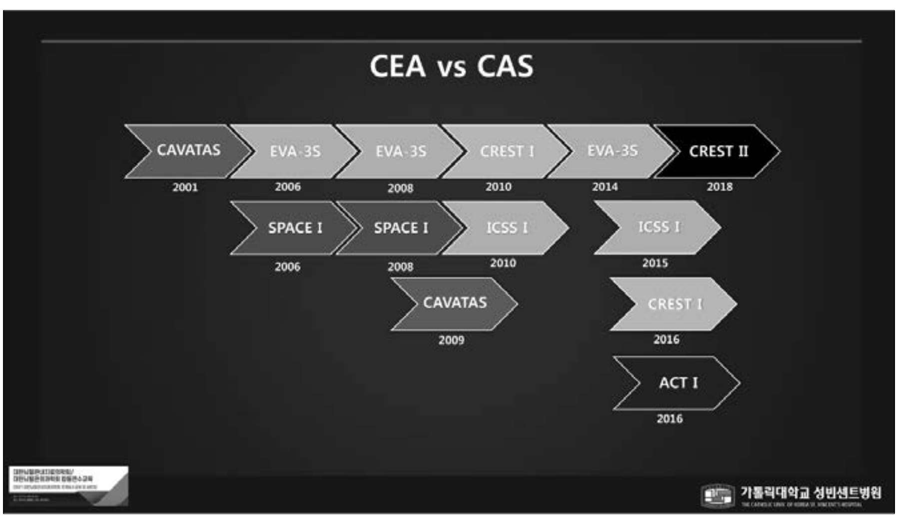
Efficacy of low flow EC-IC bypass surgery in cerebral ischemic disease is controversial. Since the report of COSS trial reported in 2011, reluctance on the performance of this surgery has been spread. However, we could have witnessed many cases of excellent clinical outcome following this bypass procedure in the real-world daily practice when performed with a narrow and concrete indication. Especially, a symptomatic occlusion of anterior circulation intractable to medical treatment has been proved to be a good candidate.

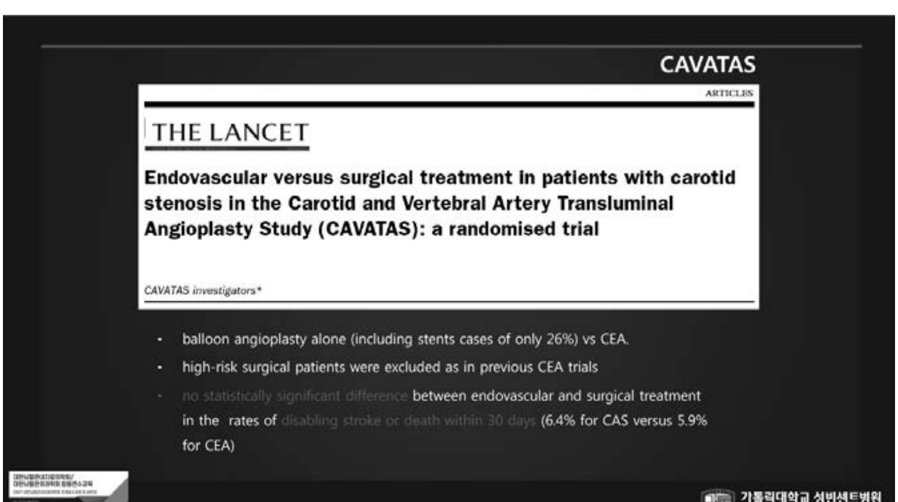
In this short lecture, I would like to introduce the possibility of its application to acute ischemic stroke (AIS) caused by large vessel occlusion (LVO). In the era of endovascular treatment (EVT), surgical management is becoming minor troopers especially in the battle field of AIS by LVO. The recanalization rate by EVT in acute setting reaches up to 85% and many prospective trials have proved EVT can improve clinical outcome. However, 15 to 25% patients of AIS by LVO still require further management rather than medical care. And very late arrival stroke patients have low chance to be recanalized. Majority of these patients are destined to end up with severe neurologic sequelae. Hence, I started to perform timely urgent low flow bypass surgery since 2017 and analyzed my case series and pooled data of retrospective reports. In this lecture, I provide you some data of this study with background knowledge and wish you to participate in the journey of “Dare to Do, Know and Spread”.

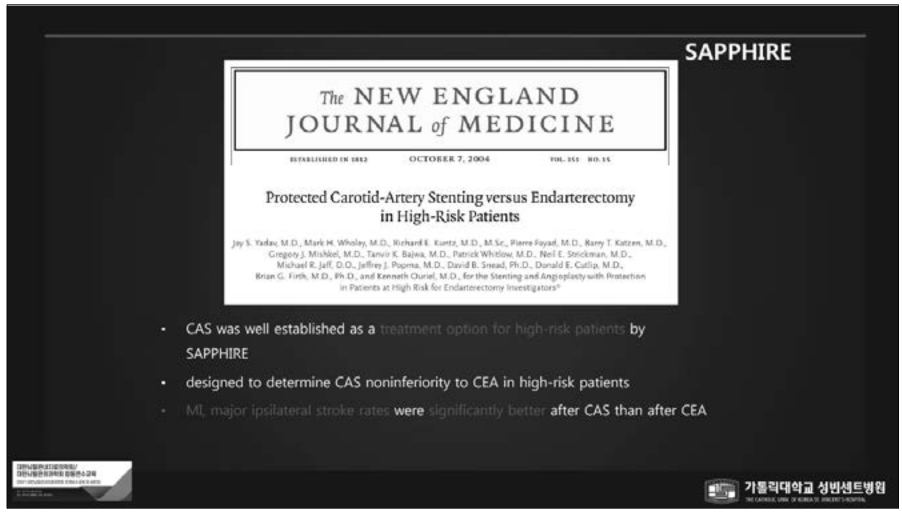
Carotid stenting

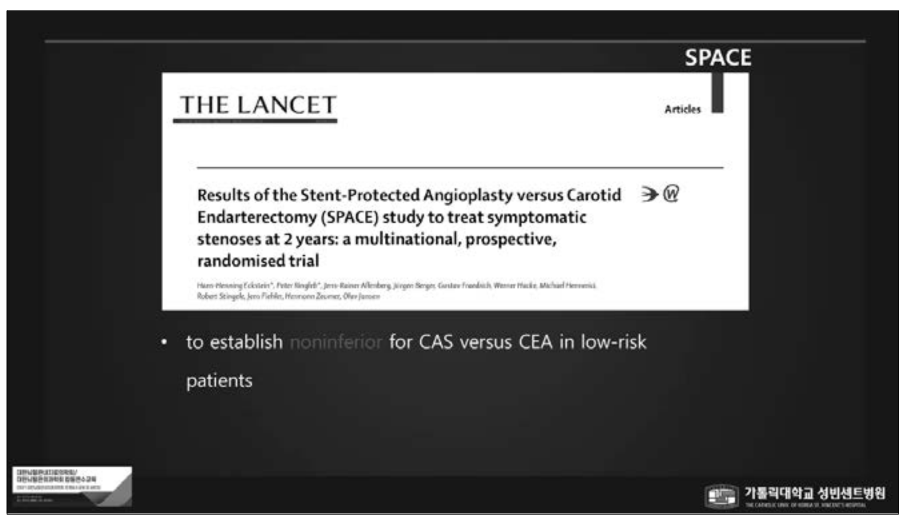
이동훈

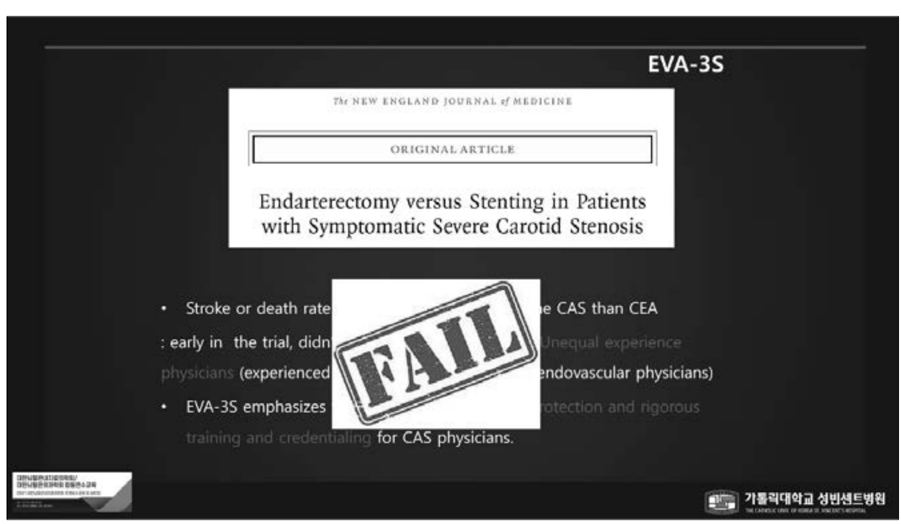
가톨릭대 성빈센트병원

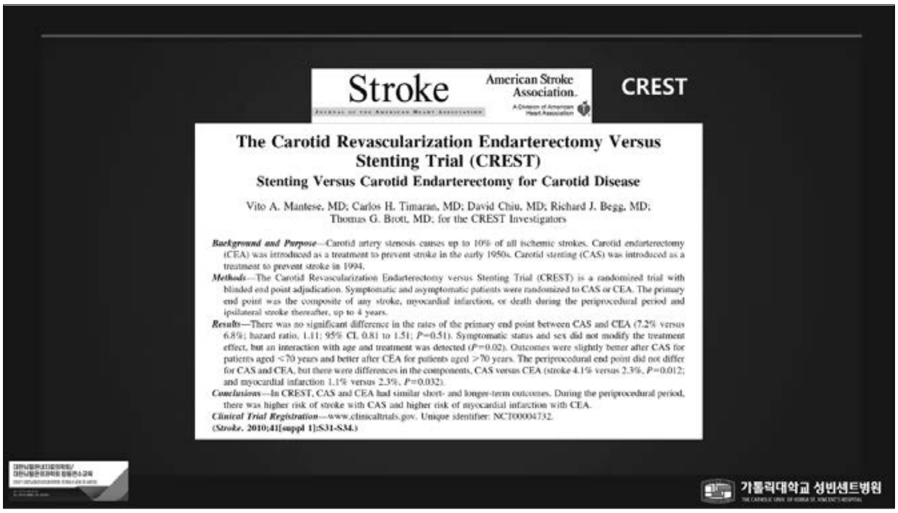





SAPPHIRE
The NEW ENGLAND JOURNAL of MEDICINE
OCTOBER 7, 2004
Protected Carotid-Artery Stenting versus Endarterectomy in High-Risk Patients
• CAS was well established as a treatment option for high-risk patients by SAPPHIRE
• designed to determine CAS noninferiority to CEA in high-risk patients
• MI, major ipsilateral stroke rates were significantly better after CAS than after CEA
가톨릭대학교 성빈센트병원


SPACE
THE LANCET
Articles
Results of the Stent-Protected Angioplasty versus Carotid Endarterectomy (SPACE) study to treat symptomatic stenoses at 2 years: a multinational, prospective, randomised trial
• to establish noninferior for CAS versus CEA in low-risk patients
가톨릭대학교 성빈센트병원


EVA-3S
The NEW ENGLAND JOURNAL of MEDICINE
ORIGINAL ARTICLE
Endarterectomy versus Stenting in Patients with Symptomatic Severe Carotid Stenosis
• Stroke or death rate
e CAS than CEA
: early in the trial, didn
Unequal experience
physicians (experienced
endovascular physicians)
• EVA-3S emphasizes
otection and rigorous
training and credentialing for CAS physicians.
FAIL
가톨릭대학교 성빈센트병원



Stroke

American Stroke Association.

The Carotid Revascularization Endarterectomy Versus Stenting Trial (CREST)

Stenting Versus Carotid Endarterectomy for Carotid Disease

Vito A. Mantese, MD; Carlos H. Timaran, MD; David Chiu, MD; Richard J. Begg, MD; Thomas G. Brott, MD; for the CREST Investigators

Background and Purpose—Carotid artery stenosis causes up to 10% of all ischemic strokes. Carotid endarterectomy (CEA) was introduced as a treatment to prevent stroke in the early 1950s. Carotid stenting (CAS) was introduced as a treatment to prevent stroke in 1994.

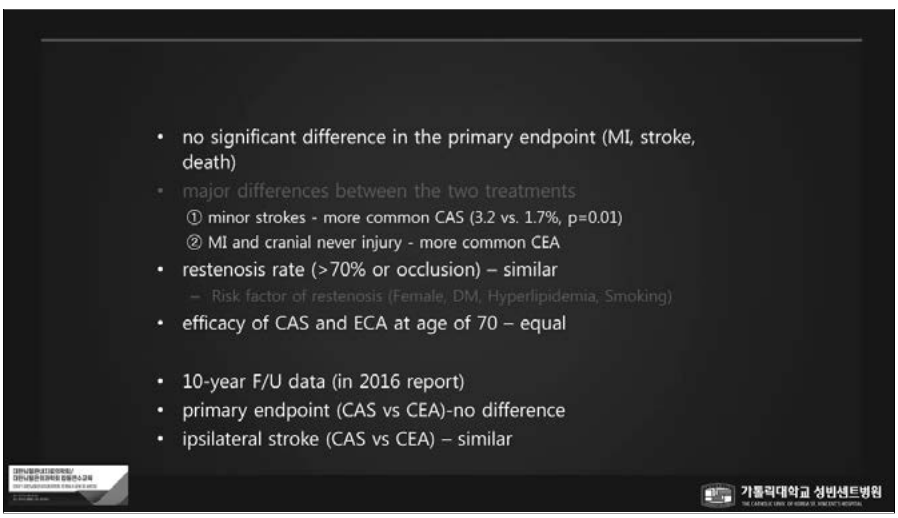
Methods—The Carotid Revascularization Endarterectomy versus Stenting Trial (CREST) is a randomized trial with blinded end point adjudication. Symptomatic and asymptomatic patients were randomized to CAS or CEA. The primary end point was the composite of any stroke, myocardial infarction, or death during the periprocedural period and ipsilateral stroke thereafter, up to 4 years.

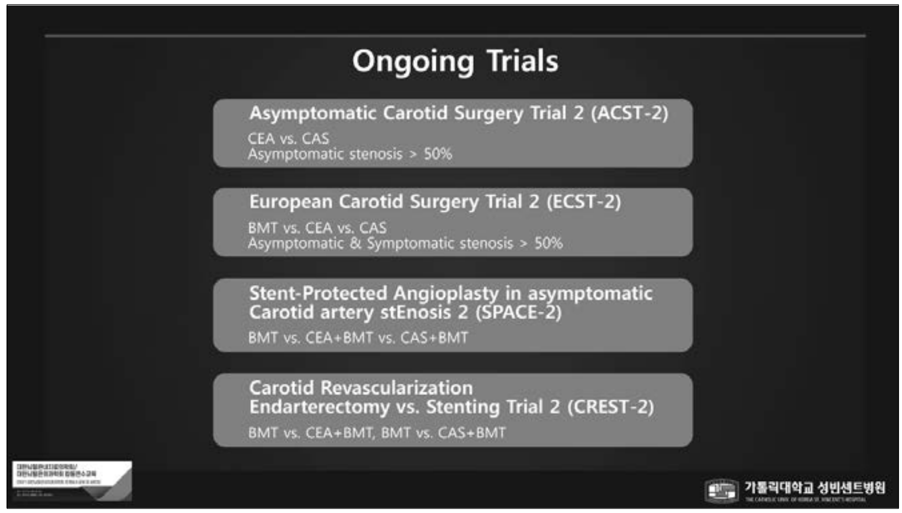
Results—There was no significant difference in the rates of the primary end point between CAS and CEA (7.2% versus 6.8%; hazard ratio, 1.11; 95% CI, 0.81 to 1.51; $P=0.51$). Symptomatic status and sex did not modify the treatment effect, but an interaction with age and treatment was detected ($P=0.02$). Outcomes were slightly better after CAS for patients aged <70 years and better after CEA for patients aged >70 years. The periprocedural end point did not differ for CAS and CEA, but there were differences in the components, CAS versus CEA (stroke 4.1% versus 2.3%, $P=0.012$; and myocardial infarction 1.1% versus 2.3%, $P=0.032$).

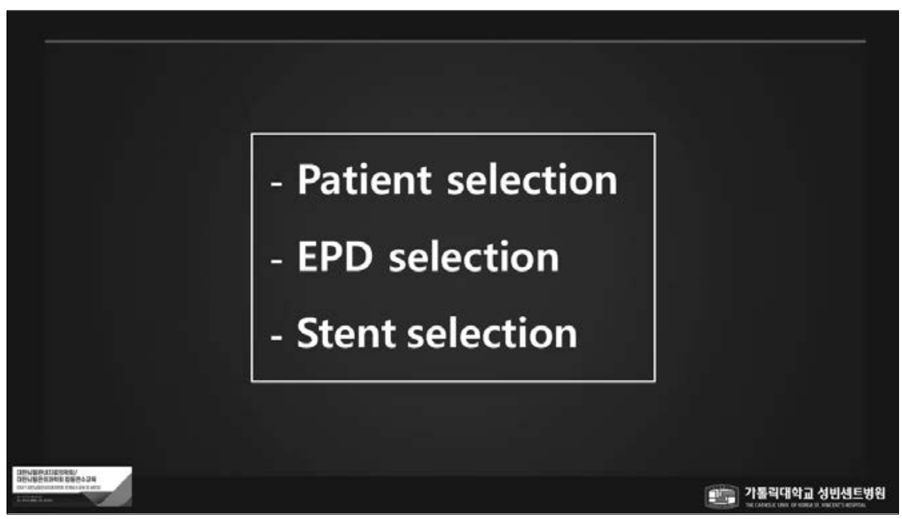
Conclusions—In CREST, CAS and CEA had similar short- and longer-term outcomes. During the periprocedural period, there was higher risk of stroke with CAS and higher risk of myocardial infarction with CEA.

Clinical Trial Registration—www.clinicaltrials.gov. Unique identifier: NCT00004732.

(*Stroke*. 2010;41[suppl 1]:S31-S34.)




Ongoing Trials
Asymptomatic Carotid Surgery Trial 2 (ACST-2)
CEA vs. CAS
Asymptomatic stenosis > 50%
European Carotid Surgery Trial 2 (ECST-2)
BMT vs. CEA vs. CAS
Asymptomatic & Symptomatic stenosis > 50%
Stent-Protected Angioplasty in asymptomatic Carotid artery stEnosis 2 (SPACE-2)
BMT vs. CEA+BMT vs. CAS+BMT
Carotid Revascularization Endarterectomy vs. Stenting Trial 2 (CREST-2)
BMT vs. CEA+BMT, BMT vs. CAS+BMT
가톨릭대학교 성빈센트병원


- Patient selection
- EPD selection
- Stent selection
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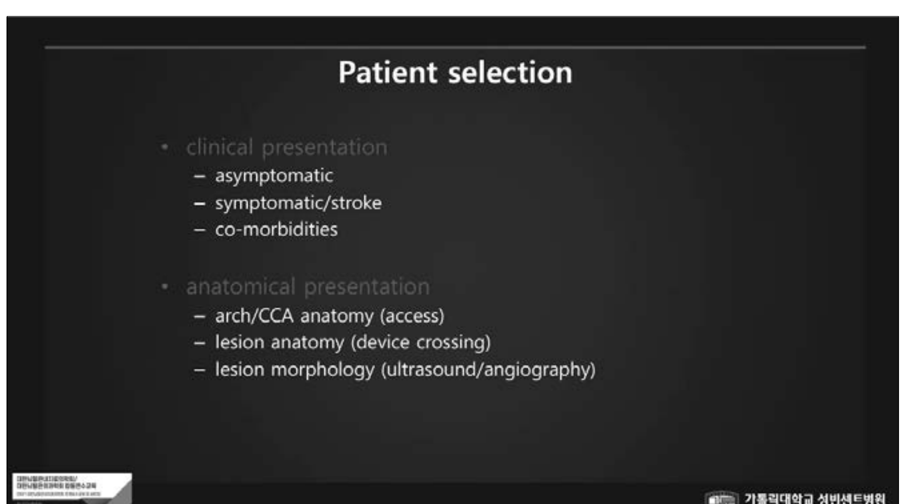
Patient selection
clinical presentation
– asymptomatic
– symptomatic/stroke
– co-morbidities
anatomical presentation
– arch/CCA anatomy (access)
– lesion anatomy (device crossing)
– lesion morphology (ultrasound/angiography)
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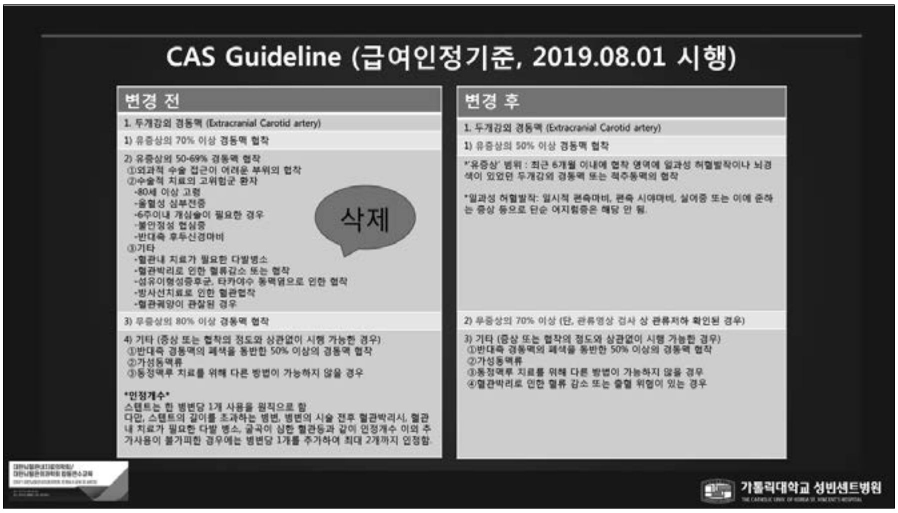
CAS Guideline (급여인정기준, 2019.08.01 시행)
변경 전
1. 두개강외 경동맥 (Extracranial Carotid artery)
1) 유증상의 70% 이상 경동맥 협착
2) 유증상의 50-69% 경동맥 협착
①외과적 수술 접근이 어려운 부위의 협착
②수술적 치료의 고위험군 환자
-80세 이상 고령
-울혈성 심부전증
-6주이내 개심술이 필요한 경우
-불안정성 협심증
-반대측 후두신경마비
③기타
-혈관내 치료가 필요한 다발병소
-혈관박리로 인한 혈류감소 또는 협착
-섬유이형성증후군, 타카야수 동맥염으로 인한 협착
-방사선치료로 인한 혈관협착
-혈관궤양이 관찰된 경우
삭제
3) 무증상의 80% 이상 경동맥 협착
4) 기타 (증상 또는 협착의 정도와 상관없이 시행 가능한 경우)
①반대측 경동맥의 폐색을 동반한 50% 이상의 경동맥 협착
②가성동맥류
③동정맥루 치료를 위해 다른 방법이 가능하지 않을 경우
인정개수
스텐트는 한 병변당 1개 사용을 원칙으로 함
다만, 스텐트의 길이를 초과하는 병변, 병변의 시술 전후 혈관박리시, 혈관내 치료가 필요한 다발 병소, 굴곡이 심한 혈관등과 같이 인정개수 이외 추가사용이 불가피한 경우에는 병변당 1개를 추가하여 최대 2개까지 인정함.
변경 후
1. 두개강외 경동맥 (Extracranial Carotid artery)
1) 유증상의 50% 이상 경동맥 협착
*'유증상' 범위 : 최근 6개월 이내에 협착 영역에 일과성 허혈발작이나 뇌경색이 있었던 두개강외 경동맥 또는 척추동맥의 협착
*일과성 허혈발작: 일시적 편측마비, 편측 시야마비, 실어증 또는 이에 준하는 증상 등으로 단순 어지럼증은 해당 안 됨.
2) 무증상의 70% 이상 (단, 관류영상 검사 상 관류저하 확인된 경우)
3) 기타 (증상 또는 협착의 정도와 상관없이 시행 가능한 경우)
①반대측 경동맥의 폐색을 동반한 50% 이상의 경동맥 협착
②가성동맥류
③동정맥루 치료를 위해 다른 방법이 가능하지 않을 경우
④혈관박리로 인한 혈류 감소 또는 출혈 위험이 있는 경우
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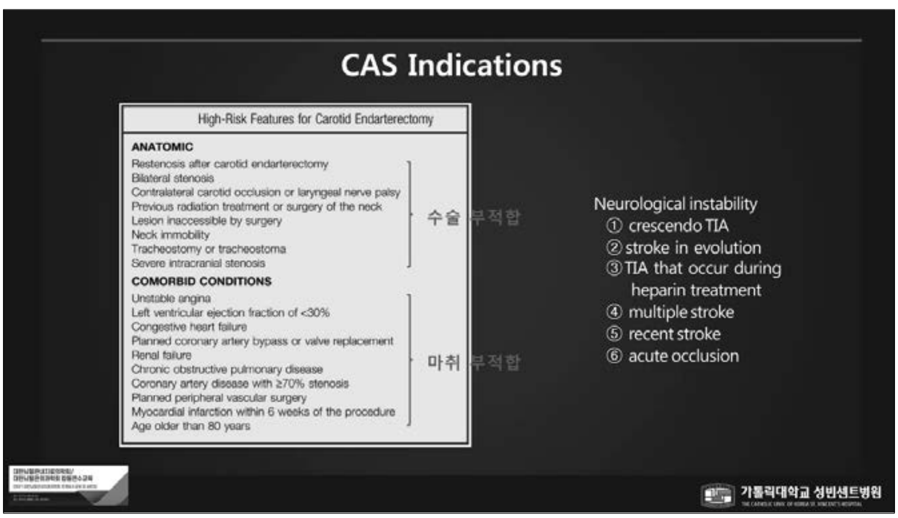
CAS Indications
High-Risk Features for Carotid Endarterectomy
ANATOMIC
Restenosis after carotid endarterectomy
Bilateral stenosis
Contralateral carotid occlusion or laryngeal nerve palsy
Previous radiation treatment or surgery of the neck
Lesion inaccessible by surgery
Neck immobility
Tracheostomy or tracheostoma
Severe intracranial stenosis
수술 부적합
COMORBID CONDITIONS
Unstable angina
Left ventricular ejection fraction of <30%
Congestive heart failure
Planned coronary artery bypass or valve replacement
Renal failure
Chronic obstructive pulmonary disease
Coronary artery disease with ≥70% stenosis
Planned peripheral vascular surgery
Myocardial infarction within 6 weeks of the procedure
Age older than 80 years
마취 부적합
Neurological instability
① crescendo TIA
② stroke in evolution
③ TIA that occur during heparin treatment
④ multiple stroke
⑤ recent stroke
⑥ acute occlusion
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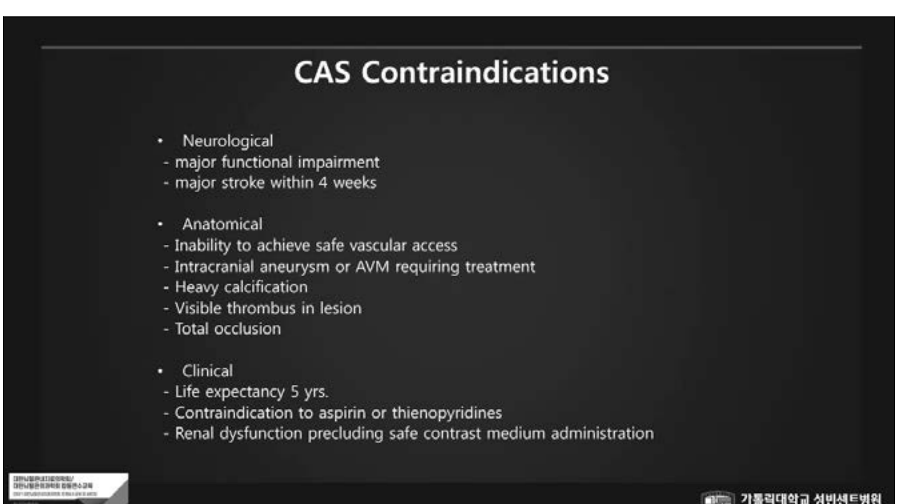
CAS Contraindications
• Neurological
- major functional impairment
- major stroke within 4 weeks
• Anatomical
- Inability to achieve safe vascular access
- Intracranial aneurysm or AVM requiring treatment
- Heavy calcification
- Visible thrombus in lesion
- Total occlusion
• Clinical
- Life expectancy 5 yrs.
- Contraindication to aspirin or thienopyridines
- Renal dysfunction precluding safe contrast medium administration
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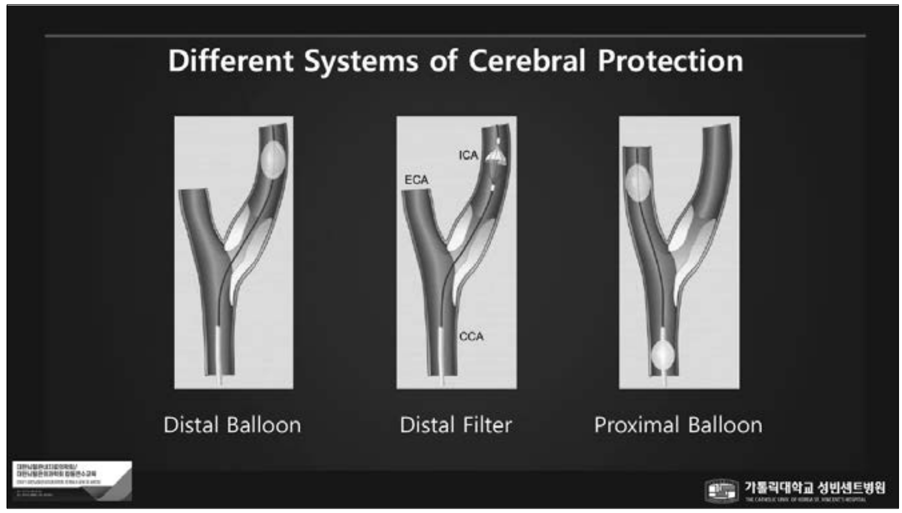
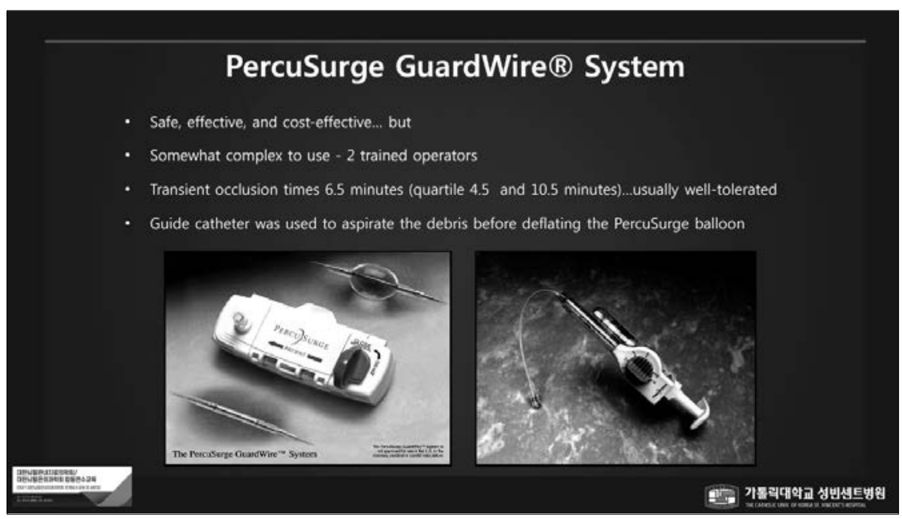

Different Systems of Cerebral Protection
ICA
ECA
CCA
Distal Balloon
Distal Filter
Proximal Balloon
가톨릭대학교 성빈센트병원


PercuSurge GuardWire® System
• Safe, effective, and cost-effective... but
• Somewhat complex to use - 2 trained operators
• Transient occlusion times 6.5 minutes (quartile 4.5 and 10.5 minutes)...usually well-tolerated
• Guide catheter was used to aspirate the debris before deflating the PercuSurge balloon
The PercuSurge GuardWire™ System
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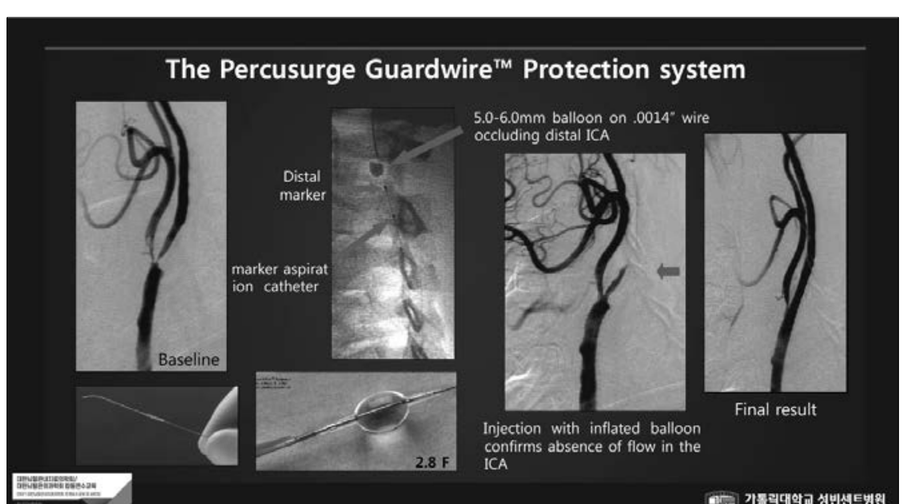
The Percusurge Guardwire™ Protection system
5.0-6.0mm balloon on .0014" wire occluding distal ICA
Distal marker
marker aspirat ion catheter
Baseline
2.8 F
Injection with inflated balloon confirms absence of flow in the ICA
Final result
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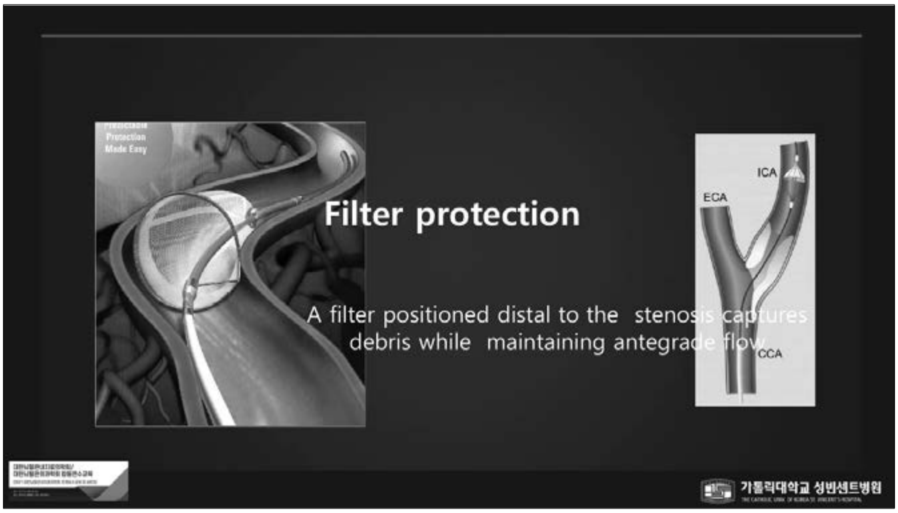
Filter protection
A filter positioned distal to the stenosis captures debris while maintaining antegrade flow
ICA
ECA
CCA
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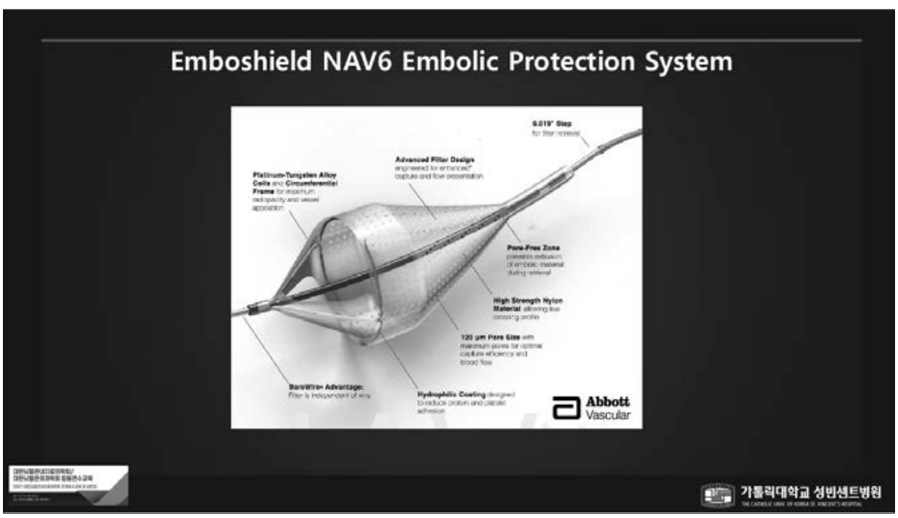
Emboshield NAV6 Embolic Protection System
0.019" Step
Advanced Filter Design
Platinum-Tungsten Alloy Coils and Circumferential Frame
Pore-Free Zone
High Strength Nylon Material
120 μm Pore Size
BareWire Advantage:
Hydrophilic Coating
Abbott Vascular
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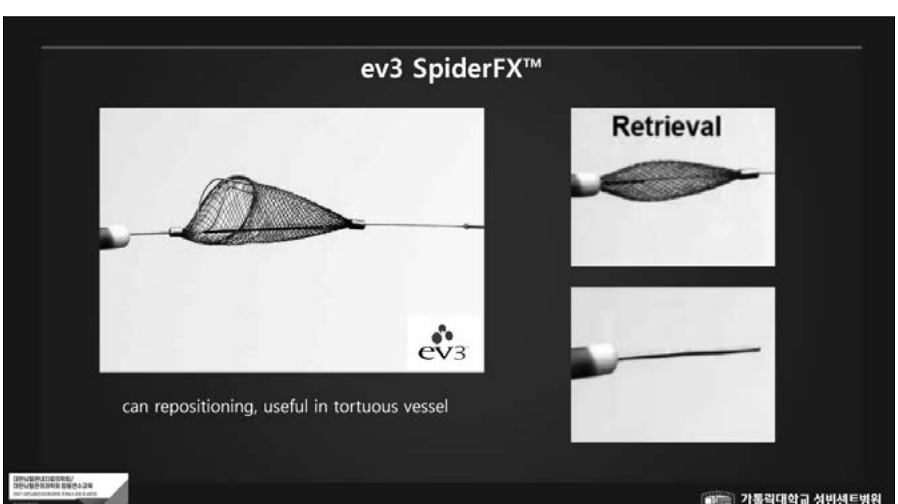
ev3 SpiderFX™
Retrieval
ev3
can repositioning, useful in tortuous vessel
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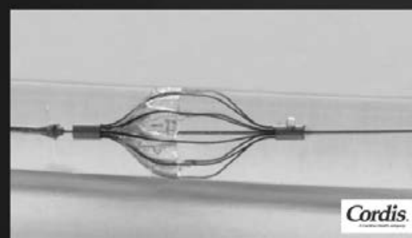
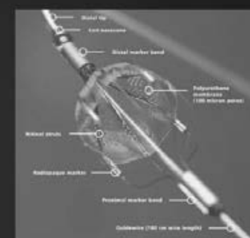
ANGIOGUARD® RX





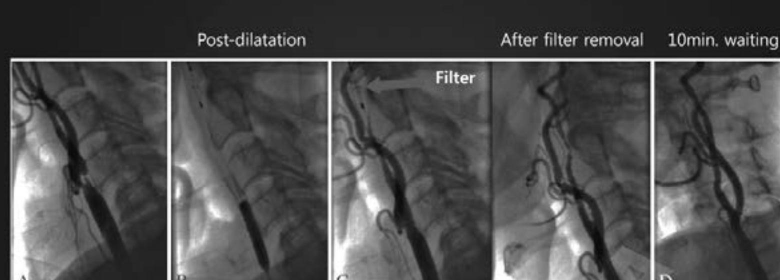
rapid exchange system

In vitro carotid flow model

	Capture Efficiency, %
AngioGuard	91.4%
FilterWire	91.7%
EmboShield	95.9%
Trap	91.3%
Percusurge	85.4%

Mueller-Huelsbeck et al.
Joint annual meeting
Deutsch-Oesteriechische Roentgengesellschaft, May 2002

Flow-limiting Vasospasm after procedure completion



→ Waiting

Bertog SC et al. J Cardiovasc Surg. 2013

Dissection

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

Additional stenting

Nadim Al-Mubarak, et al. Lippincott Williams & Wilkins

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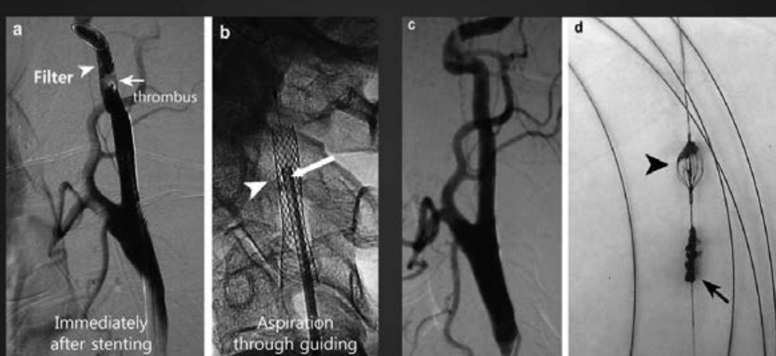
Aspiration through guiding + Abciximab



Van den Berg JC. Eur J Vasc Endovasc Surg 2008

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Filter occlusion

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

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Proximal protection
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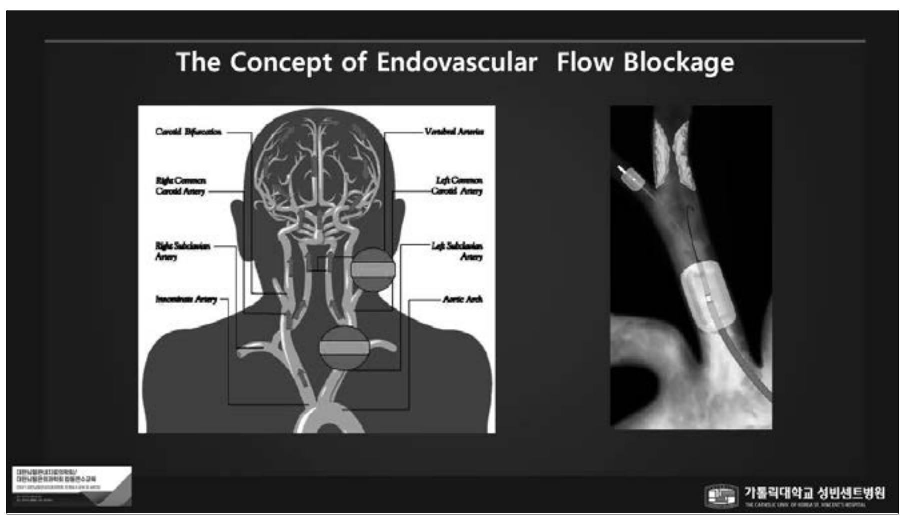
The Concept of Endovascular Flow Blockage
Carotid Bifurcation
Vertebral Arteries
Right Common Carotid Artery
Left Common Carotid Artery
Right Subclavian Artery
Left Subclavian Artery
Innominate Artery
Aortic Arch
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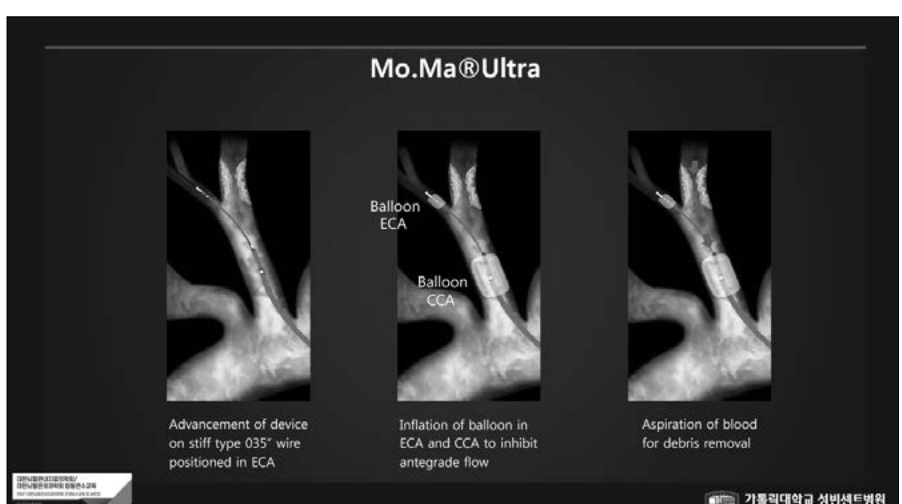
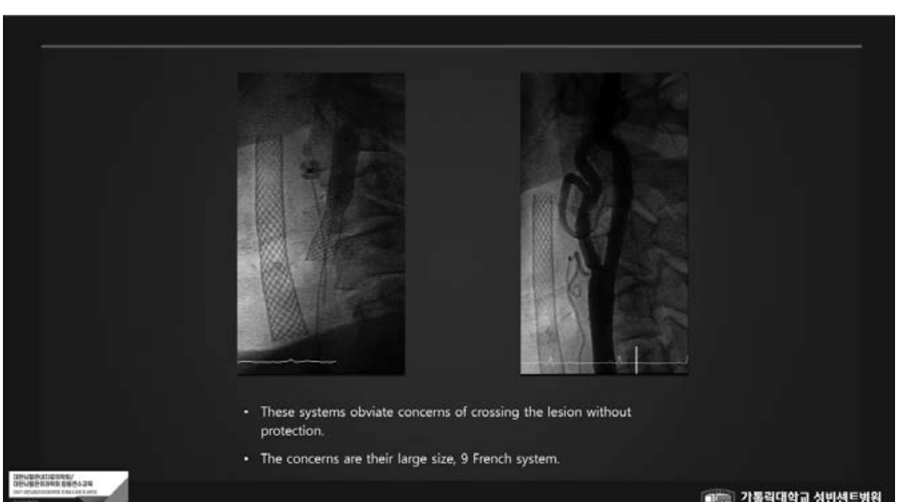

Mo.Ma®Ultra
Balloon ECA
Balloon CCA
Advancement of device on stiff type 035" wire positioned in ECA
Inflation of balloon in ECA and CCA to inhibit antegrade flow
Aspiration of blood for debris removal
가톨릭대학교 성빈센트병원


Mo.Ma®Ultra
Aspiration during dilatation and stenting
Removal of the device
가톨릭대학교 성빈센트병원


Proximal protection
ECA
CCA
가톨릭대학교 성빈센트병원


• These systems obviate concerns of crossing the lesion without protection.
• The concerns are their large size, 9 French system.
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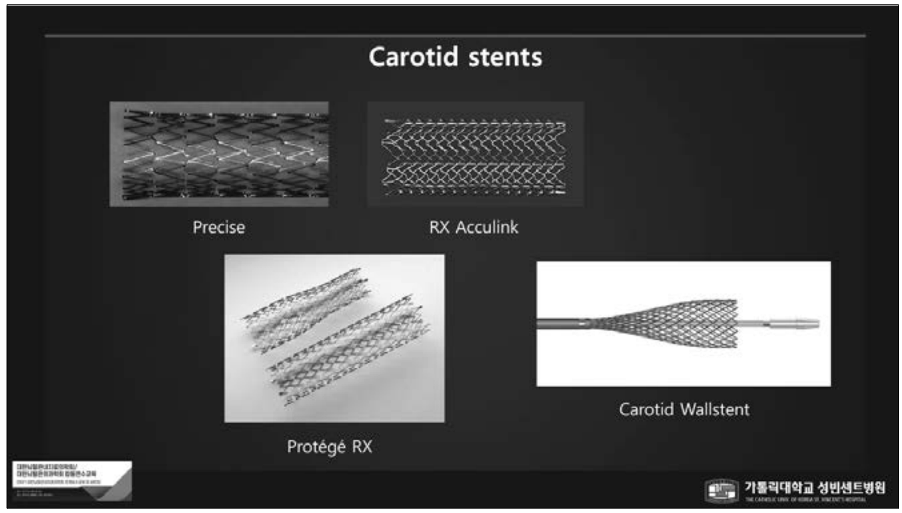
Carotid stents
Precise
RX Acculink
Protégé RX
Carotid Wallstent
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Stent Design: What we know
Actually we have 2 different stent
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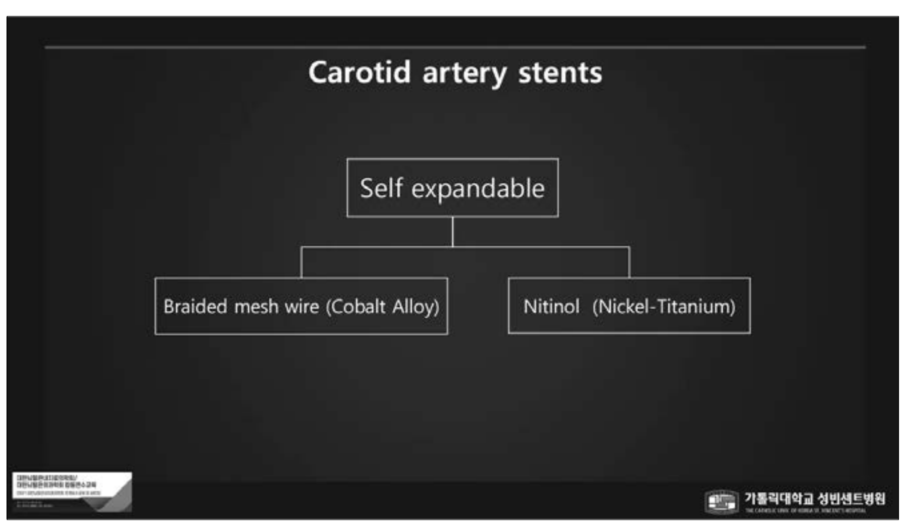
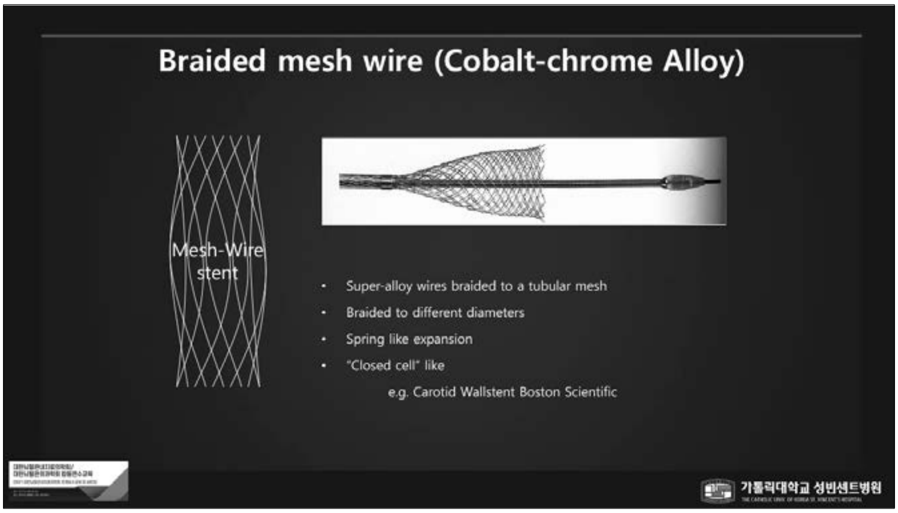

Carotid artery stents
Self expandable
Braided mesh wire (Cobalt Alloy)
Nitinol (Nickel-Titanium)
가톨릭대학교 성빈센트병원


Braided mesh wire (Cobalt-chrome Alloy)
Mesh-Wire stent
Super-alloy wires braided to a tubular mesh
Braided to different diameters
Spring like expansion
"Closed cell" like
e.g. Carotid Wallstent Boston Scientific
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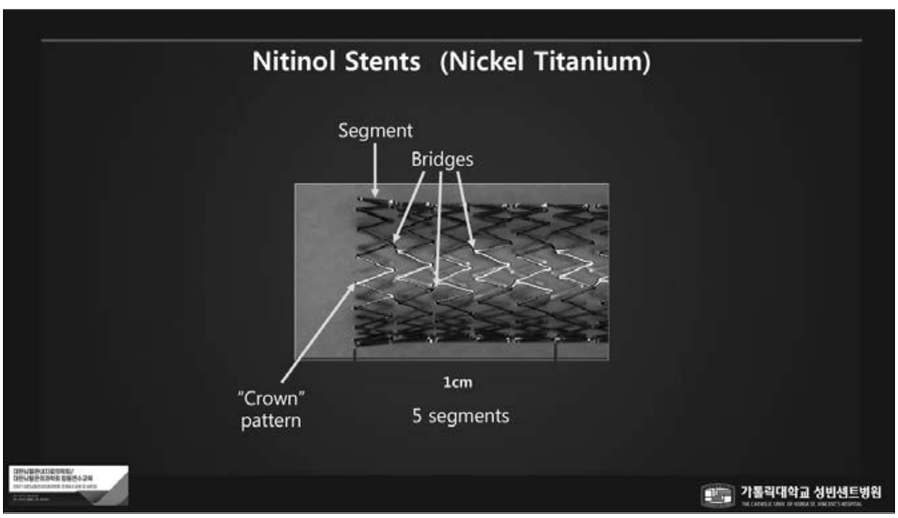
Nitinol Stents (Nickel Titanium)
Segment
Bridges
"Crown" pattern
1cm
5 segments
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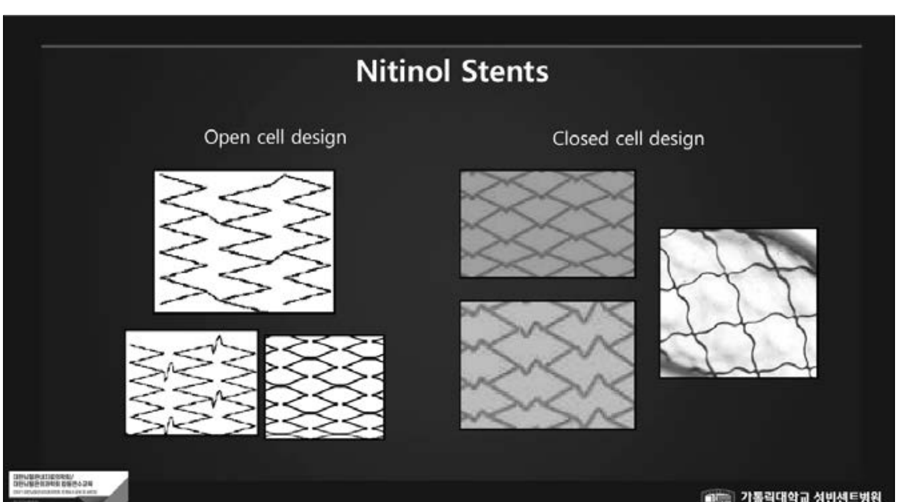
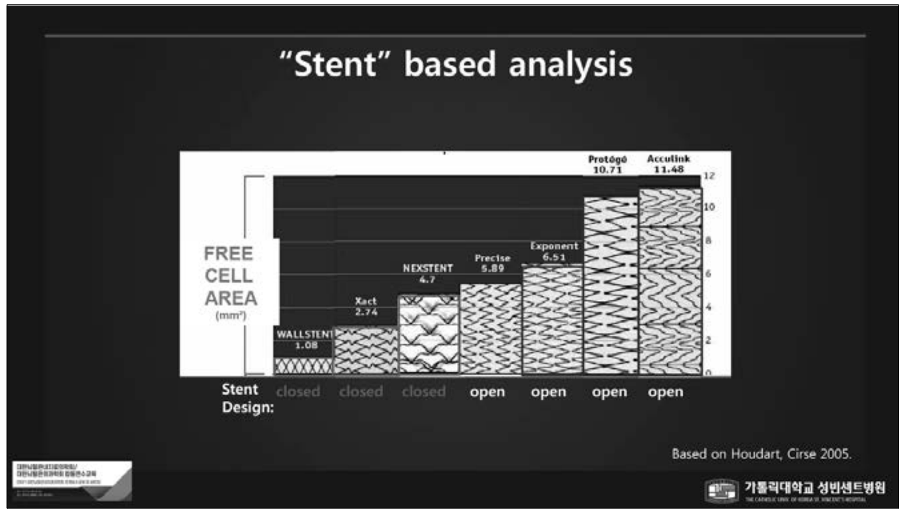

Nitinol Stents
Open cell design
Closed cell design
가톨릭대학교 성빈센트병원


"Stent" based analysis
FREE CELL AREA (mm²)
WALLSTENT 1.08
Xact 2.74
NEXSTENT 4.7
Precise 5.89
Exponent 6.51
Protégé 10.71
Acculink 11.48
12
10
8
6
4
2
0
Stent Design:
closed
closed
closed
open
open
open
open
Based on Houdart, Cirse 2005.
가톨릭대학교 성빈센트병원


Does Free Cell Area Influence the Outcome in Carotid Artery Stenting?
M. Bosiers, G. de Donato, K. Deloose, J. Verbist, P. Peeters, F. Castriota, A. Cremonesi and C. Setacci
total 3179 patients
symptomatic population are highest for the open cell types and increase with larger free cell area.
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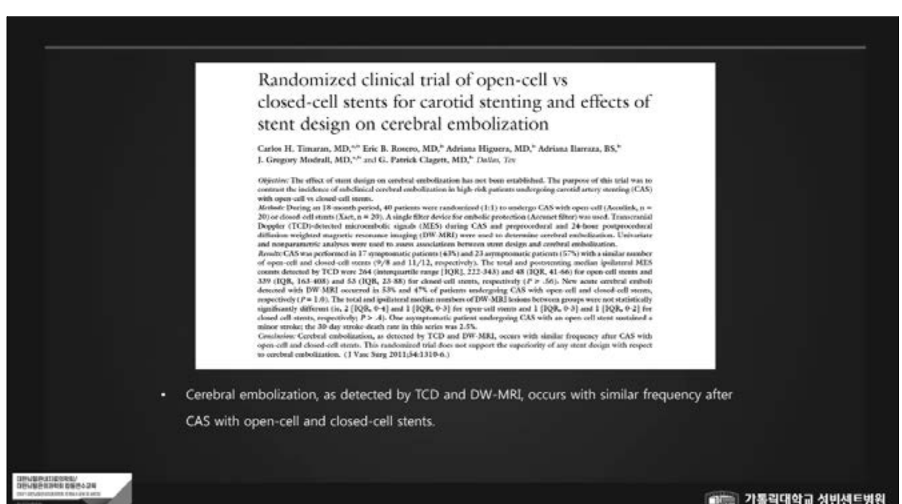
Randomized clinical trial of open-cell vs closed-cell stents for carotid stenting and effects of stent design on cerebral embolization
Carlos H. Timaran, MD, Eric B. Rosero, MD, Adriana Higuera, MD, Adriana Ilarraza, BS, J. Gregory Modrall, MD, and G. Patrick Clagett, MD, Dallas, Tex
Cerebral embolization, as detected by TCD and DW-MRI, occurs with similar frequency after CAS with open-cell and closed-cell stents.
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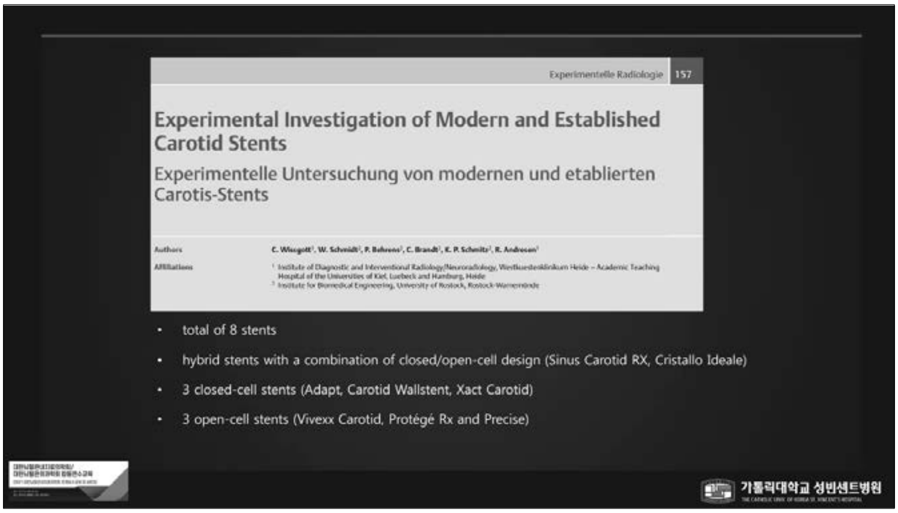
Experimentelle Radiologie 157
Experimental Investigation of Modern and Established Carotid Stents
Experimentelle Untersuchung von modernen und etablierten Carotis-Stents
Authors
Affiliations
• total of 8 stents
• hybrid stents with a combination of closed/open-cell design (Sinus Carotid RX, Cristallo Ideale)
• 3 closed-cell stents (Adapt, Carotid Wallstent, Xact Carotid)
• 3 open-cell stents (Vivexx Carotid, Protégé Rx and Precise)
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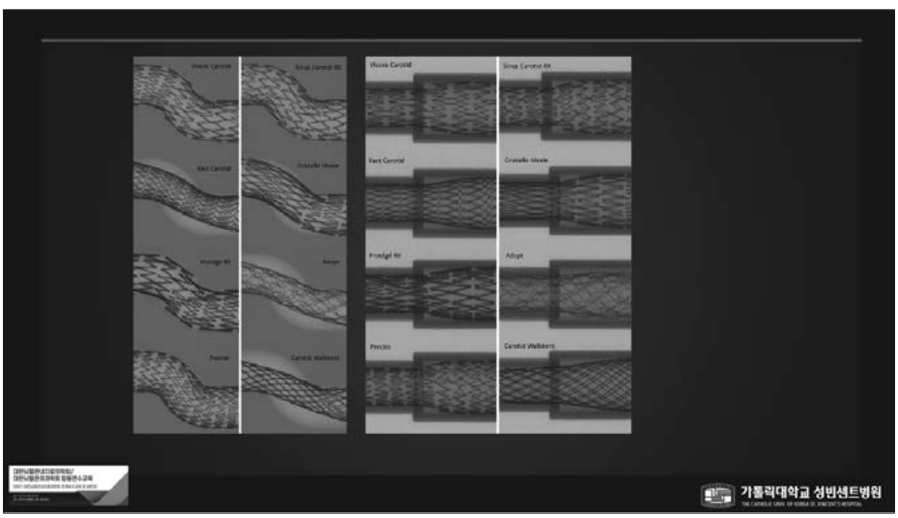
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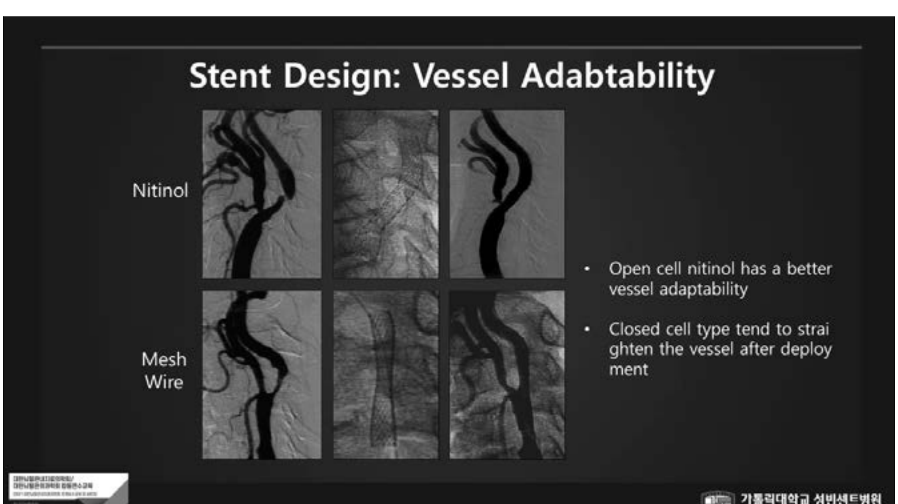
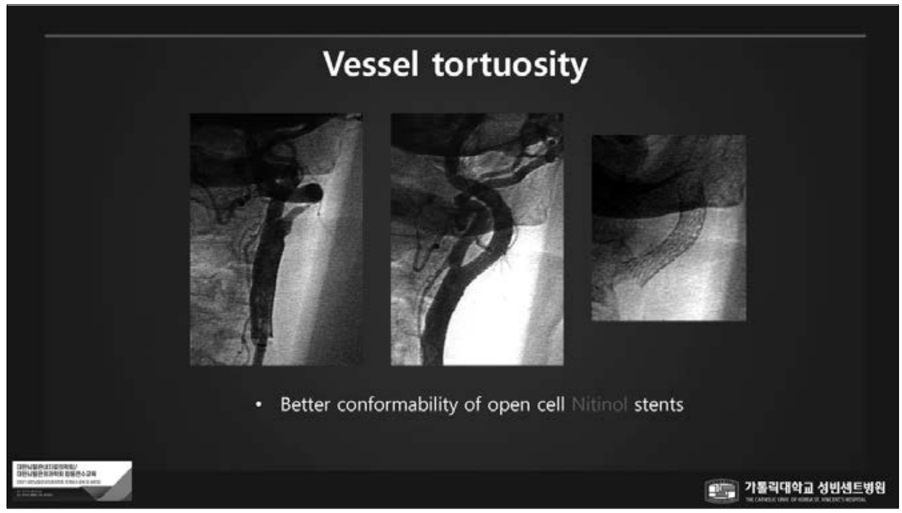
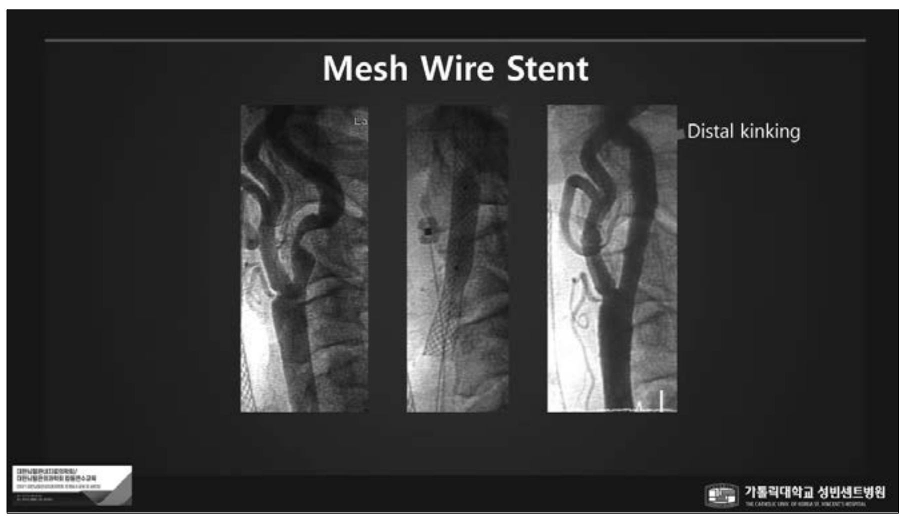
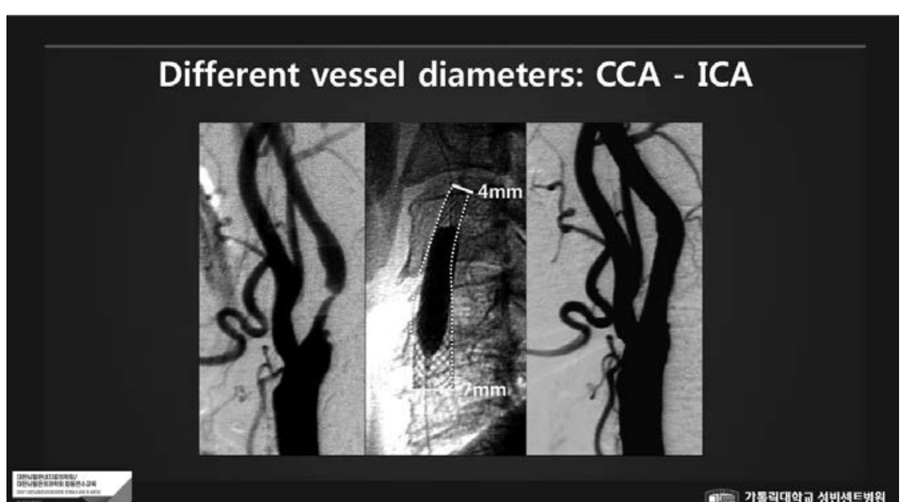
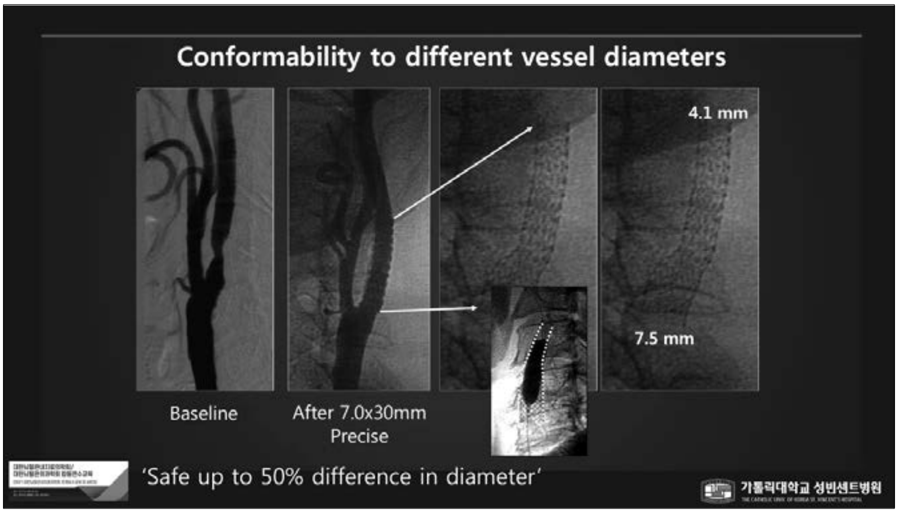
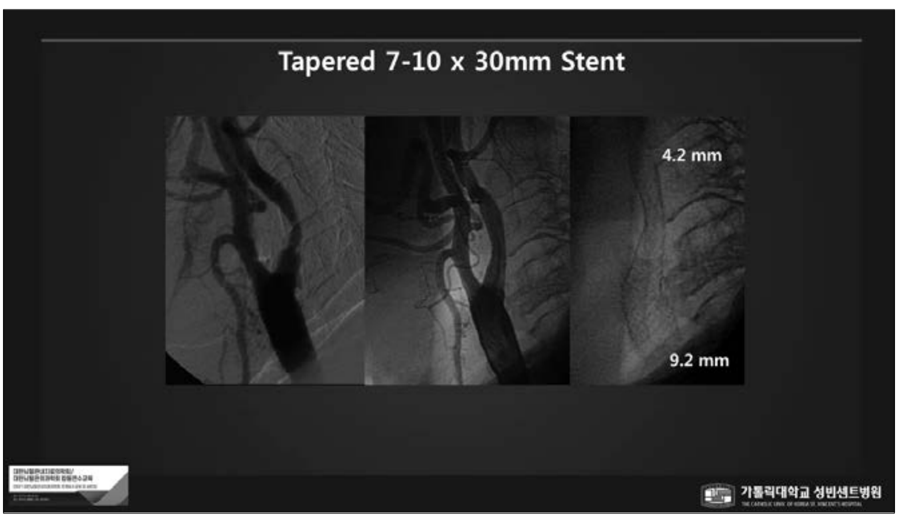

Stent Design: Vessel Adabtability
Nitinol
Mesh Wire
• Open cell nitinol has a better vessel adaptability
• Closed cell type tend to strai ghten the vessel after deploy ment
가톨릭대학교 성빈센트병원

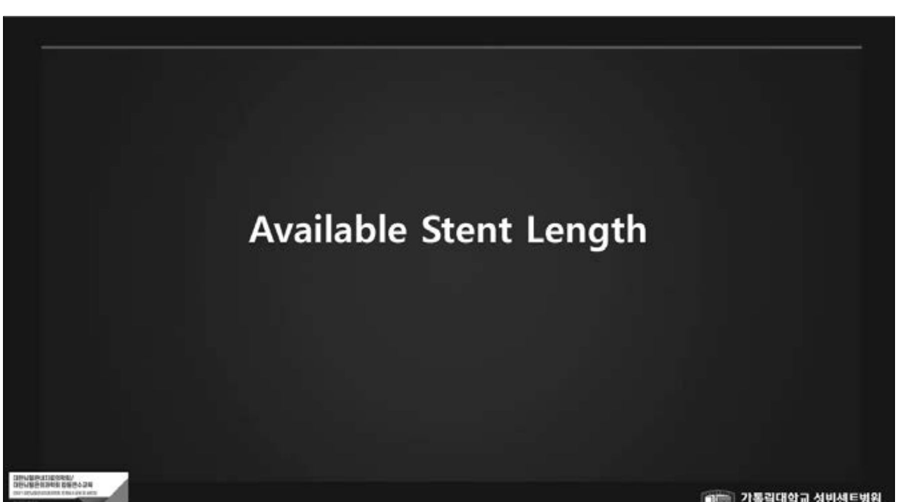

Vessel tortuosity
• Better conformability of open cell Nitinol stents
가톨릭대학교 성빈센트병원

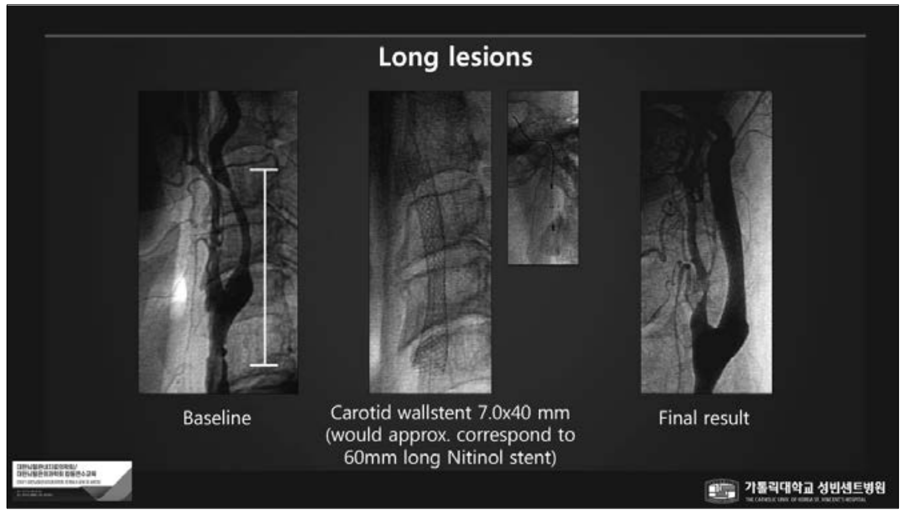

Mesh Wire Stent
Distal kinking
가톨릭대학교 성빈센트병원

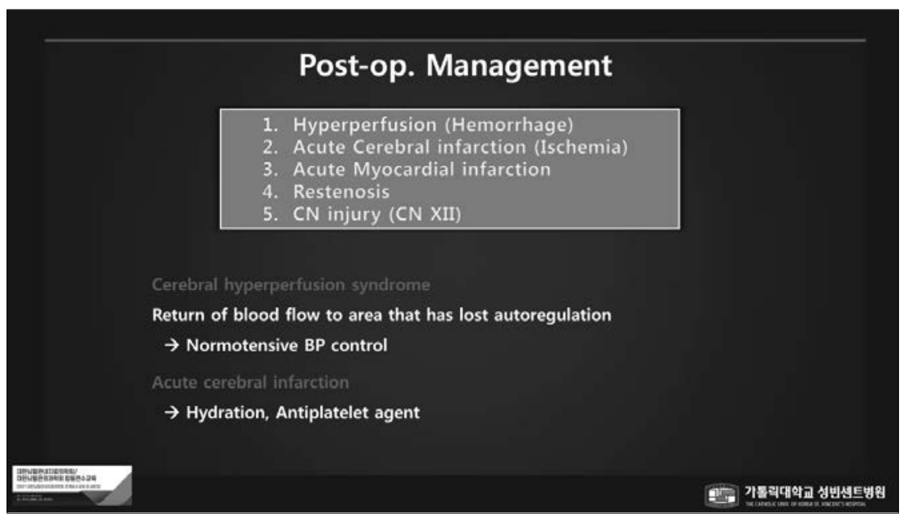

Different vessel diameters: CCA - ICA
4mm
7mm
가톨릭대학교 성빈센트병원


Conformability to different vessel diameters
4.1 mm
7.5 mm
Baseline
After 7.0x30mm
Precise
'Safe up to 50% difference in diameter'
가톨릭대학교 성빈센트병원

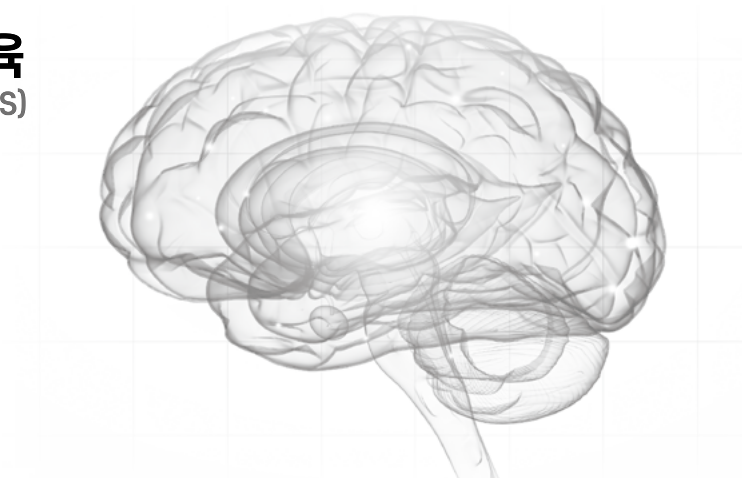

Tapered 7-10 x 30mm Stent
4.2 mm
9.2 mm
가톨릭대학교 성빈센트병원


Available Stent Length
가톨릭대학교 성빈센트병원


Long lesions
Baseline
Carotid wallstent 7.0x40 mm
(would approx. correspond to
60mm long Nitinol stent)
Final result
가톨릭대학교 성빈센트병원


Post-op. Management
1. Hyperperfusion (Hemorrhage)
2. Acute Cerebral infarction (Ischemia)
3. Acute Myocardial infarction
4. Restenosis
5. CN injury (CN XII)
Cerebral hyperperfusion syndrome
Return of blood flow to area that has lost autoregulation
→ Normotensive BP control
Acute cerebral infarction
→ Hydration, Antiplatelet agent
가톨릭대학교 성빈센트병원

대한뇌혈관내치료의학회/
대한뇌혈관외과학회 합동연수교육
(2021 대한뇌혈관내치료의학회 추계보수교육 및 ARCS)



Session 3. Expert experience for special situations in LVO

좌장 : 임동준(고려대), 장철훈(영남대)

1. Medium Vessel Occlusions
정영진(영남대병원)
하상우(조선대병원)

2. LVO with underlying Intracranial arterial stenosis
홍대영(에스포항병원)
양구현(울산대 강릉아산병원)

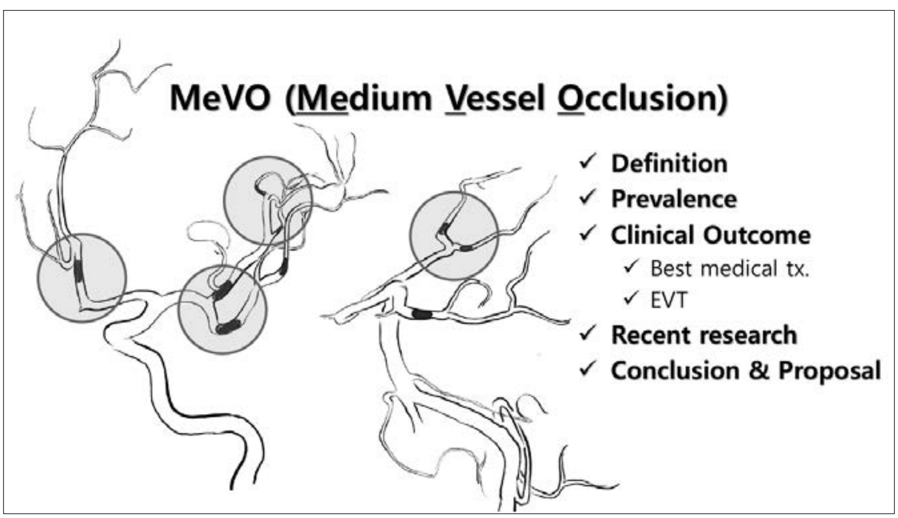
3. Acute tandem EC and IC occlusions
박정현(한림대 동탄성심병원)
조용환(동아대병원)

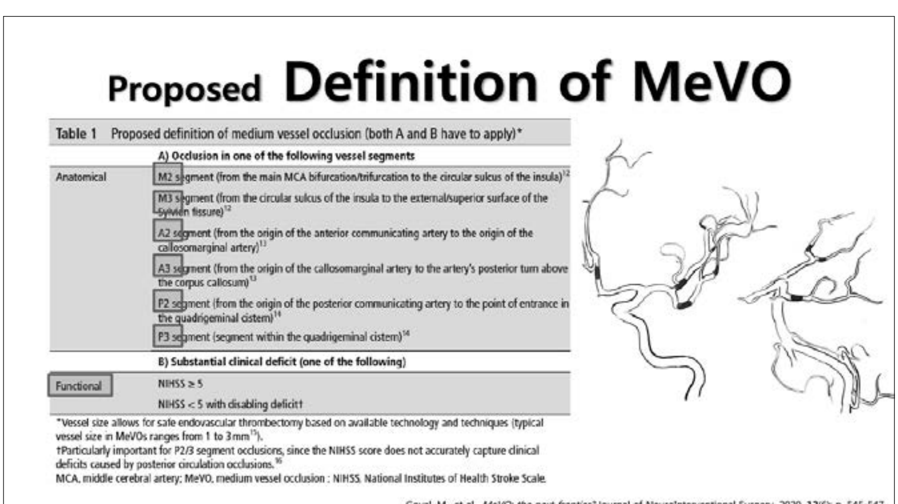
1. Medium Vessel Occlusions

MeVO(Medium Vessel Occlusion)

정영진

영남대병원





Primary, Secondary MeVO

- **Primary MeVO**
- **Secondary MeVO**
  - Thrombus fragmentation during EVT
  - Clot migration (after iv tPA)

Goyal, M., et al., *MeVO: the next frontier?* Journal of NeuroInterventional Surgery, 2020. **12**(6): p. 545-547.

Primary, Secondary MeVO

Table 2. Conceptual Differences Between Primary and Secondary MeVOs

Difference	Primary MeVOs	Secondary MeVOs	Practical Implications
Clinical presentation	Less severe symptoms; smaller neurological deficit	Severe symptoms; larger neurological deficit	Possibly higher EVT treatment rates in secondary MeVOs
Extent of ischemia	Smaller; only the territory supplied by the MeVO will be affected	Larger; more proximal territories that were supplied by the initial LVO might progress to infarction as well	Ischemia is likely to be more extensive in secondary MeVOs, which might translate into worse outcomes and a higher risk of hemorrhage
Clot fragility	Lower	May be higher because there has been fragmentation/migration	Risk of thrombus fragmentation during EVT may be higher in secondary MeVOs
Willingness to treat with EVT	Lower; risks of EVT and gaining endovascular access have to be weighed against estimated benefit in patient with smaller deficits	Higher in EVT-related secondary MeVOs; access has already been established so treatment can be performed immediately	Higher EVT treatment rates for secondary compared with primary MeVOs (over/undertreatment?)
Inclusion in a randomized MeVO EVT trial	Feasible	Challenging. EVT-related secondary MeVOs: randomization would have to occur on the angiography table; non-EVT-related secondary MeVOs: often require repeat vascular imaging, which is not routinely performed and delays treatment	Lack of equipoise for randomization of secondary MeVOs

EVT indicates endovascular thrombectomy; and MeVO, medium vessel occlusion.

Goyal, M., et al., *Secondary Medium Vessel Occlusions: When Clots Move North.* Stroke, 2021. 52(3): p. 1147-1153.

AHA/ASA Guideline

3. Although the benefits are uncertain, the use of mechanical thrombectomy with stent retrievers may be reasonable for carefully selected patients with AIS in whom treatment can be initiated (groin puncture) within 6 hours of symptom onset and who have causative occlusion of the MCA segment 2 (M2) or MCA segment 3 (M3) portion of the MCAs.	IIb	B-R	Recommendation reworded for clarity from 2015 Endovascular. COR unchanged. LOE revised. See Table XCV in online Data Supplement 1 for original wording.
In pooled patient-level data from 5 trials (HERMES, which included the 5 trials MR CLEAN, ESCAPE, REVASCAT, SWIFT PRIME, and EXTEND-IA), the direction of treatment effect for mechanical thrombectomy over standard care was favorable in M2 occlusions, but the adjusted cOR was not significant (1.28 [95% CI, 0.51–3.21]).[189] In patient-level data pooled from trials in which the Solitaire was the only or the predominant device used, a prespecified meta-analysis (SEER Collaboration: SWIFT PRIME, ESCAPE, EXTEND-IA, and REVASCAT) showed that the direction of treatment effect was favorable for mechanical thrombectomy over standard care in M2 occlusions, but the OR and 95% CI were not significant.[190] In an analysis of pooled data from SWIFT (Solitaire With the Intention for Thrombectomy), STAR (Solitaire Flow Restoration Thrombectomy for Acute Revascularization), DEFUSE 2, and IMS III, among patients with M2 occlusions, reperfusion was associated with excellent functional outcomes (mRS score 0–1; OR, 2.2 [95% CI, 1.0–4.7]).[186] Therefore, the recommendation for mechanical thrombectomy for M2/M3 occlusions does not change substantively from the 2015 AHA/ASA focused update.			See Tables XVII and XLV in online Data Supplement 1.
5. Although the benefits are uncertain, the use of mechanical thrombectomy with stent retrievers may be reasonable for carefully selected patients with AIS in whom treatment can be initiated (groin puncture) within 6 hours of symptom onset and who have causative occlusion of the anterior cerebral arteries, vertebral arteries, basilar artery, or posterior cerebral arteries.	IIb	C-LD	Recommendation reworded for clarity from 2015 Endovascular. COR unchanged. LOE amended to conform with ACC/AHA 2015 Recommendation Classification System. See Table XCV in online Data Supplement 1 for original wording.

Powers, W.J., et al., *Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association.* Stroke, 2019. **50**(12): p. e344-e418.

% of MeVO in AIS (6.7~36.0%)

	MCA		ACA			PCA		
	M2	M3/4	A1	A2	A3-5	P1	P2	P3-5
Among all AIS								
Smith et al	20%	NR	0.3%	1%	NR	1.2%	1.3%	NR
Zhao et al	20%	**ACA/M3/M4,** 16%			NR			NR
Rai et al	4%	NR	0.7%		NR	2%		NR
Among Ant. circulation AIS								
Heldner et al	15%	8%	1%		NR			

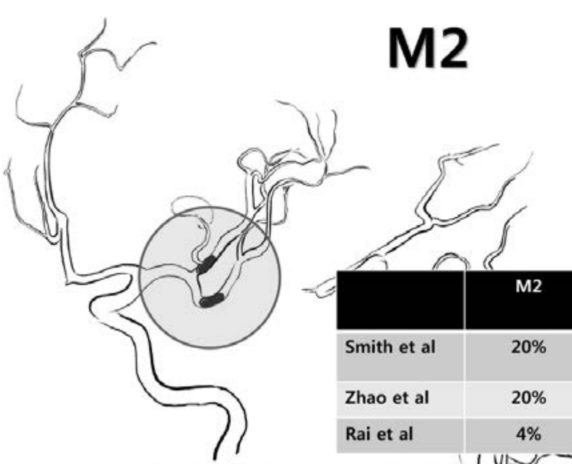
Saver, J.L., et al., *Thrombectomy for Distal, Medium Vessel Occlusions: A Consensus Statement on Present Knowledge and Promising Directions.* Stroke, 2020. **51**(9): p. 2872-2884.

Natural Course of MeVO

	MCA		ACA			PCA		
	M2	M3/4	A1	A2	A3-5	P1	P2	P3-5
Among all AIS								
Smith et al	**20%**	**NR**	**0.3%**	**1%**	**NR**	**1.2%**	**1.3%**	**NR**
mRS 0-2 mRS 3-6 (death)	40% 60% (24%)		50% 50% (0%)	29% 71% (0%)		13% 86% (25%)	22% 78% (0%)	
Zhao et al	20%	See right	ACA/M3/M4, 16%		NR			NR
Rai et al	4%	NR	0.7%		NR	2%		NR

Saver, J.L., et al., *Thrombectomy for Distal, Medium Vessel Occlusions: A Consensus Statement on Present Knowledge and Promising Directions.* Stroke, 2020. **51**(9): p. 2872-2884.
Smith, W.S., et al., *Significance of Large Vessel Intracranial Occlusion Causing Acute Ischemic Stroke and TIA.* Stroke, 2009. **40**(12): p. 3834-3840.

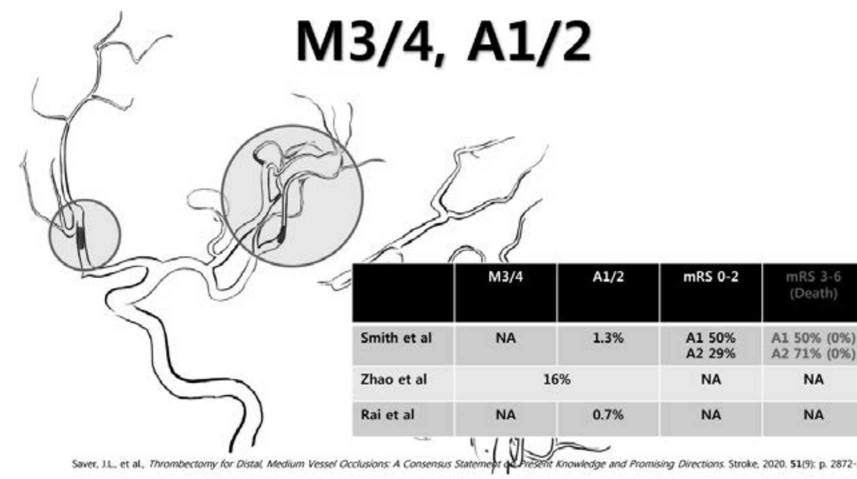
M2



	M2	mRS 0-2	mRS 3-6 (Death)
Smith et al	20%	40%	60% (24%)
Zhao et al	20%	NA	NA
Rai et al	4%	NA	NA

Saver, J.L., et al., *Thrombectomy for Distal, Medium Vessel Occlusions: A Consensus Statement on Present Knowledge and Promising Directions.* Stroke, 2020. **51**(9): p. 2872-2884.

M3/4, A1/2



	M3/4	A1/2	mRS 0-2	mRS 3-6 (Death)
Smith et al	NA	1.3%	A1 50% A2 29%	A1 50% (0%) A2 71% (0%)
Zhao et al	16%		NA	NA
Rai et al	NA	0.7%	NA	NA

Saver, J.L., et al., *Thrombectomy for Distal, Medium Vessel Occlusions: A Consensus Statement on Present Knowledge and Promising Directions.* Stroke, 2020. **51**(9): p. 2872-2884.

MeVO with/without tPA

Table 1. Baseline Characteristics of the Study Sample (N=258)

Variable	Entire patient sample (N=258)	Intravenous alteplase (N=186)	No intravenous alteplase (N=72)	P value
Age in years, median (IQR)	72 (63–79)	73 (63–80)	70.5 (64–77.5)	0.532
Female sex, n (%)	127 (49.2)	99 (53.2)	28 (38.9)	0.058
Medical history, n (%)				
Hypertension	172 (67.1)	123 (67.2)	49 (66.7)	1.000
Diabetes	50 (19.4)	36 (19.3)	14 (19.4)	1.000
Atrial fibrillation*	[illegible]	[illegible]	[illegible]	[illegible]
Independent baseline functional status, n (%)	[illegible]	[illegible]	[illegible]	[illegible]
Baseline NIHSS, median (IQR)	7 (5–12)	8 (5–13)	[illegible]	[illegible]
Baseline NIHSS, n (%)				
0–5	[illegible]	[illegible]	[illegible]	
6–12	[illegible]	[illegible]	[illegible]	
>12	[illegible]	[illegible]	[illegible]	
Systolic blood pressure in mmHg, median (IQR)	[illegible]	[illegible]	[illegible]	[illegible]
Glucose level in mmol/L, median (IQR)†	[illegible]	[illegible]	[illegible]	[illegible]
Baseline ASPECTS, median (IQR)‡	[illegible]	[illegible]	[illegible]	[illegible]
Occlusion site, n (%)				
Proximal M2	[illegible]	[illegible]	[illegible]	
Distal M2	[illegible]	[illegible]	[illegible]	
M3	[illegible]	[illegible]	[illegible]	
A2	[illegible]	[illegible]	...	
A3	[illegible]	[illegible]	[illegible]	
P2	[illegible]	[illegible]	[illegible]	
P3	[illegible]	[illegible]	...	
Onset to baseline imaging in minutes, median (IQR)	[illegible]	[illegible]	[illegible]	<0.0011
Baseline imaging to follow-up CTA in minutes, median (IQR)§	[illegible]	[illegible]	[illegible]	[illegible]

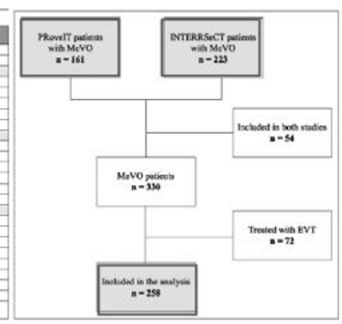


Figure 1. **Flow chart of included patients with medium vessel occlusion (MeVO) from the INTERRSeCT and PRoveIT studies.** EVT indicates endovascular treatment; INTERRSeCT, The Identifying New Approaches to Optimize Thrombus Characterization for Predicting Early Recanalization and Reperfusion With IV Alteplase and Other Treatments Using Serial CT Angiography; and PRoveIT, Precise and Rapid Assessment of Collaterals Using Multi-Phase CTA in the Triage of Patients With Acute Ischemic Stroke for IA Therapy.

Ospel, J.M., et al., *Clinical Course of Acute Ischemic Stroke Due to Medium Vessel Occlusion With and Without Intravenous Alteplase Treatment.* Stroke, 2020. **51**(11): p. 3232-3240.

MeVO with/without tPA

- **MeVO, N=258 patients (INTERRSeCT, ProveIT)**
  - NIHSS 7 (5~12)
  - Recanalization (2b/3) 41.8% (84/201)
  - mRS 0,1 50.0% (129/258)
  - mRS 0,1,2 67.4% (174/258)
  - mRS 6 8.9% (23/258)
- **with tPA, 72.1% (186/258)**
  - Recanalization (2b/3) 47.2% (75/159)
- **without tPA, 41.8% (84/281)**
  - Recanalization (2b/3) 21.4% (9/42)
- **Excellent functional outcome (mRS 0-1) α**
  - **Early recanalization** **(OR 2.29 [95% CI, 1.23-4.28])**
  - **Not tPA** (OR 1.70 [95% CI, 0.88-3.25])
- **Every 2 patients with MeVO,**
  - Did not achieved excellent clinical outcome (mRS 0-1) with best medical management
  - Early recanalization was strongly associated with excellent outcome, but occurred in < 50% of patients with iv tPA

2b/3	mRS 0-2	sICH
41.8% (84/201)	67.4% (174/258)	9.2%(22/239) *All ICH (Sx, Asx)

Ospel, J.M., et al., *Clinical Course of Acute Ischemic Stroke Due to Medium Vessel Occlusion With and Without Intravenous Alteplase Treatment.* Stroke, 2020. **51**(11): p. 3232-3240.

MeVO with/without tPA

Table 3. Intravenous Alteplase Treatment, Recanalization Status, and Clinical O...

mRS 0-1 α Early Recanalization

Not tPA

??? Early Recanalization by EVT ???

		50/117 (42.7)	2.29 (1.23–4.28)
mRS 0–2	63/84 (75.0)	69/117 (59.0)	2.10 (0.998–4.27)
mRS*	...	...	0.57 (0.34–0.96)

All OR are adjusted for age, sex, and baseline National Institutes of Health Stroke Score. mRS indicates modified Rankin Scale; OR, odds ratio; and rAOL, revised arterial occlusive lesion score.
*Represents the common OR from a proportional odds model. The parallel regression assumption was tested with the Brant test.

Ospel, J.M., et al., *Clinical Course of Acute Ischemic Stroke Due to Medium Vessel Occlusion With and Without Intravenous Alteplase Treatment.* Stroke, 2020. **51**(11): p. 3232-3240.

Early Recanalization by EVT in MeVO

- Angiographic outcome
- Clinical outcome
- Safety

Results, EVT for MeVO

Table 1 Original research manuscripts that were identified during the literature search

2b/3 N, 1041	mRS 0-2 N, 748	sICH N, 56
76.9% (1041/1354)	55.24% (748/1354)	4.16% (56/1354)

sICH: symptomatic ICH

Ospel, J. and M. Goyal, *A review of endovascular treatment for medium vessel occlusion stroke.* Journal of NeuroInterventional Surgery, 2021. **13**(7): p. 623-630.

Systemic Review & Meta Analysis

Table 2 Systematic reviews and meta-analyses that were identified during the l

First Author Year	Study type	Research question	Main findings	N of studies	N with MeVO EVT	NIHSS (median/mean)	Technique used	Angiographic outcome	Clinical outcome	sICH	2b/3	mRS(0-2)	sICH
Phan et al 2018[20]	MA	What are the reperfusion rates in M2 occlusions treated with SR vs. DA?	Both SR and DA are effective in recanalizing M2 occlusions. The literature is skewed by DA being performed sooner after onset of stroke compared with SR EVT.	12	835	14	SR (n=612) vs DA (n=223)	TICI 2b/3: 81% (SR) vs 87% (DA) TICI 3: 54% (SR) vs 57% (DA) (I^2=37%)	mRS 0-2: 60% (SR) vs 75% (DA) mRS 0-1: 40% (SR) vs 66% (DA) (I^2=52%)	6% (SR) vs 3% (DA) (I^2=0%)	81(SRT) 87(CAT)	60(SRT) 75(CAT)	6(SRT) 3(CAT)
Saber et al 2018[42]	MA	What are the angiographic results and functional outcome after M2 EVT and how do they compare to EVT for LVO?	M2 EVT is technically feasible and safe with high functional independence. There may be a slightly increased risk of ICH.	12	1080	14	SR, DA	TICI 2b/3: 81% (I^2=20%)	mRS 0-2: 59% (I^2=61%)	10% (I^2=75%)	81%	59%	10%
Kim et al[16] 2019	MA	What are the angiographic results and functional outcome after M2 EVT and how do they compare to EVT for M1 occlusions?	M2 EVT is technically feasible. Further studies are needed to better characterize the effect of EVT in M2 occlusions.	8	650	–	–	TICI 2b/3: 69% (I^2 not provided)	mRS 0-2: 59% (I^2 not provided)	6% (I^2 not provided)	69%	59%	6%
Chen et al[34] 2017	SR	What is the evidence for M2 EVT in the existing literature?	M2 EVT results in high functional independence with modest ICH rates. But given the relatively favorable clinical course of M2 occlusions with conservative management, the benefits of EVT remain unclear.	8	630	–	SR, DA	TICI 2b/3: 78% (I^2 not provided)	mRS 0-2: 63% mRS 0-1: 40% (I^2 not provided)	5% (I^2 not provided)	78%	63%	5%

Note: MA = meta-analysis, SR = stent retriever, DA = direct aspiration, EVT = endovascular treatment, (s)ICH = (symptomatic) intracranial hemorrhage; mRS = modified Rankin Score.

SRT: Stent retrieval thrombectomy
CAT: Contact aspiration thrombectomy

Ospel, J. and M. Goyal, *A review of endovascular treatment for medium vessel occlusion stroke.* Journal of NeuroInterventional Surgery, 2021. **13**(7): p. 623-630.

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	**67.4% (174/258)**	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
with tPA	72.1% (186/258)	68.3% (127/186)		
without tPA	21.4% (9/42)	65.3% (47/72)		
EVT for MeVO	76.9% (1041/1354)	**55.24% (748/1354)**		4.16% (56/1354)
Review Article & Meta Analysis				
Phan et al. N=835 Overall Stent retriever Aspiration first	 82.8% 80.5% 86.8%	 **62.0%** 59.9% 74.5%	 **44.2%** 39.9% 65.6%	 5.3% 5.7% 2.6%
Saber et al, N=1080	81%	**59%**	NA	10%
Kim et al, N=650	69%	**59%**	NA	6%
Chen et al, N=630	78%	**62%**	40%	5%

Ospel, J.M., et al., *Clinical Course of Acute Ischemic Stroke Due to Medium Vessel Occlusion With and Without Intravenous Alteplase Treatment.* Stroke, 2020. **51**(11): p. 3232-3240.
Ospel, J. and M. Goyal, *A review of endovascular treatment for medium vessel occlusion stroke.* Journal of NeuroInterventional Surgery, 2021. **13**(7): p. 623-630.

CAT vs. SRT in MeVO

Phan K et al. Endovascular Therapy for Distal MCA Occlusions

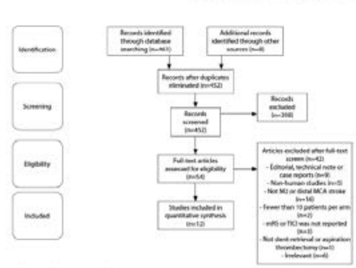


Fig. 1. PRISMA flow chart of search strategy for the present systematic review and meta-analysis. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; MCA, middle cerebral artery; mRS, modified Rankin scale; TICI, thrombolysis in cerebral infarction.

Table 1. Baseline and procedural characteristics

Variable	Overall	Stent retriever	Aspiration first	P value for difference
Age (years)	69.9 (67.5–72.3)	69.8 (66.1–73.5)	70.7 (69.4–72.0)	0.931
Females (%)	45.7 (40.8–50.6)	46.2 (40.4–52.1)	43.9 (33.8–54.4)	0.318
Hypertension (%)	65.3 (57.0–72.8)	68.5 (60.3–75.7)	54.3 (41.3–66.8)	0.047
Hyperlipidaemia (%)	37.0 (24.9–51.0)	45.4 (31.4–60.2)	19.6 (11.2–32.1)	0.015
Diabetes (%)	21.5 (18.0–25.5)	22.3 (18.0–27.2)	16.1 (8.6–28.3)	0.314
Atrial fibrillation (%)	41.0 (32.0–50.7)	40.8 (33.6–48.5)	29.0 (2.9–84.9)	0.473
Coronary artery disease (%)	11.4 (5.5–22.0)	13.2 (5.6–28.0)	8.0 (2.0–26.9)	0.327
Prior stroke/TIA (%)	13.1 (8.2–20.3)	12.1 (6.2–22.4)	14.1 (7.2–25.8)	0.742
Current smoker	14.4 (6.7–28.5)	11.2 (3.6–29.7)	23.1 (13.9–35.9)	0.224
Alteplase use	58.2 (47.5–68.1)	57.5 (47.0–67.3)	66.1 (33.4–88.3)	0.690
NIHSS baseline	13.6 (12.4–14.9)	13.6 (11.9–15.3)	13.8 (11.9–15.7)	0.857
ASPECTS baseline	8.7 (8.3–9.1)	8.8 (8.3–9.3)	8.5 (7.5–9.5)	0.682
Onset to door time (minutes)	129.1 (70.0–187.0)	154.0 (146.0–162.0)	97.4 (22.0–172.8)	0.010
Onset to groin puncture time (minutes)	220.9 (133.3–331.5)	259.9 (229.2–290.6)	136.2 (5.3–807.1)	0.021
Time of groin puncture to recanalization (minutes)	37.5 (32.3–42.7)	35.6 (29.6–41.7)	40.8 (26.0–55.6)	0.273

Values are presented as either weighted mean (95% confidence interval).
TIA, transient ischemic attack; NIHSS, National Institute of Health Stroke Scale; ASPECTS, Alberta Stroke Program Early Computed Tomography Score.

Phan, K., et al., *Contact Aspiration versus Stent-Retriever Thrombectomy for Distal Middle Cerebral Artery Occlusions in Acute Ischemic Stroke: Meta-Analysis.* Neurointervention, 2018. **13**(2): p. 100-109.

Table 2. Meta-analysis of procedural and 90-day outcomes

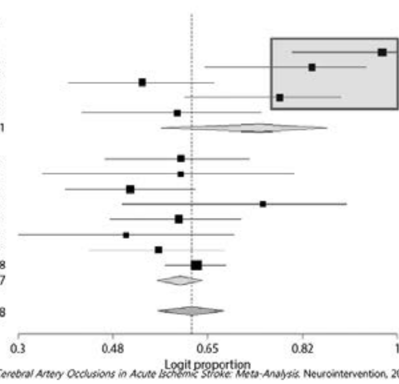
Variable	Overall	Stent-retriever	Aspiration first	P-value for difference
TICI 2b–3 (%)	82.8 (78.5–86.4)	80.5 (76.1–84.3)	86.8 (77.6–92.6)	0.168
TICI 3 (%)	55.8 (47.0–64.3)	53.5 (42.9–63.9)	57.1 (43.3–69.9)	0.700
90-day mRS 0–2 (%)	62.0 (55.8–67.8)	59.9 (55.8–63.8)	74.5 (56.4–86.8)	0.120
90-day mRS 0–1 (%)	44.2 (33.7–55.2)	39.9 (31.5–49.0)	65.6 (47.9–79.8)	0.003
90-day mortality (%)	12.4 (8.9–17.0)	14.7 (11.0–19.4)	4.3 (1.2–14.5)	0.212
All ICH (%)	11.2 (8.5–14.5)	11.7 (8.6–15.6)	9.4 (5.0–16.8)	0.530
sICH (%)	5.3 (3.7–7.5)	5.7 (3.9–8.3)	2.6 (0.8–7.7)	0.183
aICH (%)	6.0 (4.2–8.3)	6.6 (4.1–10.5)	4.1 (1.6–9.9)	0.378
Distal embolization (%)	5.7 (1.8–17.2)	5.9 (0.6–39.4)	4.6 (0.9–20.0)	0.598
Dissection or perforation (%)	3.3 (1.7–6.5)	3.8 (1.6–8.7)	1.9 (0.5–7.2)	0.344

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
Phan et al. N=835				
Overall	82.8%	62.0%	44.2%	5.3%
Stent retriever	80.5%	59.9%	39.9%	5.7%
Aspiration first	86.8%	74.5%	65.6%	2.6%

Phan, K., et al., *Contact Aspiration versus Stent-Retriever Thrombectomy for Distal Middle Cerebral Artery Occlusions in Acute Ischemic Stroke: Meta-Analysis.* Neurointervention, 2018. **13**(2): p. 100-109.

CAT vs. SRT in MeVO

Studies	Estimate (95% CI)	Ev/Trt
Altenbernd et al.[20]	0.968 (0.804, 0.995)	30/31
Kim et al.[9] (ADAPT)	0.840 (0.643, 0.939)	21/25
Mokin et al.[24] (ADAPT)	0.529 (0.394, 0.661)	27/51
Park and Kwak[25]	0.781 (0.607, 0.892)	25/32
Vargas et al.[30]	0.594 (0.419, 0.747)	19/32
Subgroup ADAPT (I^2=76.49%, P=0.002)	0.745 (0.564, 0.868)	122/171
Coutinho et al.[22]	0.600 (0.460, 0.725)	30/50
Dorn et al.[8]	0.600 (0.348, 0.808)	9/15
Flores et al.[23]	0.508 (0.388, 0.626)	33/65
Kim et al.[9] (stent-retriever)	0.750 (0.492, 0.903)	12/16
Mokin et al.[24] (stent-retriever)	0.597 (0.471, 0.711)	37/62
Protto et al.[26]	0.500 (0.302, 0.698)	11/22
Salahuddin et al.[27]	0.559 (0.432, 0.680)	33/59
Sarraj et al.[28]	0.628 (0.571, 0.682)	181/288
Subgroup stent-retriever (I^2=0%, P=0.540)	0.599 (0.558, 0.638)	346/577
Overall (I^2=51.66%, P=0.016)	0.620 (0.558, 0.678)	468/748



Phan, K., et al., *Contact Aspiration versus Stent-Retriever Thrombectomy for Distal Middle Cerebral Artery Occlusions in Acute Ischemic Stroke: Meta-Analysis.* Neurointervention, 2018. **13**(2): p. 100-109.

Best 3 Result of EVT in MeVO

Table 2 Details of endovascular treatment and clinical outcomes

Variable	FAST	Stent retriever	p Value
Onset to door time, median (IQR)	137 (47–307)	143.5 (77.5–299.25)	0.897*
Door to puncture time, median (IQR)	99 (82.5–120.5)	98 (66.5–123.25)	0.626*
Puncture to recanalization time, median (IQR)	53 (41–74)	38.5 (31.5–57.25)	0.045*
Time intervals, median (IQR)			
Puncture to carotid catheterization	24 (16–35)	20.5 (15.25–23)	0.080*
Guide catheter to access to the target occlusion	4 (3.5–7.5)	3 (3–4)	0.120*
Start of thrombectomy to recanalization	18 (7–42.5)	15.5 (12.25–33.5)	0.678*
TICI 2b–3 by first thrombectomy attempt	14 (56.0%)	9 (56.2%)	0.987
TICI 2b–3 by primary chosen device	16 (64.0%)	13 (81.2%)	0.305†
TICI 2b–3 <60 min (puncture to recanalization)	15 (60.0%)	12 (75.0%)	0.323
TICI 2b–3 <30 min (carotid catheterization to recanalization)	16 (64.0%)	12 (75.0%)	0.460
Rescue treatments used	5 (20.0%)	2 (12.5%)	0.689†
Stent retriever	5	0	
FAST	0	2	
Intra-arterial tirofiban	5	0	
Final TICI 2b–3	18 (72.0%)	14 (87.5%)	0.441†
Distal embolization	3 (12.0%)	4 (26.7%)	0.392†
Uninvolved territory embolization	0	0	
Intracranial hemorrhage			
Hemorrhagic infarction 1	3 (12.0%)	2 (12.5%)	1.000†
Hemorrhagic infarction 2	0	1 (6.2%)	0.390†
Parenchymal hematoma 1	0	0	
Parenchymal hematoma 2	1 (4.0%)	0	1.000†
Symptomatic ICH	1 (4.0%)	0	1.000†
SAH	0	1 (6.2%)	0.390†
mRS 0–2 at 3 months	21 (84.0%)	12 (75.0%)	0.689†
Mortality	0	1 (6.2%)	0.390†

*Mann–Whitney U test.
†Fisher's exact test.
FAST, forced arterial suction thrombectomy; ICH, intracerebral hemorrhage; mRS, modified Rankin Scale; SAH, subarachnoid hemorrhage; TICI, Thrombolysis in Cerebral Infarction.

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
FAST (CAT)	72% (18/25)	84% (21/25)	NA	4% (1/25)
SRT first	87.5% (14/16)	75% (12/16)	NA	0%

* M2
* FAST: Penumbra 4Max

Kim, Y.-W., et al., *Endovascular thrombectomy for M2 occlusions: comparison between forced arterial suction thrombectomy and stent retriever thrombectomy.* Journal of NeuroInterventional Surgery, 2017. 9(7): p. 626

Best 3 Result of EVT in MeVO

Table 2 Procedure Time

Procedure and outcome	All patients, (n=58)	Isolated M2 or M3 (n=31)	LVO+M2 or M3 (n=27)	Difference (95% CI)*
Time from symptom onset to groin puncture (median, IQR), min	105 (95–120)	105 (95–125)	110 (95–120)	0 (−10 to 10)
Time from symptom onset to recanalization (median, IQR), min	130 (115–145)	127.5 (115–145)	130 (115–150)	0 (−15 to 10)
Procedure duration (median, IQR), min	54.3 (37–65)	45.3 (30–55)	63.5 (45–75)	−22 (−40 to 5)
Post-treatment mTICI score 2b–3 (n/N (%)), per core laboratory	58/58 (100%)	31/31 (100%)	27/27 (100%)	0%, N/A
Post-treatment mTICI score 2b–3 (n/N (%)), per site PI	53/58 (91.4%)	28/31 (90.3%)	25/27 (92.6%)	−2.3% (−27.4% to 23.4%)
Post-treatment mTICI score 3 (n/N (%)), per core laboratory	48/58 (82.8%)	24/31 (77.4%)	24/27 (88.9%)	−11.5% (−36.4% to 14.1%)
Post-treatment mTICI score 3 (n/N (%)), per site PI	41/58 (70.7%)	22/31 (71.0%)	19/27 (70.4%)	1.0% (−25.0% to 26.1%)
Post-treatment NIHSS score (median, IQR)	4 (3–6)	4 (3–5)	5 (3–7)	−1 (−2 to 0)
Good functional outcome at discharge, mRS 0–2 (n/N (%))	54/58 (93.1%)	29/31 (93.5%)	25/27 (92.6%)	1.0% (−24.3% to 26.5%)
Good functional outcome at 90 days, mRS 0–2 (n/N (%))	55/58 (94.8%)	30/31 (96.8%)	25/27 (92.6%)	4.2% (−21.3% to 29.6%)
Symptomatic ICH (n/N (%))	2/58 (3.4%)	0/31 (0%)	2/27 (7.4%)	−7.4% (−32.6% to 18.2%)
Asymptomatic ICH (n/N (%))	10/58 (17.2%)	2/31 (6.5%)	8/27 (29.6%)	−23.2% (−46.6% to 3.0%)
Vessel dissection (n/N (%))	0/58 (0%)	0/31 (0%)	0/27 (0%)	0%, N/A
Vessel perforation (n/N (%))	0/58 (0%)	0/31 (0%)	0/27 (0%)	0%, N/A
Major groin complication (n/N (%))	0/58 (0%)	0/31 (0%)	0/27 (0%)	0%, N/A

*Wilcoxon rank sum or Fisher's exact test for difference between isolated M2 or M3 and LVO + M2 or M3 groups. Hodges-Lehmann estimate and CI was compu Wilcoxon rank sum test. Exact estimate and Clopper-Pearson CI was computed for results of Fisher's exact test.
ICH, intracranial hemorrhage; LVO, large vessel occlusion; mRS, modified Rankin Scale; mTICI, modified Thrombolysis in Cerebral Infarction; NIHSS, National Insti Stroke Scale; PI, Principal Investigator.

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
F. ADAPT	91.4% (53/58)	94.8% (55/58)	NA	3.4% (2/58)
	Vessel dissection 0% Vessel perforation 0%			

* M2, M3
* Frontline ADAPT: Penumbra 3Max

Altenbernd, J., et al., *Frontline ADAPT therapy to treat patients with symptomatic M2 and M3 occlusions in acute ischemic stroke: initial experience with the Penumbra ACE and 3MAX reperfusion system.* Journal of NeuroInterventional Surgery, 2018. 10(5): p. 434.

Best 3 Result of EVT in MeVO

Table 3. Demographics and outcomes of MAT in patients with solitary M2 occlusion

Outcome parameter		*p* value*
Final TICI [n (%)]		
0–2a	5 (16)	
2b	12 (37)	
3	15 (47)	
NIHSS (mean±SD)		<0.0001
Baseline	10.9±5.1	
Discharge	4.3±4.0	
mRS ≤2 [n (%)]		<0.0001
Baseline	4 (13)	
At 90 days	25 (78)	

*Paired t-test. MAT : manual aspiration thrombectomy, TICI : Thrombolysis in Cerebral Infarction, NIHSS : National Institutes of Health Stroke Scale, mRS : modified Rankin scale

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
Manual Aspiration	84% (17/32)	78% (25/32)	NA	

* M2
* Manual Apiration: Penumbra 4Max

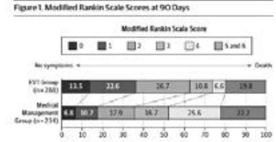
Park, J. and H. Kwak, *Manual Aspiration Thrombectomy Using Penumbra Catheter in Patients with Acute M2 Occlusion : A Single-Center Analysis.* Journal of Korean Neurosurgical Society, 2016. **59**(4): p. 352-356.

EVT (M2) vs Medical

Table 1. Patient Baseline Characteristics

Characteristic	Study Group EVT (n = 288)	Medical Management (n = 234)	P Value
Age, y			
Mean (SD)	66 (15)	70 (14)	.002
Median (IQR)	68 (56-78)	73 (60-81)	.003
Male sex, No. (%)	144 (50)	112 (47.9)	.60
NIHSS score, median (IQR)[a]	16 (11-20)	15 (11-20)	.90
Clinical history, No. (%)			
Hypertension	216 (75)	178 (76.	
Hyperlipidemia	120 (41.7)	77 (32.	
Diabetes	60 (20.8)	66 (28.	
Atrial fibrillation	103 (35.8)	80 (34.	
Current smoker	66 (22.9)	51 (21.	
ASPECTS, median (IQR)[b]	9 (7-10)	9 (7-9	
IV tPA treatment, No. (%)	172 (59.7)	174 (74.	
Time metrics, median (IQR), min			
From LKN to arrival at the ED	158 (73-262)	86 (48-	
From LKN to GP	270 (181-380)	NA	
From CT to GP	74 (52-111)	NA	
From GP to recanalization	41 (32-55)	NA	

Figure 1. Modified Rankin Scale Scores at 90 Days



Outcomes are compared for the endovascular therapy (EVT) vs medical management groups.

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
Medical Tx (N=234)	NA	35.5% (83/234)	17.5% (41/234)	2.1% (5/234)
Stent + Apiration + ia Thrombolytids (N=288)	78% (225/288)	62.8% (181/288)	36.1% (104/288)	5.6% (16/288)

Sarraj, A., et al., *Endovascular Therapy for Acute Ischemic Stroke With Occlusion of t*

EVT (P2/3) vs Medical

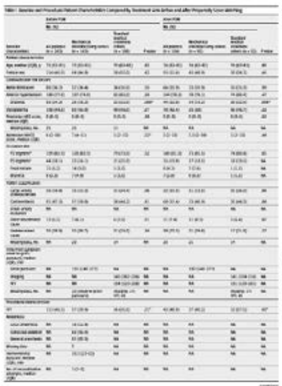


Table 1. Baseline and Procedural Patient Characteristics Compared by Treatment Arm Before and After Propensity Score Matching (continued)

Baseline characteristic	Before PSM No. (%) All patients (n = 243)	Mechanical thrombectomy cohort (n = 143)	Standard medical treatment cohort (n = 100)	P value	After PSM No. (%) All patients (n = 184)	Mechanical thrombectomy cohort (n = 92)	Standard medical treatment cohort (n = 92)	P value
Recanalization degree								
mTICI score ≤2a	NA	18 (12.6)	NA	NA	NA	NA	NA	NA
mTICI score ≥2b/3	NA	125 (87.4)	NA	NA	NA	NA	NA	NA
First-pass thrombectomy method	NA							
Stent retriever (+/- aspiration)	N							
Primary aspiration	N							
Intra-arterial recombinant tPA administration	N							

Abbreviations: IQR, interq... mRS, modified Rankin Scal... infarction; NA, not applica... PSM, propensity score ma... TOAST, Trial of ORG 10172...
* indicating statistical signi...

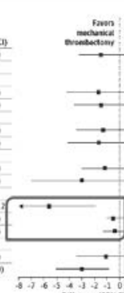
	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
Medical Tx (N=92)	NA	75.4% (43/92)	54.4% (31/92)	4.3% (4/92)
EVT (N=92) Stent (72.0%) Stent+Aspiration (26.6%)	NA	76.6% (59/92)	66.2% (61/92)	4.3% (4/92)

Meyer, L., et al., *Thrombectomy for Primary Distal Posterior Cerebral Artery Occlusion Stroke.* JAMA Neurology, 2021. **78**(4): p. 434-444.

EVT (P2/3) vs Medical

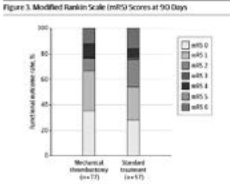
Figure 2. Early Clinical Outcome at Discharge

Group	No. of patients: Mechanical thrombectomy	Standard treatment	Change in NIHSS score: Mechanical thrombectomy (95% CI)	Standard treatment 95% CI)	Difference (95% CI)	P value
All patients	85	86	-3.9 (-5.4 to -2.5)	-2.4 (-3.1 to -1.2)	-1.5 (-3.2 to 0.8)	.06
Subgroup						
Sex						
Female	41	37	-3.8 (-6.1 to -1.5)	-2.1 (-3.1 to -1.1)	-1.7 (-4.2 to 0.7)	.16
Male	44	49	-4.0 (-5.9 to -2.1)	-2.6 (-3.8 to -1.4)	-1.4 (-3.6 to 0.8)	.19
Age, y						
<70	36	33	-4.3 (-6.0 to -2.6)	-3.0 (-4.3 to -1.6)	-1.3 (-3.4 to 0.8)	.23
≥70	49	53	-3.7 (-5.9 to -1.4)	-2.0 (-3.0 to -1.0)	-1.7 (-4.1 to 0.8)	.18
Occlusion site						
P2	70	69	-3.6 (-5.2 to -2.1)	-2.4 (-3.3 to -1.5)	-1.2 (-3.0 to 0.6)	.18
P3	15	17	-5.2 (-9.3 to -1.1)	-2.2 (-4.0 to -0.4)	-3.0 (-7.0 to 1.1)	.14
NIHSS score						
≥10	21	22	-9.5 (-14.3 to -4.6)	-3.9 (-6.4 to -1.4)	-5.6 (-10.9 to -0.2	
9-6	19	17	-4.2 (-5.3 to -3.0)	-4.7 (-5.8 to -3.6)	-0.5 (-1.0 to 2.1)	
≤5	45	47	-1.2 (-2.1 to -0.3)	-0.8 (-1.3 to -0.4)	-0.4 (-1.3 to 0.6)	
IVT						
Yes	33	48	-5.3 (-7.4 to -3.1)	-4.2 (-5.3 to -3.2)	-1.1 (-3.4 to 1.3)	
No	52	38	-3.1 (-5.0 to -1.1)	-0.5 (-0.7 to -6.0)	-3.0 (-5.0 to -0.9)	



Improvement of National Institutes of Health Stroke Scale (NIHSS) scores and differences were compared by treatment group and stratified by... indicates intravenous thrombolysis.

Figure 3. Modified Rankin Scale (mRS) Scores at 90 Days



Functional outcome rates (mRS) at 90 days were stratified and compared by treatment status after propensity score matching.

Meaning Results of this study suggest that, among patients who experienced stroke attributed to primary distal occlusion of the posterior cerebral artery of the P2 or P3 segment, mechanical thrombectomy is a reasonable, safe and technically feasible therapy option.

If patients, not for iv tPA with high NIHSS (≥10)

Meyer, L., et al., *Thrombectomy for Primary Distal Posterior Cerebral Artery Occlusion Stroke.* JAMA Neurology, 2021. **78**(4): p. 434-444.

EVT for MeVO

- **Safety Outcome**
  - higher than LVOs
  - Similar(???), Not inferior versus Best Medical Treatment
- **Special symptoms, which not captured NIHSS, mRS**
  - abulia d/t A2/3 occlusion
  - alexia, agraphia d/t M2/3 occlusion
  - quadrantanopia d/t P2/3 occlusion
- **For Better Outcome**
  - Reduce Procedural Related Complications
- **Which is Better, for reduce periprocedural complications**
  - Procedure Attitude
  - Techniques, CAT >SRT, or Combined, or Others
  - Devices Selection
    - aspiration catheter, retriever stent, microwire

News, EVT in MeVO

	2b/c	mRS 0-2	mRS 0-1 (excellent outcome)	sICH
Best Medical Tx.	41.8% (84/201)	67.4% (174/258)	50% (129/258)	9.2%(22/239) *All ICH (Sx, Asx)
CAT, 3MAX	68.8%	74.5	65.6%	2.6%
Aperio	100% (4/4)	NA	NA	0% (0/4)
Trevo NXT	100% (22/22)	NA	NA	NA
mFRESH technique	100% (4/4)	NA	NA	0% (0/4)
Microwire				

Phan, K., et al., *Contact Aspiration versus Stent-Retriever Thrombectomy for Distal Middle Cerebral Artery Occlusions in Acute Ischemic Stroke: Meta-Analysis.* Neurointervention, 2018. **13**(2): p. 100-109.
Kaschner, M., et al., *The New Fully Radiopaque Aperio Hybrid Stent Retriever: Efficient and Safe? An Early Multicenter Experience.* World Neurosurgery, 2020. **141**.
Etter, M.M., et al., *Initial Experience With the Trevo NXT Stent Retriever.* Frontiers in Neurology, 2021. **12**: p. 704329.
Kim, J.-H., Y.-J. Jung, and C.-H. Chang, *Feasibility and safety of the strategy of first stenting without retrieval using Solitaire FR as a treatment for emergent large-vessel occlusion due to underlying intracranial atherosclerosis.* Journal of Neurosurgery, 2021: p. 1-9.

EVT in MeVO, Do IT or NOT

Multinational survey (ESCAPE ALICE, n=184)

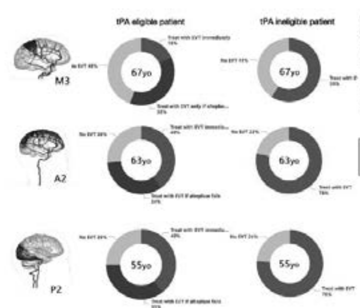


Figure 2 Treatment decision of the ESCAPE ALICE participants (n=184) for the three medium vessel occlusion case scenarios. Assuming eligibility for intravenous alteplase (tPA), 18–40% of physicians would offer endovascular treatment (EVT). In the case of ineligibility for intravenous alteplase, 59–78% would proceed with EVT.

Table 2 Detailed description of medium vessel occlusion case scenarios

Occlusion site	Case vignette
M3	A patient in their late 60s presents with dysphasia. The NIHSS is 4. ASPECTS on non-contrast CT is 10. CT angiography shows an M3 occlusion. Symptom onset was 2 hours ago. The premorbid functional status was normal. How would you treat this patient?
A2	A patient in their early 60s presents with right sided leg paralysis. The NIHSS is 3. ASPECTS on non-contrast CT is 10. CT angiography shows an A2 occlusion. Symptom onset was 4 hours ago. The premorbid functional status was normal. How would you treat this patient?
P2	A patient in their mid 50s presents with left sided hemianopia. Their NIHSS is 2. ASPECTS on non-contrast CT is 10. CT angiography shows a P2 occlusion. Symptom onset was 3.5 hours ago. The premorbid functional status was normal. The patient is an Air Canada pilot. How would you treat this patient?

ASPECTS, Alberta Stroke Program Early CT Score; NIHSS, National Institutes of Health Stroke Scale.

✓ **59-78% would proceed with EVT**

Goyal, M., et al., *MeVO: the next frontier?* Journal of NeuroInterventional Surgery, 2020. **12**(6): p. 545-547.

Conclusion and Future

- **MeVO,**
  – being increasingly recognized as a target for EVT
  – iv tPA, standard treatment of choice **(?)**
  – (Not), **eligible for iv tPA,**
    ✓limited but promising evidence for MeVO EVT
    ✓**Higher NIHSS, slightly aggressive**
    ✓Lower NIHSS, a bit defensive
    ✓**with well selected good devices**

1. Medium Vessel Occlusions

Medium Vessel Occlusion(MeVO)

하상우

조선대병원

Introduction

MeVO

- **Medium vessel occlusion**
  : M2/3, A2/3, P2/3 segment occlusion. (With disabling deficits.)
- **25-40% of all AIS**
- **M2 occlusion : 50% good functional outcome at 90 days**
- **M3, A2/3, P2/3 : clinical course → Unknown**

Introduction

Clinical course of AIS due to MeVO

Stroke

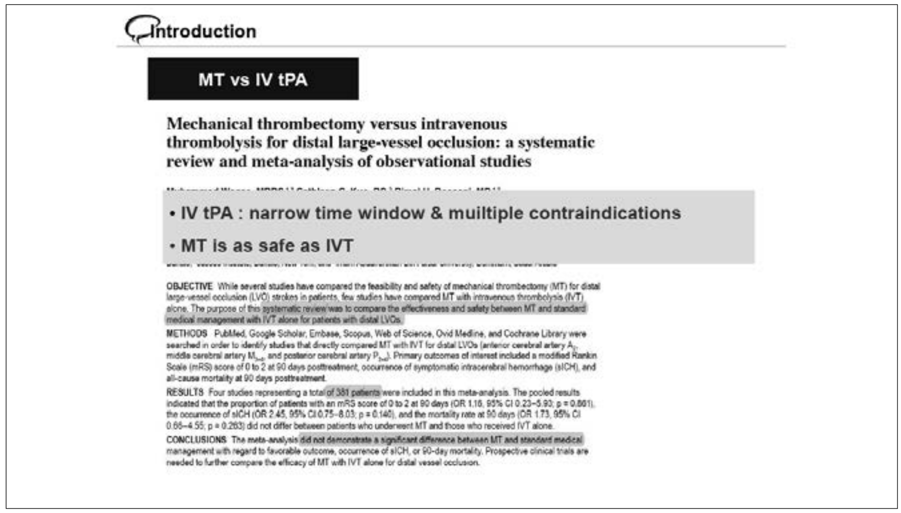
CLINICAL AND POPULATION SCIENCES

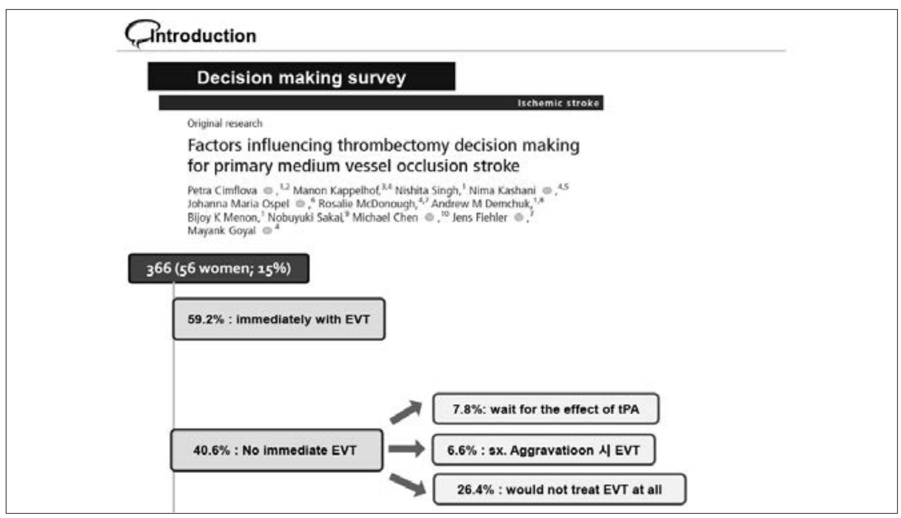
Clinical Course of Acute Ischemic Stroke Due to Medium Vessel Occlusion With and Without Intravenous Alteplase Treatment

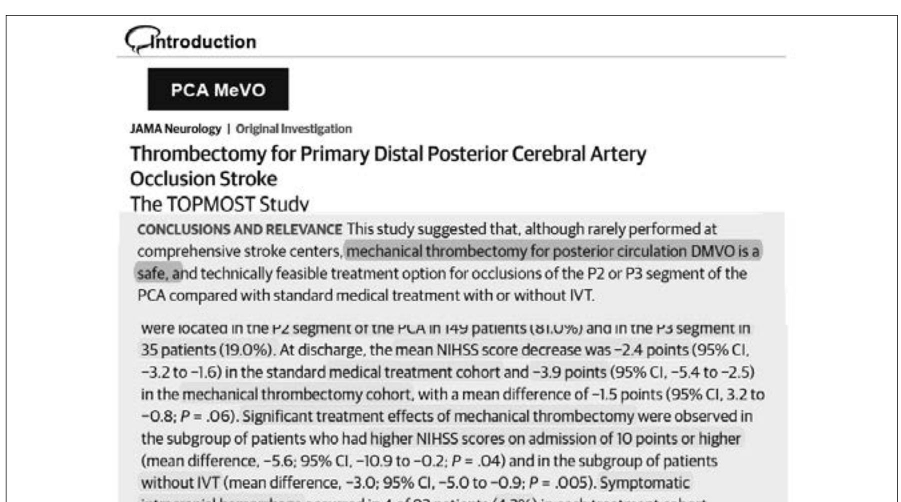
Johanna M. Ospel, MD; Bijoy K. Menon, MD; Andrew M. Demchuk, MD; Mohammed A. Almekhlafi, MD; Nima Kashani, MD; Arnuv Mayank; Enrico Fainardi, MD; Marta Rubiera, MD; Alexander Khaw, MD; Jai J. Shankar, MD; Dar Dowlatshahi, MD; Josep Puig, MD; Sung-Il Sohn, MD; Seong H. Ahn, MD; Alexandre Poppe, MD; Ana Calleja, MD; Michael D. Hill, MD; Mayank Goyal, MD, PhD

CONCLUSIONS: One of every 2 patients with MeVO did not achieve excellent clinical outcome at 90 days with best medical management. Early recanalization was strongly associated with excellent outcome but occurred in <50% of patients despite intravenous alteplase treatment.

- **50% → excellent clinical outcome at 90 days**
- **<50% → early recanalization (21 ~ 43%)**


Introduction
MT vs IV tPA
Mechanical thrombectomy versus intravenous thrombolysis for distal large-vessel occlusion: a systematic review and meta-analysis of observational studies
• IV tPA : narrow time window & muiltiple contraindications
• MT is as safe as IVT
OBJECTIVE While several studies have compared the feasibility and safety of mechanical thrombectomy (MT) for distal large-vessel occlusion (LVO) strokes in patients, few studies have compared MT with intravenous thrombolysis (IVT) alone. The purpose of this systematic review was to compare the effectiveness and safety between MT and standard medical management with IVT alone for patients with distal LVOs.
METHODS PubMed, Google Scholar, Embase, Scopus, Web of Science, Ovid Medline, and Cochrane Library were searched in order to identify studies that directly compared MT with IVT for distal LVOs (anterior cerebral artery A, middle cerebral artery M, and posterior cerebral artery P). Primary outcomes of interest included a modified Rankin Scale (mRS) score of 0 to 2 at 90 days posttreatment, occurrence of symptomatic intracerebral hemorrhage (sICH), and all-cause mortality at 90 days posttreatment.
RESULTS Four studies representing a total of 381 patients were included in this meta-analysis. The pooled results indicated that the proportion of patients with an mRS score of 0 to 2 at 90 days (OR 1.16, 95% CI 0.23–5.93; p = 0.861), the occurrence of sICH (OR 2.45, 95% CI 0.75–8.03; p = 0.140), and the mortality rate at 90 days (OR 1.73, 95% CI 0.66–4.55; p = 0.263) did not differ between patients who underwent MT and those who received IVT alone.
CONCLUSIONS The meta-analysis did not demonstrate a significant difference between MT and standard medical management with regard to favorable outcome, occurrence of sICH, or 90-day mortality. Prospective clinical trials are needed to further compare the efficacy of MT with IVT alone for distal vessel occlusion.


Introduction
Decision making survey
Ischemic stroke
Original research
Factors influencing thrombectomy decision making for primary medium vessel occlusion stroke
Petra Cimflova, Manon Kappelhof, Nishita Singh, Nima Kashani, Johanna Maria Ospel, Rosalie McDonough, Andrew M Demchuk, Bijoy K Menon, Nobuyuki Sakai, Michael Chen, Jens Fiehler, Mayank Goyal
366 (56 women; 15%)
59.2% : immediately with EVT
40.6% : No immediate EVT
7.8%: wait for the effect of tPA
6.6% : sx. Aggravatioon 시 EVT
26.4% : would not treat EVT at all


Introduction
PCA MeVO
JAMA Neurology | Original Investigation
Thrombectomy for Primary Distal Posterior Cerebral Artery Occlusion Stroke
The TOPMOST Study
CONCLUSIONS AND RELEVANCE This study suggested that, although rarely performed at comprehensive stroke centers, mechanical thrombectomy for posterior circulation DMVO is a safe, and technically feasible treatment option for occlusions of the P2 or P3 segment of the PCA compared with standard medical treatment with or without IVT.
were located in the P2 segment of the PCA in 149 patients (81.0%) and in the P3 segment in 35 patients (19.0%). At discharge, the mean NIHSS score decrease was −2.4 points (95% CI, −3.2 to −1.6) in the standard medical treatment cohort and −3.9 points (95% CI, −5.4 to −2.5) in the mechanical thrombectomy cohort, with a mean difference of −1.5 points (95% CI, 3.2 to −0.8; P = .06). Significant treatment effects of mechanical thrombectomy were observed in the subgroup of patients who had higher NIHSS scores on admission of 10 points or higher (mean difference, −5.6; 95% CI, −10.9 to −0.2; P = .04) and in the subgroup of patients without IVT (mean difference, −3.0; 95% CI, −5.0 to −0.9; P = .005). Symptomatic intracranial hemorrhage occurred in 4 of 92 patients (4.3%) in each treatment cohort.

Introduction

Primary vs Secondary

COMMENTS AND OPINIONS

Secondary Medium Vessel Occlusions

When Clots Move North

Table 2. Conceptual Differences Between Primary and Secondary MeVOs

Difference	Primary MeVOs	Secondary MeVOs	Practical Implications
Clinical presentation	Less severe symptoms; smaller neurological deficit	Severe symptoms; larger neurological deficit	Possibly higher EVT treatment rates in secondary MeVOs
Extent of ischemia	Smaller; only the territory supplied by the MeVO will be affected	Larger; more proximal territories that were supplied by the initial LVO might progress to infarction as well	Ischemia is likely to be more extensive in secondary MeVOs, which might translate into worse outcomes and a higher risk of hemorrhage
Clot fragility	Lower	May be higher because there has been fragmentation/migration	Risk of thrombus fragmentation during EVT may be higher in secondary MeVOs
Willingness to treat with EVT	Lower; risks of EVT and gaining endovascular access have to be weighed against estimated benefit in patient with smaller deficits	Higher in EVT-related secondary MeVOs; access has already been established so treatment can be performed immediately	Higher EVT treatment rates for secondary compared with primary MeVOs (over/undertreatment?)
Inclusion in a randomized MeVO EVT trial	Feasible	Challenging. EVT-related secondary MeVOs: randomization would have to occur on the angiography table; non-EVT-related secondary MeVOs: often require repeat vascular imaging, which is not routinely performed and delays treatment	Lack of equipoise for randomization of secondary MeVOs

EVT indicates endovascular thrombectomy; and MeVO, medium vessel occlusion.

Introduction

LVO vs MeVO

Revascularization, Functional Outcome, and Mortality

CONCLUSION

Mechanical thrombectomy procedures for distal circulation is as effective and safe compared with the proximal group. Though distal vessels supply smaller territory when symptoms are pronounced the benefit of the procedure outweighs the risks.

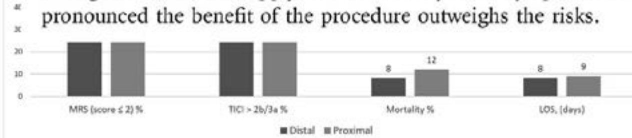
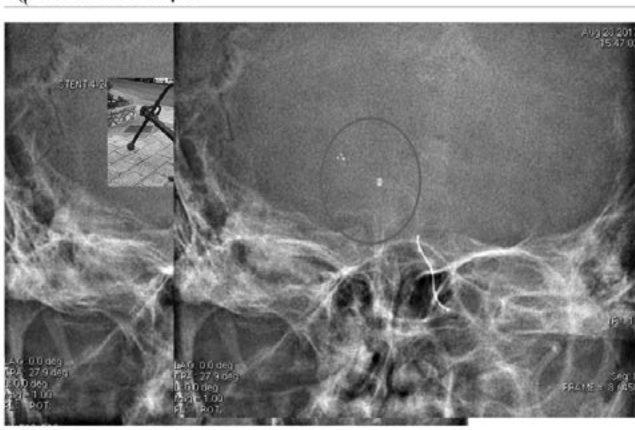
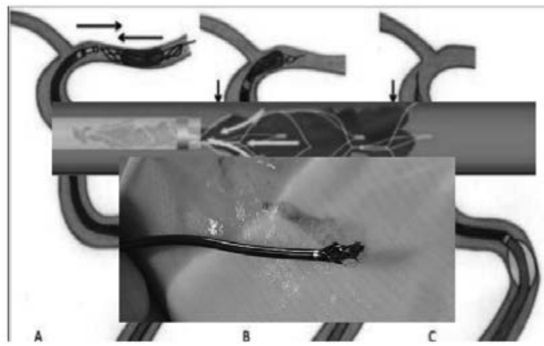


Figure 4. Bar graph showing revascularization, functional outcome, and mortality. LOS, length of stay; mRS, modified Rankin score; TICI, Thrombolysis in Cerebral Infarction.

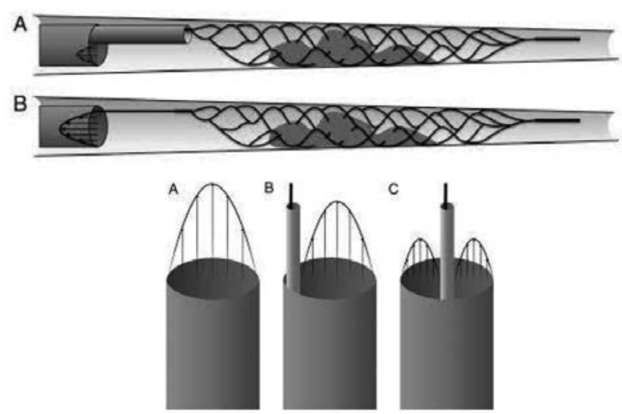
Anchor Technique



Solumbra



Bare wire thrombectomy technique



Blind exchange with mini-pinning technique

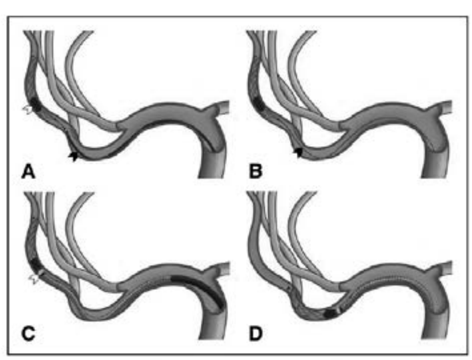
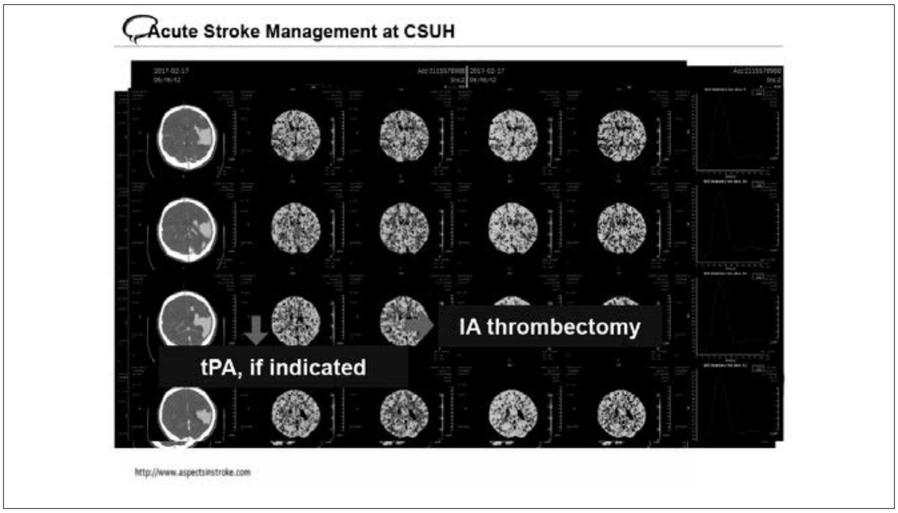
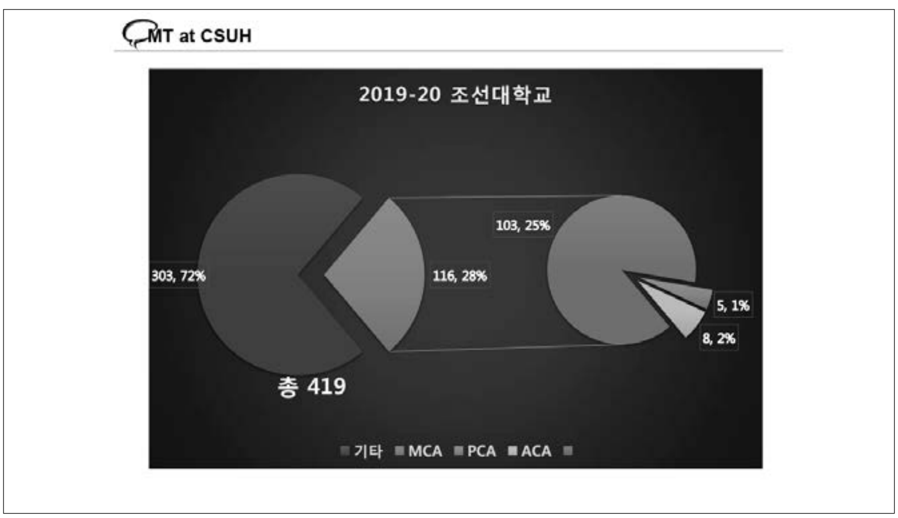


Figure 1. Illustrations depicting the blind exchange with mini-pinning technique.



Acute Stroke Management at CSUH
IA thrombectomy
tPA, if indicated
http://www.aspectsinstroke.com



MT at CSUH
2019-20 조선대학교
303, 72%
116, 28%
103, 25%
5, 1%
8, 2%
총 419
기타 MCA PCA ACA

2. LVO with underlying Intracranial arterial stenosis

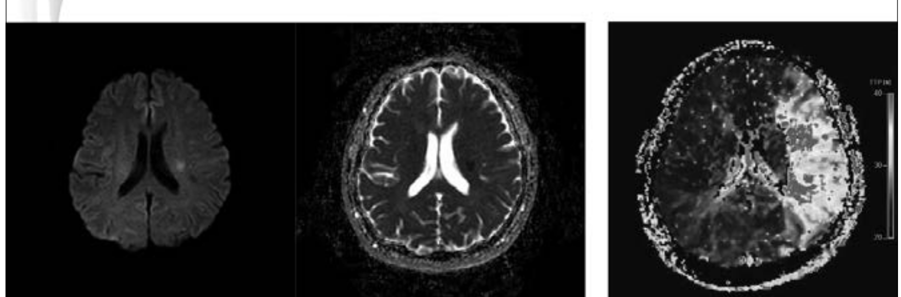
Trouble IAT : ICAS – LVO

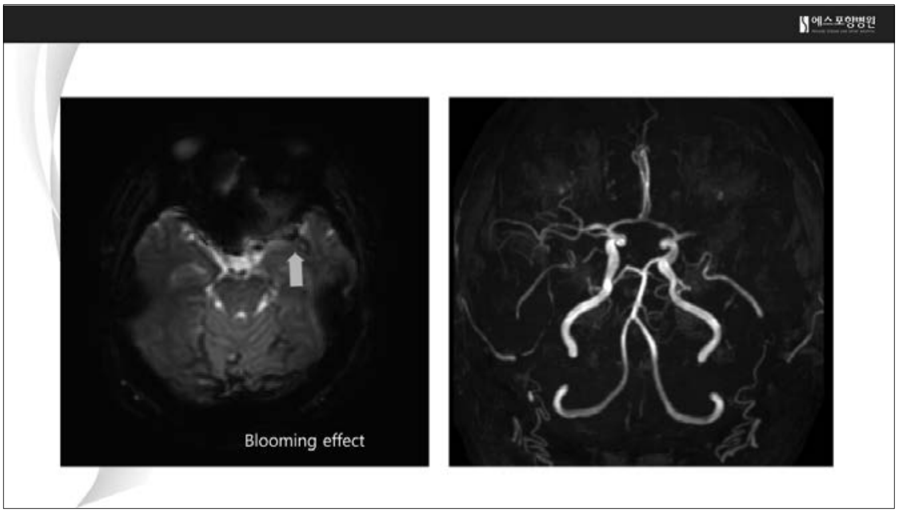
홍대영

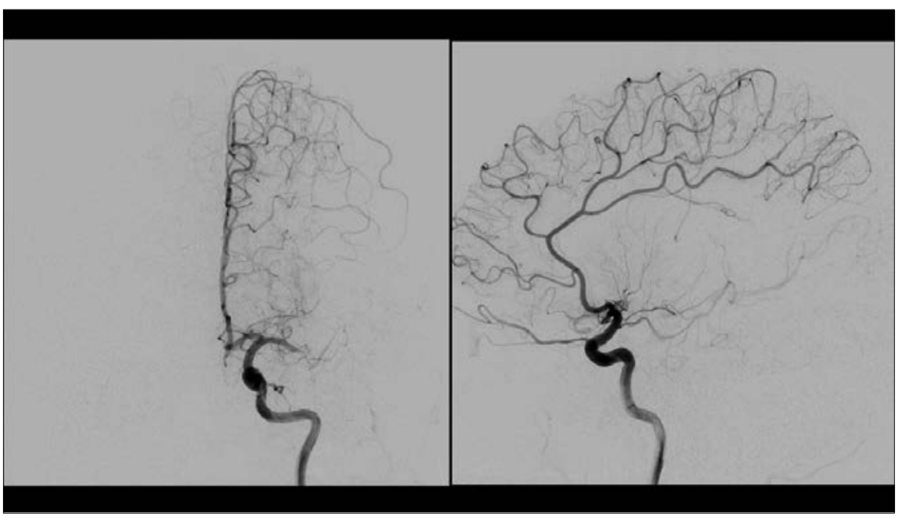
에스포항병원

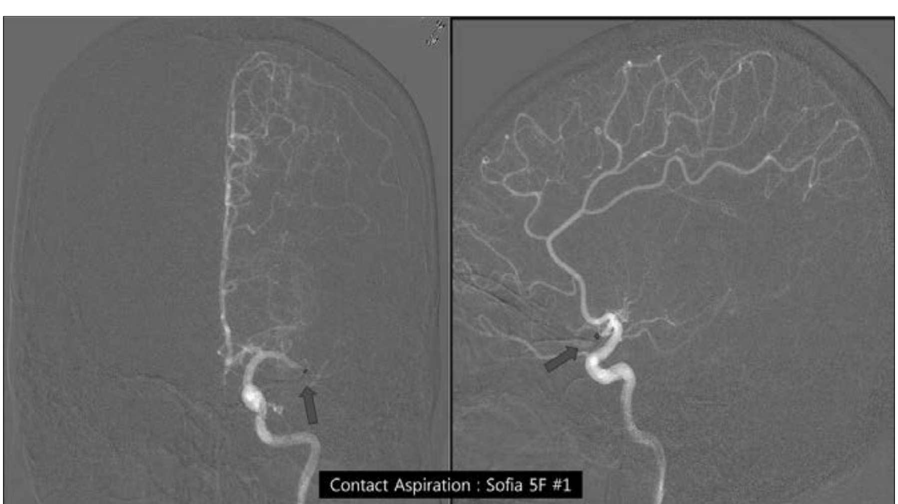
Case 1

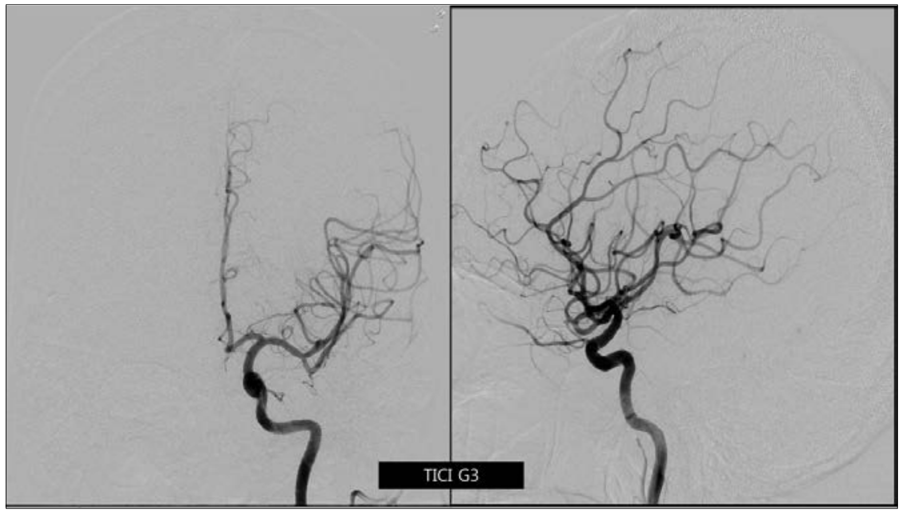
- 53/M
- Rt side weakness (arm G4/leg G4)
- Last normal time : 1hr30min
- P/Hx : angina + HL – 아스피린 복용중
- Smoking(+)
- NIHSS – 4점
- EKG : U-R




Blooming effect

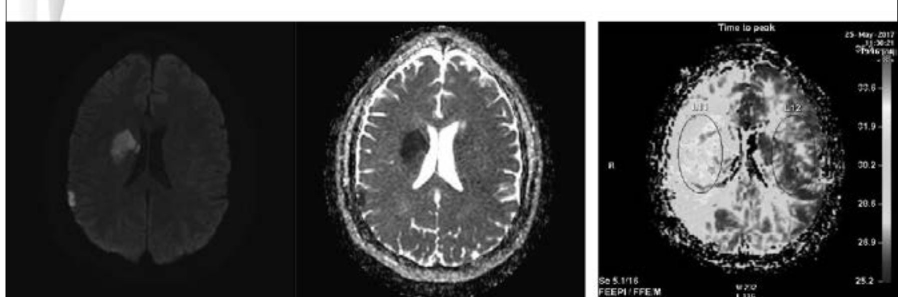



Contact Aspiration : Sofia 5F #1

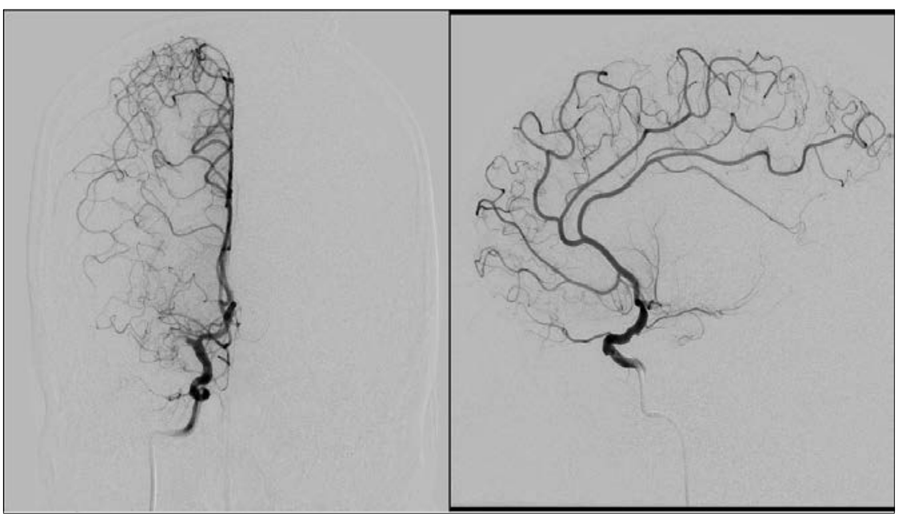


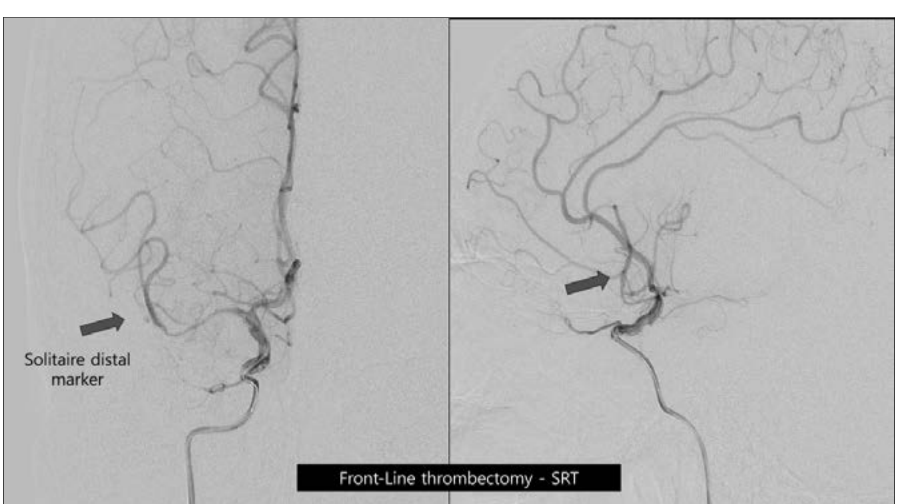
Case 2

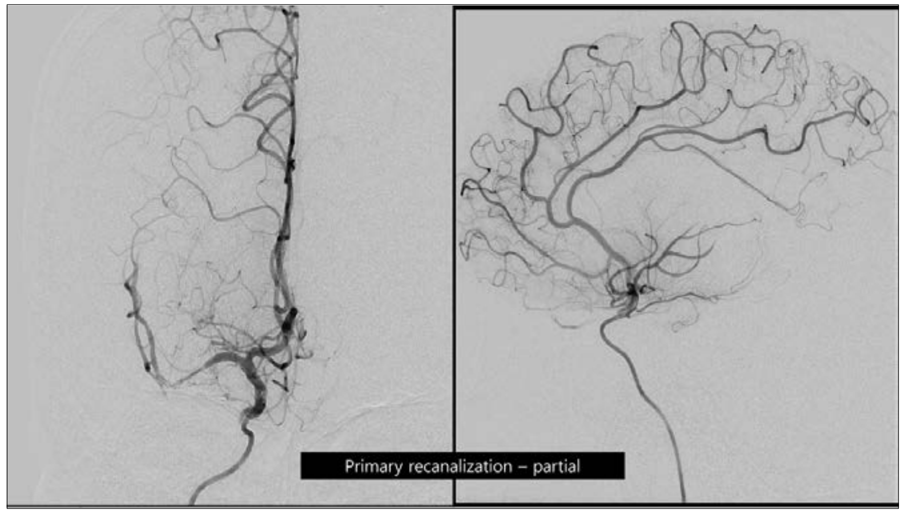
- 2017.5.25
- 45/M
- Lt side hemiplegia (arm G1/leg G1)
- Awaken infarction : 3hr40min
- P/Hx : HTN + HL
- Smoking(+)
- NIHSS – 12점
- EKG : U-R




Blooming effect
R
5 cm
A
F
F




Solitaire distal marker
Front-Line thrombectomy - SRT


Primary recanalization – partial


Reocclusion-recanalization → Solitaire #5


10atm
10atm
1st Rescue balloon mounted stent (Energy 2*13mm)

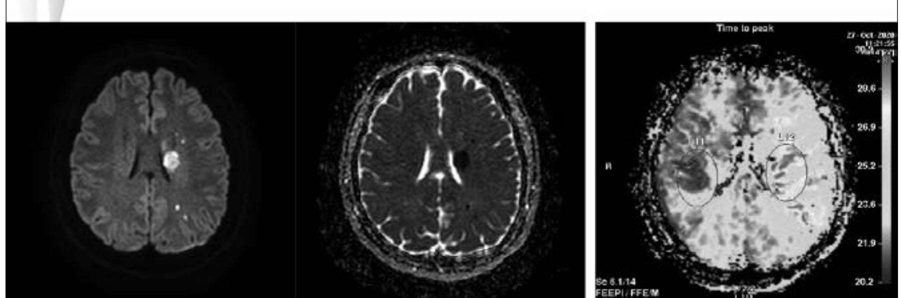

delay 10min
delay 10min
Delay 10 min - recannalization

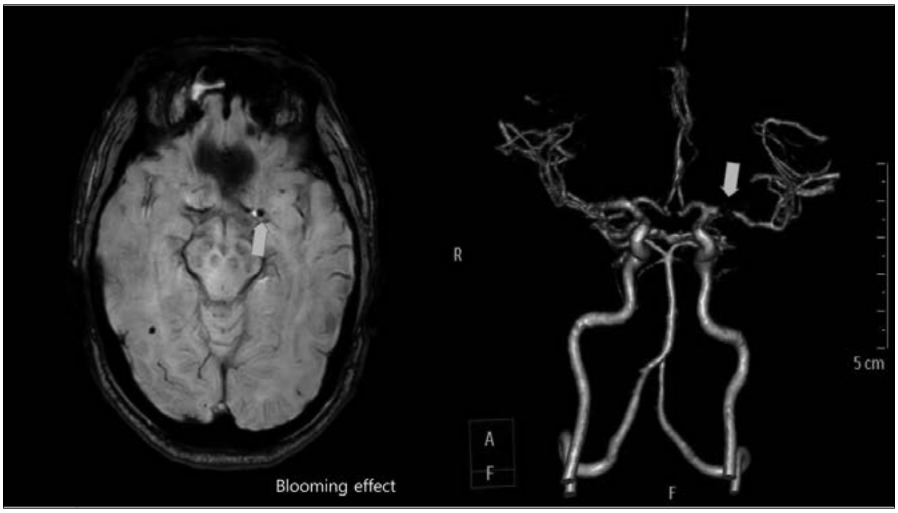

delay 15min
delay 15min
Delay 15min – Reocclusion

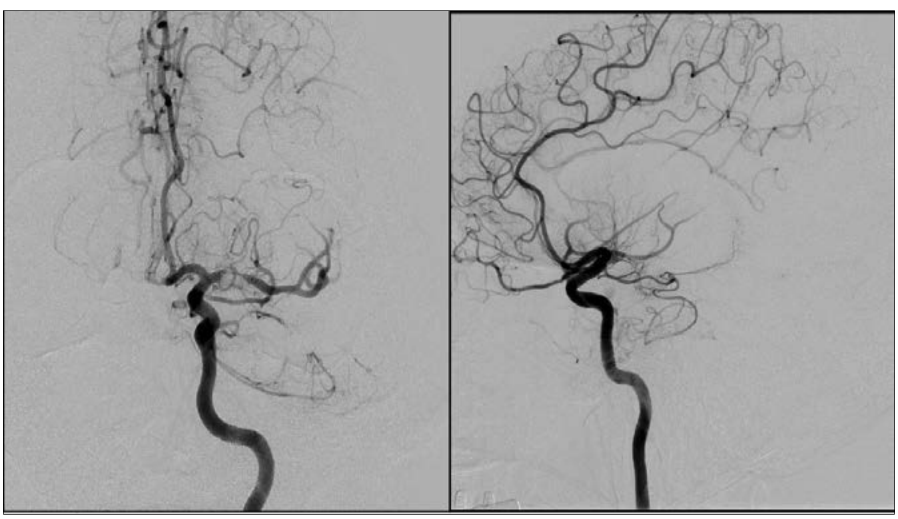

total tirofiban 1.25mg
total tirofiban 1.25mg
2nd Rescue tirofiban 1.25mg

Case 3

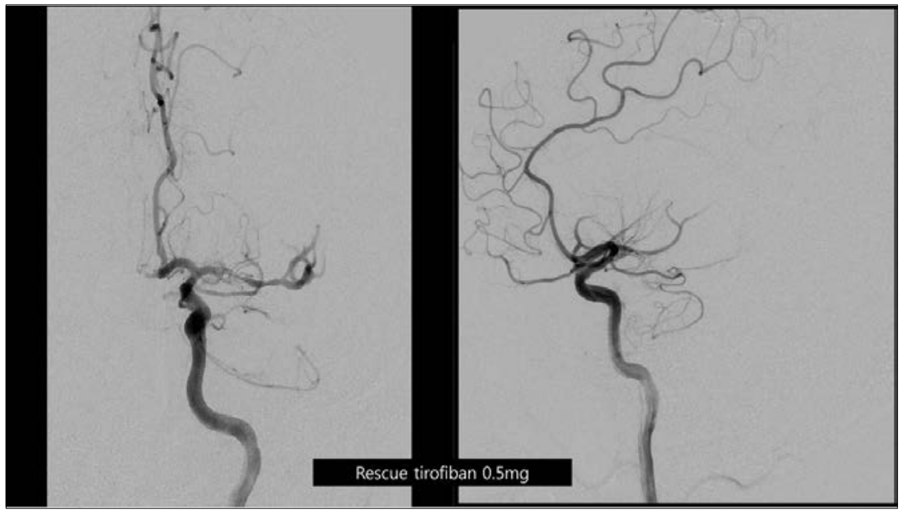
- 2020.10.27
- 50/M
- Rt side weakness (arm G4/leg G4)
- Awaken infarction : 5hr40min
- P/Hx : HL
- Smoking(+)
- NIHSS – 5점
- EKG : U-R

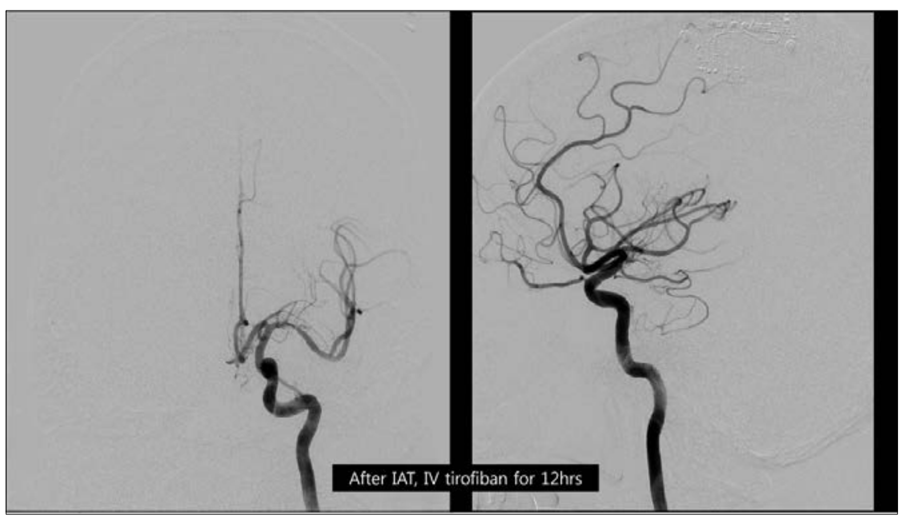


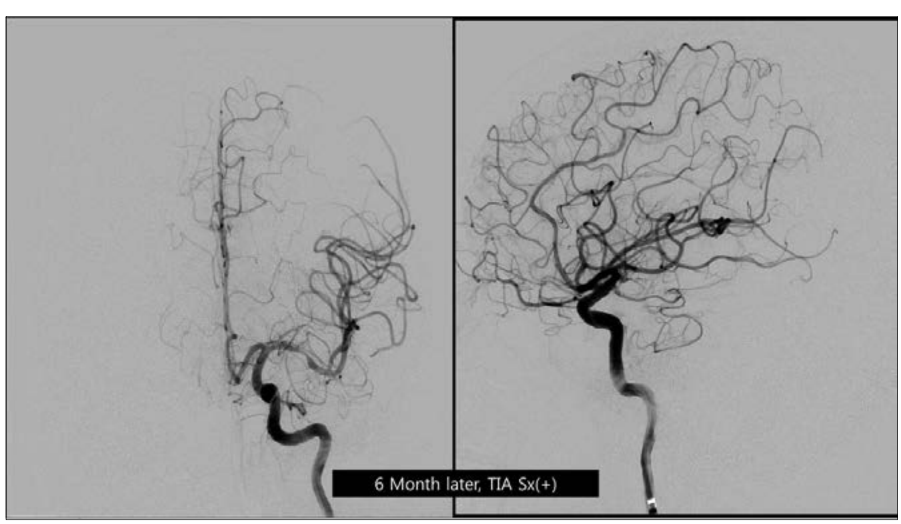

R
5 cm
A
F
Blooming effect
F

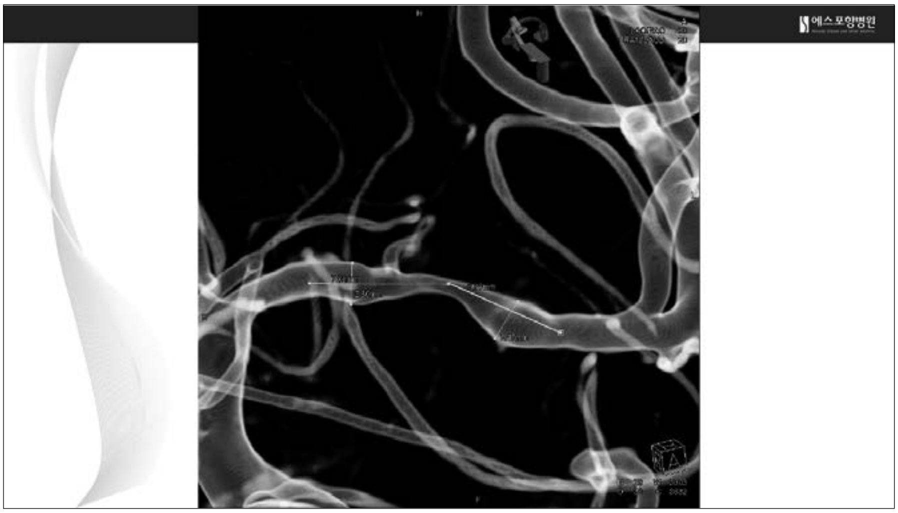


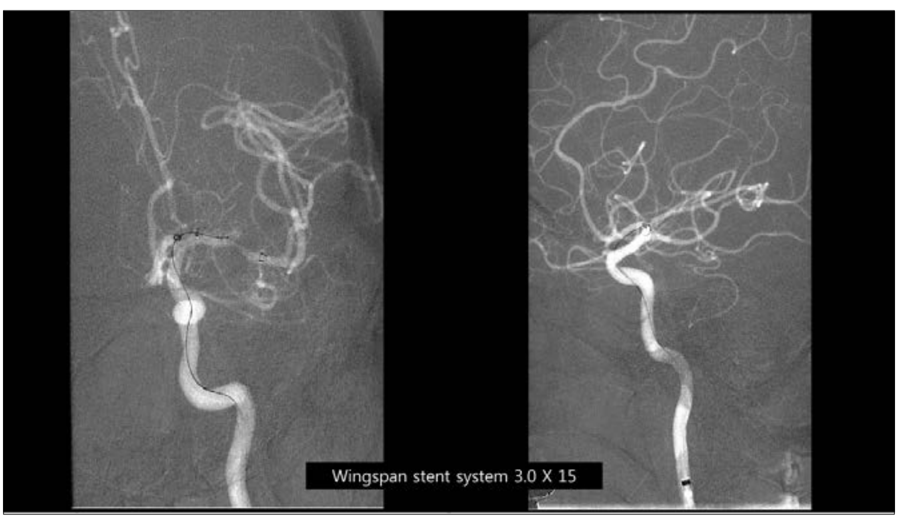

Front-Line Solumbra #1

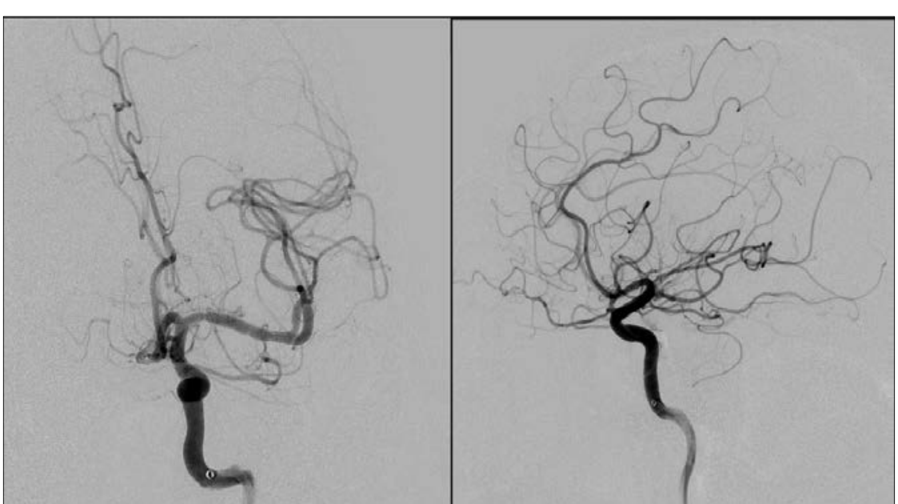

Rescue tirofiban 0.5mg


After IAT, IV tirofiban for 12hrs


6 Month later, TIA Sx(+)




Wingspan stent system 3.0 X 15



ICAS – LVO vs Embolic

- Frequent re-occlusion or flow stagnation (ex 65% vs 3.3%)
- Use of a different front-line thrombectomy technique (SRT vs CA)
- More require rescue treatments
  - balloon, stent, tirofiban etc
- longer procedure time and poor outcomes

→

- Detect the clues of ICAS-LVO in Pre or intra-procedure
- Need for new fast strategy

에스포항병원

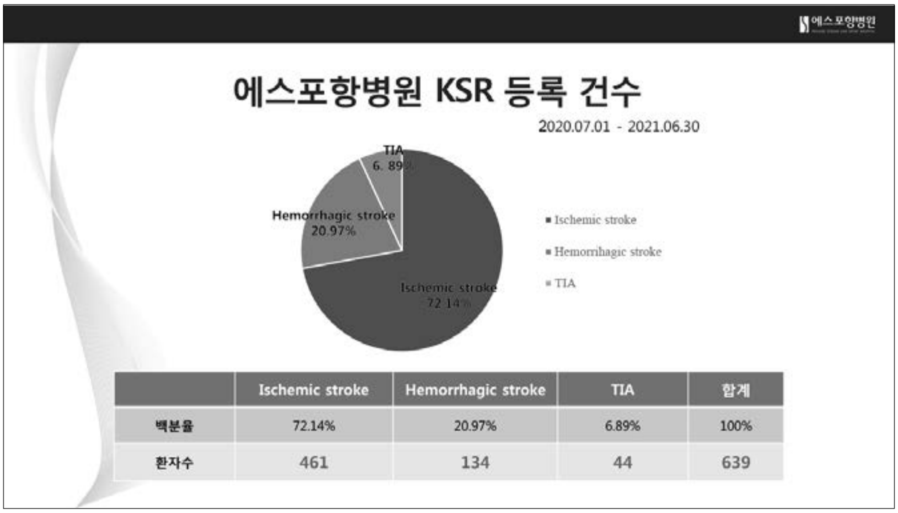
ICAS – LVO : Incidence

- 5~36% in EVT eligible patients (ASIA : 15-20% vs Western : 5-8%)

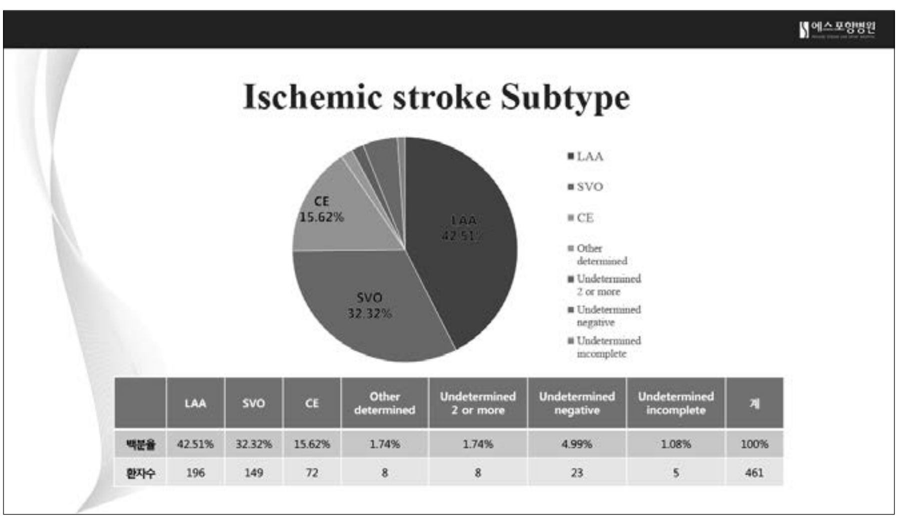
TABLE 1 | Frequencies of intracranial atherosclerosis-related large vessel occlusion (ICAS-LVO) in endovascular treatment-eligible patients.

Study	Definition of ICAS-LVO	Nation of study population	Anterior or posterior circulation	Total number of patients included	ICAS-LVO%
Matias-Guiu et al. (29)	TOAST classification	Spain	Both	88	17.0
Kang et al. (30)	Fixed focal stenosis[a]	Korea	Both	132	30.3
Gascou et al. (19)	Intracranial stenosis	France	Both	144[b]	5.5
Al Kasab et al. (16)	Significant fixed focal stenosis	US	Both	435	8.3
Lee et al. (24)	Significant fixed focal stenosis	Korea	Both	158	15.2
Lee et al. (23)	Significant fixed focal stenosis	Korea	Both	53[c]	17.0
Yi et al. (26)	Significant fixed focal stenosis	China	Both	55	21.8
Yoon et al. (28)	Significant fixed focal stenosis	Korea	Both	172	22.9
Jia et al. (20)	Significant fixed focal stenosis	China	Anterior	140	34.0
Kim et al. (22)	Significant fixed focal stenosis	Korea	Posterior	51[d]	37.3
Baek et al. (31)	Truncal-type occlusion (by DSA)	Korea	Both	259	12.4
Baek et al. (18)	Truncal-type occlusion (by CTA)	Korea	Both	238	18.1

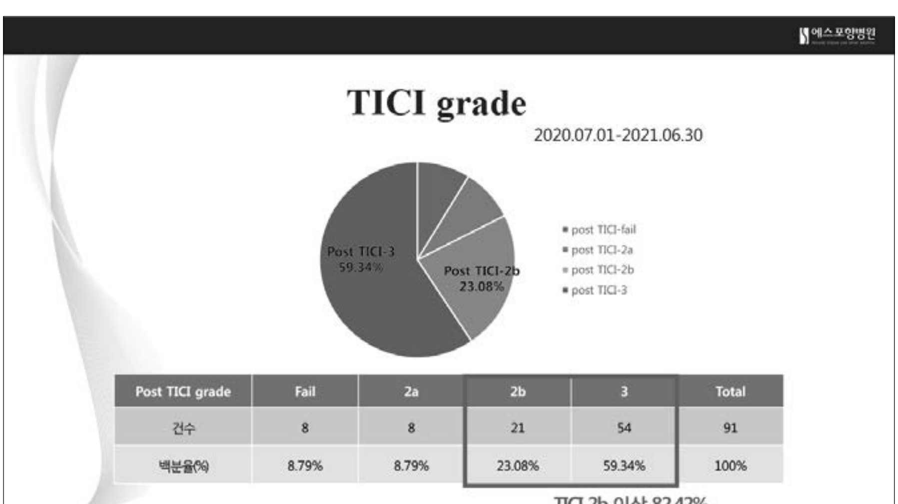
Front. Neurol. 10:298, Baek J-H and Kim BM (2019)



	Ischemic stroke	Hemorrhagic stroke	TIA	합계
백분율	72.14%	20.97%	6.89%	100%
환자수	461	134	44	639



	LAA	SVO	CE	Other determined	Undetermined 2 or more	Undetermined negative	Undetermined incomplete	계
백분율	42.51%	32.32%	15.62%	1.74%	1.74%	4.99%	1.08%	100%
환자수	196	149	72	8	8	23	5	461

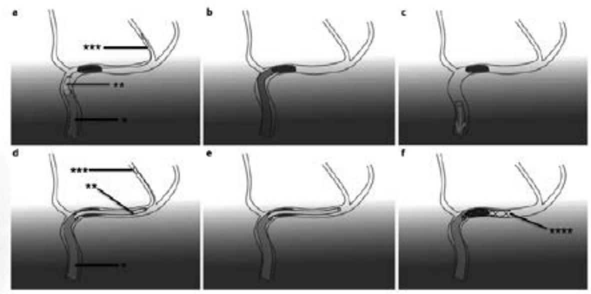


Post TICI grade	Fail	2a	2b	3	Total
건수	8	8	21	54	91
백분율(%)	8.79%	8.79%	23.08%	59.34%	100%

TICI 2b 이상 82.42%

Recent strategy

ADAPT (Sofia) + balloon guiding → Solumbra (solitare + Sofia) + balloon guiding



Our Hospital Data

- 기간 : 2019.1.1~2021.6 (30개월)
- IAT : 214 case

	ICAS-LVO	Medium vessel occlusion	Tandem lesion
건수	48 case	68 case	61 case
백분율(%)	22.4%	31.7%	28.5%

ICAS – LVO

: clinical characteristics compare to embolism related occlusion

- More frequent in Male
- ***** Better collaterals *****
  - lower NIHSS
  - lower infarction severity
  - much higher mismatch ratio
- Current smoking
- Hyperlipidemia
- DM - controversy

ICAS – LVO

: clinical characteristics compare to embolism related occlusion

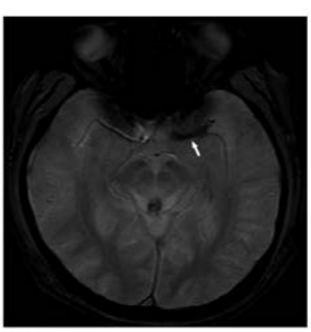
- ICAS - "Response to Injury Theory"
- Most common involve vessel :
  proximal and middle M1 > BA > pc-ICA > VA
  - frequent in post circulation
- Smaller clot burden
- Frequent re-occlusion or flow stagnation
  - platelet aggregation

ICAS – LVO : DDx Clues

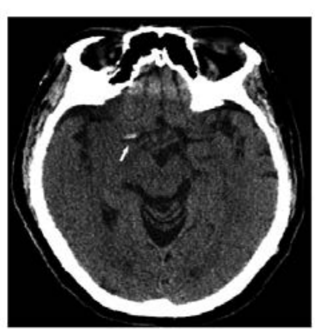
	Surrogate markers	ICAS-related	Embolic
Before starting EVT	Atrial fibrillation, 2017 (13)	+*	+++
	Susceptibility artifact on MR gradient echo image, 2015 (28)	+	+++
	Hyperdense artery sign on NECT, 2017 (29)	+	++
	Truncal-type occlusion on CT angiography, 2017 (13), 2016 (14)	+++	+
During the EVT	Truncal-type occlusion, 2016 (7), 2017 (13), 2016 (14)	++++	+
	Residual stenosis, 2014 (8), 2015 (16), 2018 (23)	++++	+

Front. Neurol. 10:308, Park H, Baek J-H and Kim BM (2019)

Blooming artifact and Hyperdense sign for embolic occlusion



Blooming artifact



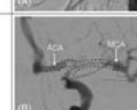
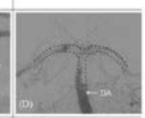
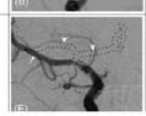
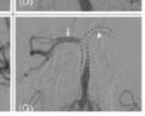
Hyperdense sign

Branching site occlusion(Embolic) vs Truncal type occlusion(ICAS)

	Branching-site occlusion	Truncal-type occlusion
Principle	Involvement of the bifurcation site	Intact bifurcation site and all distal major branches beyond occlusion
DSA	(1) Failure of advancement of ACOM collateral flow to ipsilateral MCA[a] (T-occlusion) (2) Direct visualization of Y- or T-shaped filling defect[b,c,d] (Y- or T-shaped clot) (3) Absence or partial visualization of another branch[d] (branch-missing sign)	(1) Advancement of ACOM collateral flow to ipsilateral MCA[a] (below T-occlusion) (2) Clearly-visible distal major branches and bifurcation site beyond occlusion[b,c,d]
CTA	Vague or invisible major distal branches and bifurcation site beyond occlusion	Clearly-visible distal major branches and bifurcation site beyond occlusion

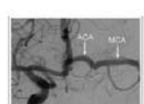
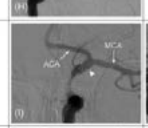
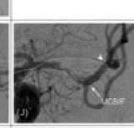
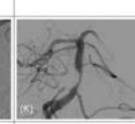
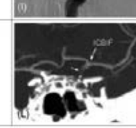
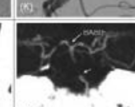
Front. Neurol. 10:298. Baek J-H and Kim BM (2019)

Branching site occlusion(Embolic) vs Truncal type occlusion(ICAS)

Occlusion type	Findings	Internal carotid artery	Middle cerebral artery	Basilar artery
Braching-site occlusion	Failure of advancement of collateral flow through ACOM *on contralateral ICA angiogram*			
	Y- or T-shaped filling defect *on stent retriever deployment, on microcatheter angiogram, or after minimal recanalization*			
	Branch-missing sign *on stent retriever deployment*			

Front. Neurol. 10:298. Baek J-H and Kim BM (2019)

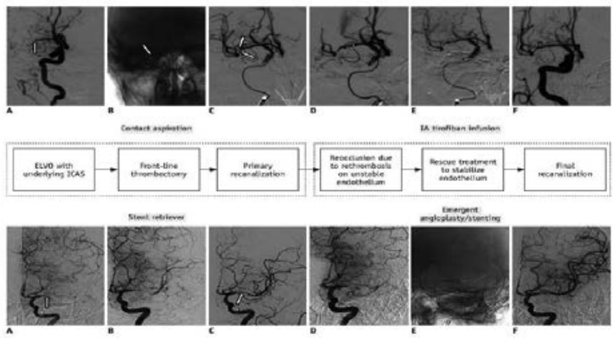
Branching site occlusion(Embolic) vs Truncal type occlusion(ICAS)

Truncal-type occlusion	Advancement of collateral flow through ACOM *on contralateral ICA angiogram*			
	Clearly-visible all major branches and its birufcation site *on stent retriever deployment, on microcatheter angiogram, or after minimal recanalization*			
	Clearly-visible all major branches and its birufcation site *on CTA images*			

Front. Neurol. 10:298. Baek J-H and Kim BM (2019)

Front-Line thrombectomy for ICAS-LVO

SRT(Stent retrieval) vs CA(Contact Aspiration)



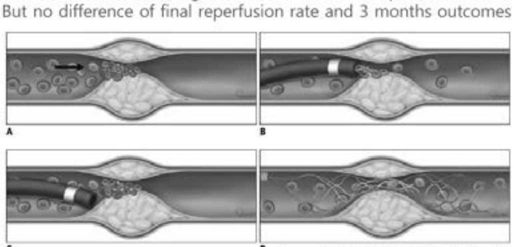
Korean J Radiol 2019;20(5):739-748, Kang DH

Front-Line thrombectomy for ICAS-LVO

SRT(Stent retrieval) vs CA(Contact Aspiration)

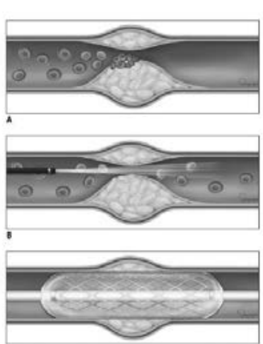
SRT superior to CA :
- Shorter time from puncture to initial reperfusion (17 vs 31 min)
- Shorter procedure duration (39 vs 75.5 min)
- Lower rate of switching to an alternative technique (4.3 vs 40%)

But no difference of final reperfusion rate and 3 months outcomes

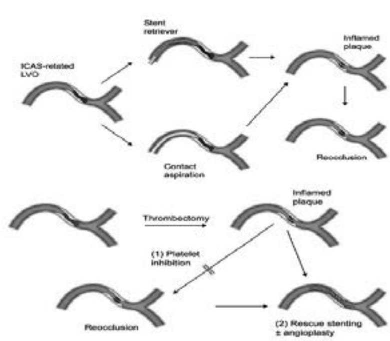


Korean J Radiol 2019;20(5):739-748, Kang DH

Rescue Treatment for ICAS-LVO

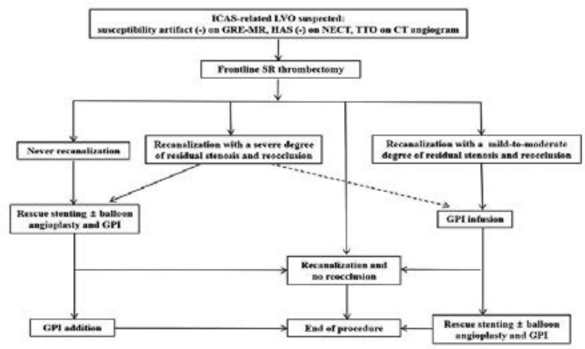


Korean J Radiol 2019;20(5):739-748, Kang DH



Front. Neurol. 10:308, Park H, Baek J-H and Kim BM (2019)

Rescue Treatment for ICAS-LVO



Front. Neurol. 10:308, Park H, Baek J-H and Kim BM (2019)

Rescue Treatment for ICAS-LVO

frontiers in Neurology

ORIGINAL RESEARCH
published: 06 July 2021
doi: 10.3389/fneur.2021.608270

Combination of Rescue Stenting and Antiplatelet Infusion Improved Outcomes for Acute Intracranial Atherosclerosis-Related Large-Vessel Occlusion

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OPEN ACCESS

Rescue Treatment for ICAS-LVO

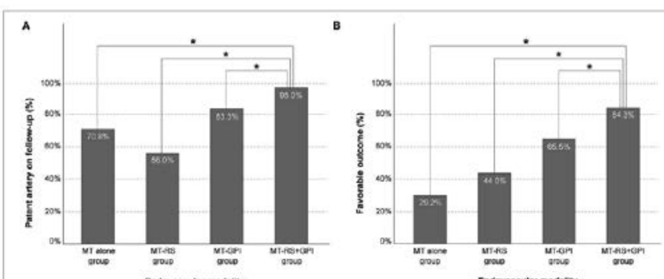
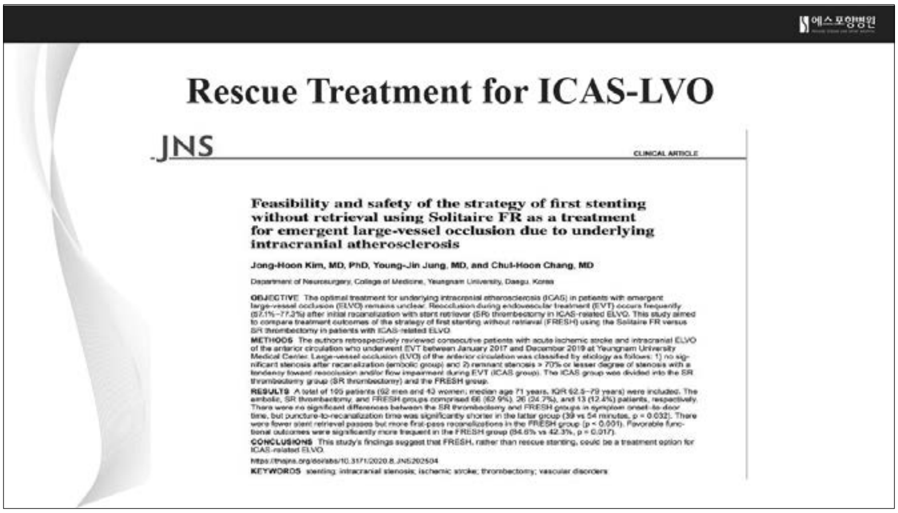


FIGURE 2 | Frequency of **(A)** patent artery on follow-up and **(B)** favorable outcome based on endovascular modality. MT-RS, rescue stenting after mechanical thrombectomy failure; MT-GPI, glycoprotein IIb/IIIa infusion after mechanical thrombectomy failure; MT-RS+GPI, rescue stenting with glycoprotein IIb/IIIa infusion after mechanical thrombectomy failure. *Significantly different between groups.



Rescue Treatment for ICAS-LVO

JNS

CLINICAL ARTICLE

Feasibility and safety of the strategy of first stenting without retrieval using Solitaire FR as a treatment for emergent large-vessel occlusion due to underlying intracranial atherosclerosis

Jong-Hoon Kim, MD, PhD, Young-Jin Jung, MD, and Chul-Hoon Chang, MD

Department of Neurosurgery, College of Medicine, Yeungnam University, Daegu, Korea

OBJECTIVE The optimal treatment for underlying intracranial atherosclerosis (ICAS) in patients with emergent large-vessel occlusion (ELVO) remains unclear. Reocclusion during endovascular treatment (EVT) occurs frequently (57.1%–77.2%) after initial recanalization with stent retriever (SR) thrombectomy in ICAS-related ELVO. This study aimed to compare treatment outcomes of the strategy of first stenting without retrieval (FRESH) using the Solitaire FR versus SR thrombectomy in patients with ICAS-related ELVO.

METHODS The authors retrospectively reviewed consecutive patients with acute ischemic stroke and intracranial ELVO of the anterior circulation who underwent EVT between January 2017 and December 2019 at Yeungnam University Medical Center. Large-vessel occlusion (LVO) of the anterior circulation was classified by etiology as follows: 1) no significant stenosis after recanalization (embolic group) and 2) remnant stenosis > 70% or lesser degree of stenosis with a tendency toward reocclusion and/or flow impairment during EVT (ICAS group). The ICAS group was divided into the SR thrombectomy group (SR thrombectomy) and the FRESH group.

RESULTS A total of 105 patients (62 men and 43 women; median age 71 years, IQR 62.5–79 years) were included. The embolic, SR thrombectomy, and FRESH groups comprised 66 (62.9%), 26 (24.7%), and 13 (12.4%) patients, respectively. There were no significant differences between the SR thrombectomy and FRESH groups in symptom onset–to-door time, but puncture-to-recanalization time was significantly shorter in the latter group (39 vs 54 minutes, p = 0.032). There were fewer stent retrieval passes but more first-pass recanalizations in the FRESH group (p < 0.001). Favorable functional outcomes were significantly more frequent in the FRESH group (84.6% vs 42.3%, p = 0.017).

CONCLUSIONS This study's findings suggest that FRESH, rather than rescue stenting, could be a treatment option for ICAS-related ELVO.

https://thejns.org/doi/abs/10.3171/2020.8.JNS202504

KEYWORDS stenting; intracranial stenosis; ischemic stroke; thrombectomy; vascular disorders

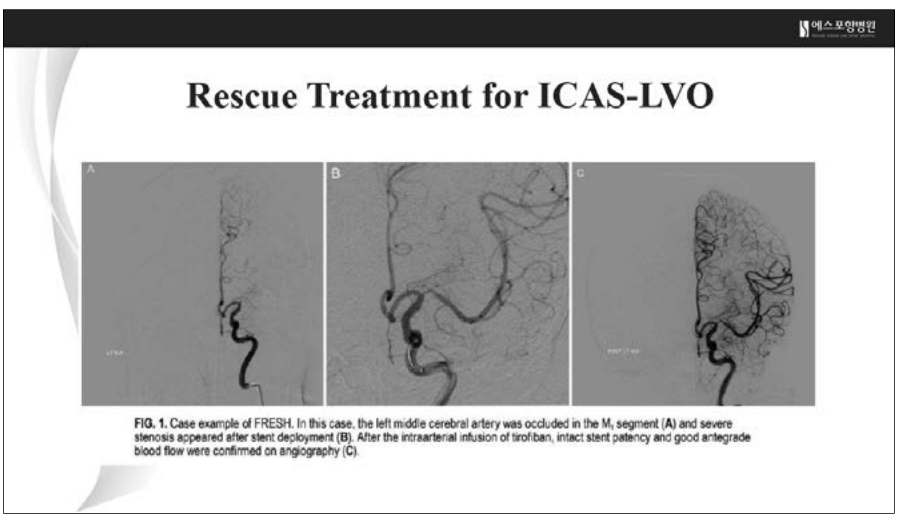


FIG. 1. Case example of FRESH. In this case, the left middle cerebral artery was occluded in the M_1 segment (A) and severe stenosis appeared after stent deployment (B). After the intraarterial infusion of tirofiban, intact stent patency and good antegrade blood flow were confirmed on angiography (C).

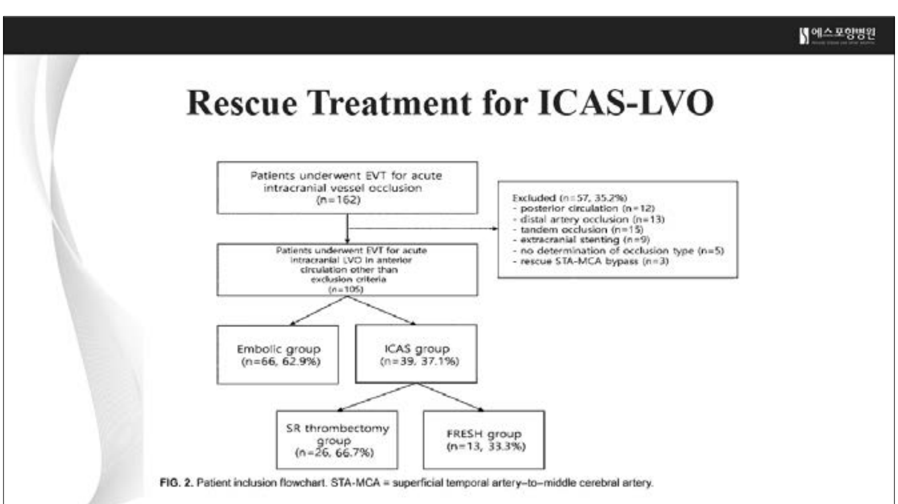


FIG. 2. Patient inclusion flowchart. STA-MCA = superficial temporal artery–to–middle cerebral artery.

Rescue Treatment for ICAS-LVO

TABLE 1. Comparisons of baseline characteristics and outcomes between the embolic and ICAS groups

	Total	Embolic	ICAS	p Value
Clinical outcomes (n, %) (continued)				
Mortality				>0.99
No	95 (90.5)	60 (90.9)	35 (89.7)	
Yes	10 (9.5)	6 (9.1)	4 (10.3)	
mRS score at 3 mos				0.688
0–2	56 (53.3)	34 (51.5)	22 (56.4)	
3–6	49 (46.7)	32 (48.5)	17 (43.6)	

ICA = internal carotid artery; IV = intravenous; MCA = middle cerebral artery.
Median values are presented as the median (IQR).
*p < 0.05; **p < 0.01.

TABLE 2. Comparisons of baseline characteristics and outcomes between the SR thrombectomy and FRESH groups

	Total	SR Thrombectomy	FRESH	p Value
Clinical outcomes (n, %)				
Symptomatic ICH				0.281
No	35 (89.7)	22 (84.6)	13 (100)	
Yes	4 (10.3)	4 (15.4)	0 (0)	
Mortality				0.281
No	35 (89.7)	22 (84.6)	13 (100)	
Yes	4 (10.3)	4 (15.4)	0 (0)	
mRS score at 3 mos				0.017*
0–2	22 (56.4)	11 (42.3)	11 (84.6)	
3–6	17 (43.6)	15 (57.7)	2 (15.4)	

Median values are presented as the median (IQR).
*p < 0.05; **p < 0.01.

Take home massage

- 시술 전 혹은 시술 중 ICAS-LVO clue 확인
- ICAS-LVO 의심되면 Front-Line은 stent retrieval 먼저 선택
- EVT는 최대한 간단하게 – 여러 번 시도하지 말고 다른 방법을 고민
- Rescue treatments 후에는 반드시 20min delay Angio 확인
- Postop manage시 DAPT + high dose statin 사용
- 주기적인 F/U

2. LVO with underlying Intracranial arterial stenosis

Direct stent angioplasty for intracranial atherosclerotic-related large artery occlusion

양구현

울산대 강릉아산병원

최근 여러 연구를 통해 기계적 혈전 절제술(Mechanical thrombectomy, MT)이 전방 순환계의 두개내 대동맥 폐색(Large artery occlusion, LAO)으로 인한 급성 허혈성 뇌졸중(Acute ischemic stroke, AIS) 환자를 위한 가장 효율적이고 안전한 치료법 중 하나임은 보편적으로 받아들여 진 상태이다.

그러나 이전 많은 연구들은 대부분 서양인들을 대상으로 한 연구들 이었다. 서양인들의 뇌졸중 원인은 심장 또는 경동맥 병변에서 기인한 색전증이다 (Embolic LAO). 이에 대해 스텐트 리트리버 또는 접촉식 흡인의 현재 기술은 색전을 제거하고 성공적인 재개통을 달성하는 데 매우 효과적이며 색전을 제거하고는 원인에 따라 항 응고제 또는 항 혈소판제를 적절히 유지함으로써 치료의 완결과 이차적 예방을 할 수 있다. 그러나 우리 나라를 비롯한 동양인의 경우 근본적인 두개내 죽상동맥경화증 관련 폐색 (Intracranial atherosclerotic-related oc-clusion, ICAS-O)이 서양인보다 더 많은 비율을 차지하는 사실에 기반할 때 다음과 같은 특수성을 늘 염두해 두어야 한다. ICAS-O는 embolic LAO에 비해 실질적인 개통율이 낮고 재폐색율이 높은 특성을 보이면서 스텐트 리트리버에 대해 불응성을 보이는 경우가 많다. 심한 잔류 협착은 초기 재관류를 달성한 후 혈소판 응집을 쉽게 일으키고 종종 재개통을 위한 치료를 만들기 쉽다는 점까지 감안하면 특히 스텐트를 이용한 두개내 혈관 성형술에 대해서 좀더 적극적인 고려를 해보는 것도 중요하다.

두개내 스텐트 혈관성형술의 주요 단점에는 1) 복잡한 시술, 2) 긴 시술 시간, 3) 인접 perforating artery 폐쇄, 4) 스텐트 내 혈전 등이 있다. 조기 항혈소판 투여는 영구적 두개내 스텐트 삽입술로 인한 두개내 출혈 합병증과 그에따른 기능 회복의 불리한 결과를 증가시킬 수 있다고 가정할 수 있지만 실제 스텐트 삽입술의 효능 및 안전성 문제에 대한 판단에 근거가 의미 있는 메타 분석을 허용하기에도 현재 문헌에 대한 연구가 너무 적다.

따라서 스텐트를 이용한 두개내 혈관성형술을 MT에 실패한 LAO 환자에게 제한적으로 실행하는 rescue treatment에 의미를 좀더 두고 볼지 아니면 개통 후 잔류 협착에 대해서도 적극적으로 넓게 적용을 할지 판단을 위해서 더 엄격한 전향적 연구가 필요하다.

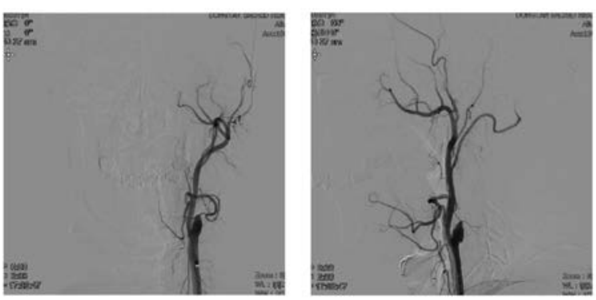
3. Acute tandem EC and IC occlusions

Acute Tandem EC – IC occlusions

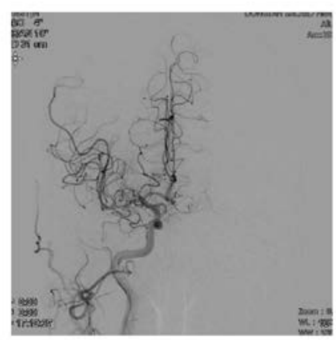
박정현

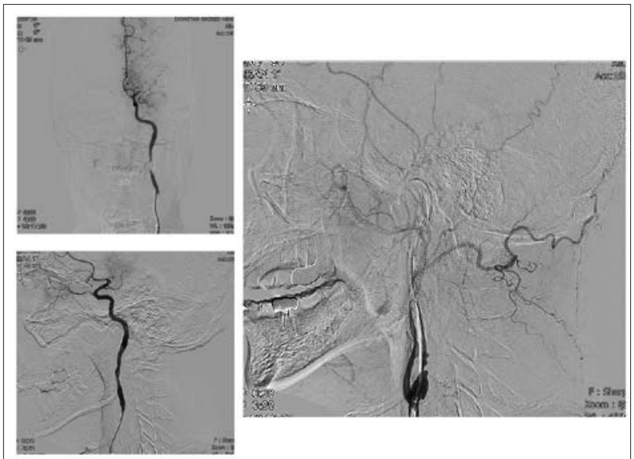
한림대 동탄성심병원

Case 1. Male / 58 Y.O.

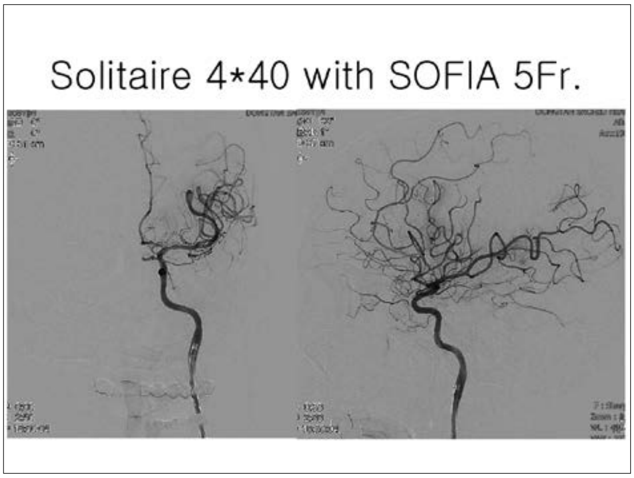


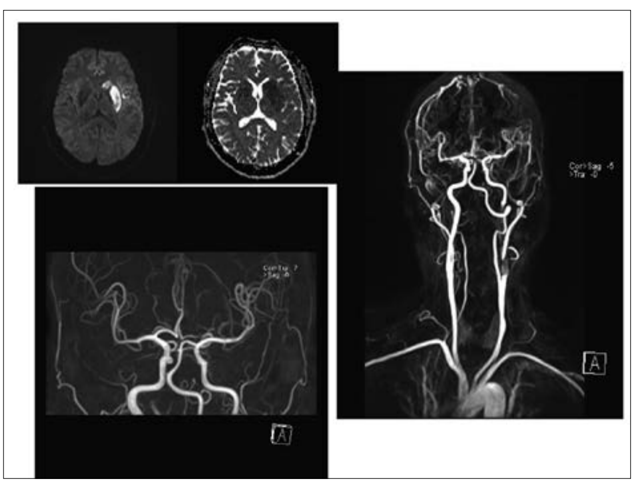
Rt. ICA Angiogram





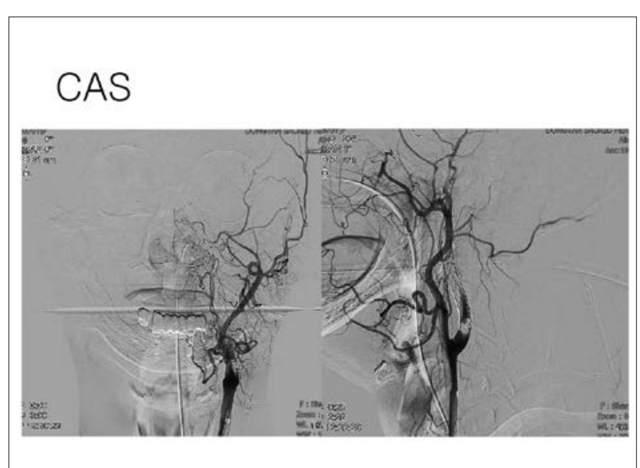
After CAS

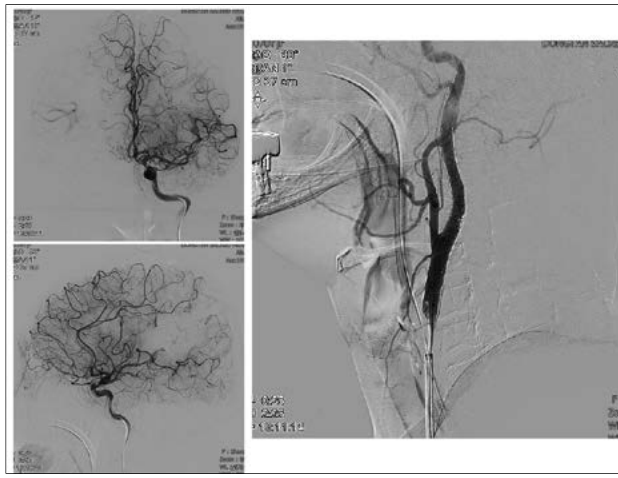

Solitaire 4*40 with SOFIA 5Fr.

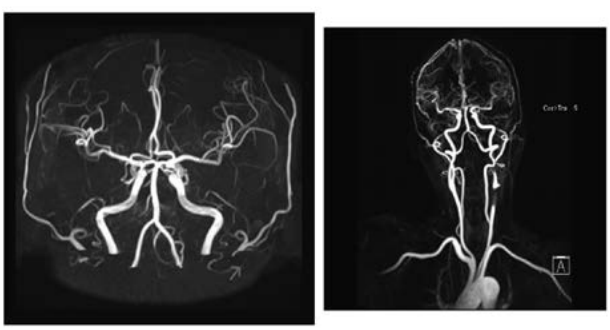



Case 2 70 / Female


Case 2. Female / 70 Y.O.


CAS

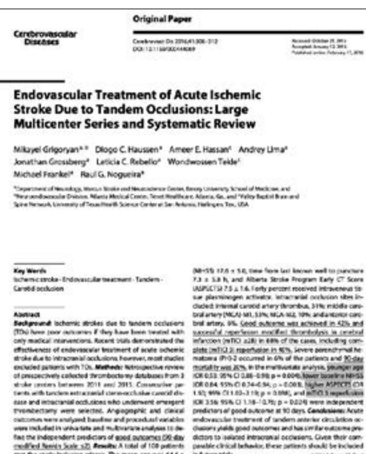





NEUROSURGICAL FOCUS

Management of acute ischemic stroke due to tandem occlusion: should endovascular recanalization of the extracranial or intracranial occlusive lesion be done first?

Leonardo Rangel-Castilla, MD, Gary B. Rajah, MD, Hakeem J. Shakir, MD, Hussain Shallwani, MD, Sirin Gandhi, MD, Jason M. Davies, MD, PhD, Kenneth V. Snyder, MD, PhD, Elad I. Levy, MD, MBA, and Adnan H. Siddiqui, MD, PhD


Original Paper

Cerebrovascular Diseases

Endovascular Treatment of Acute Ischemic Stroke Due to Tandem Occlusions: Large Multicenter Series and Systematic Review

Mikayel Grigoryan, Diogo C. Haussen, Ameer E. Hassan, Andrey Lima, Jonathan Grossberg, Leticia C. Rebello, Wondwossen Tekle, Michael Frankel, Raul G. Nogueira

Key Words

Ischemic stroke · Endovascular treatment · Tandem · Carotid occlusion


Impact of Emergent Cervical Carotid Stenting in Tandem Occlusion Strokes Treated by Thrombectomy: A Review of the TITAN Collaboration

OPEN ACCESS

3. Acute tandem EC and IC occlusions

Acute Tandem occlusion

조용환

동아대병원

Introduction

- Tandem Lesion: 10% ~ 20% of all LVO stroke, poor response to IV-tPA (recanalization rate 9%)
  > MT (recanalization rate 78~88%)
- Cervical ICA steno-occlusion lesion: Technical challenge

  : Two treatment strategies
  - c-ICA stenting + antithrombotic therapy vs intracranial mechanical thrombectomy alone (± angioplasty)
  - Intracranial first vs Extracranial first

  : Tx is driven by individual, institutional practice

Stent vs No stent

- Acute c-ICH stenting appears feasible…
  - higher rate of ICH
  - risk of in-stent thrombosis
  - iatrogenic artery to artery embolization
  - hemodynamic instability
- No stent approach
  - high risk of recurrence and infarct progression

Results—Responses from 162 stroke experts were analyzed; most were stroke physicians (n=65, 40.1%) and neurointerventionalists (n=74, 45.7%), from Canada (n=95, 58.6%), the United States (n=42, 25.9%), and other countries (n=25, 15.4%). Over half (n=96, 59.3%) of respondents consider acute stenting of the cervical internal carotid artery as a treatment option, whereas 40.7% (n=66) would never use it. Most respondents (n=113, 69.8%) agree that there exists uncertainty about the optimal acute management of patients with tandem occlusion. A majority (n=88, 54.3%) of physicians surveyed would include patients in a randomized trial addressing this question.

Stroke. 2019 May;50(5):1254-1256. doi: 10.1161/STROKEAHA.118.023758.

In DAUH

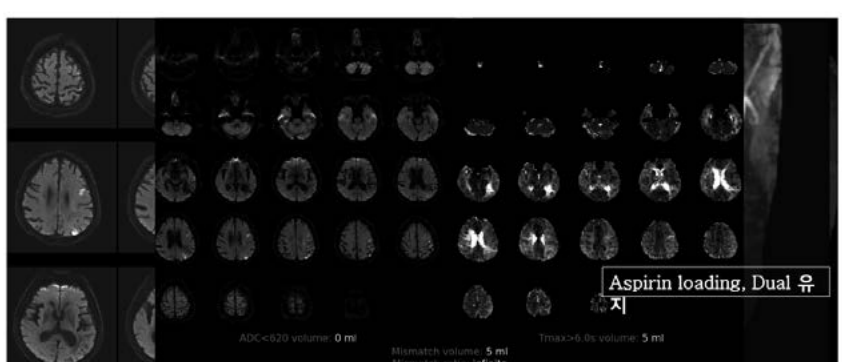
- $\boxed{\text{Stenting}}$ vs No stent

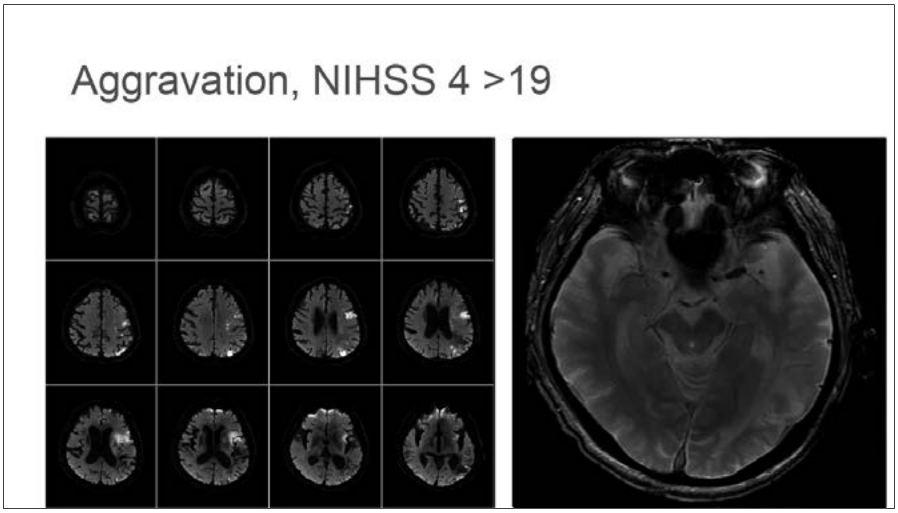
- Intracranial first (Retrograde) approach vs Extracranial first (Anterograde)approach
  > Depends on an operator, or a situation

Case 1: Intracranial first approach

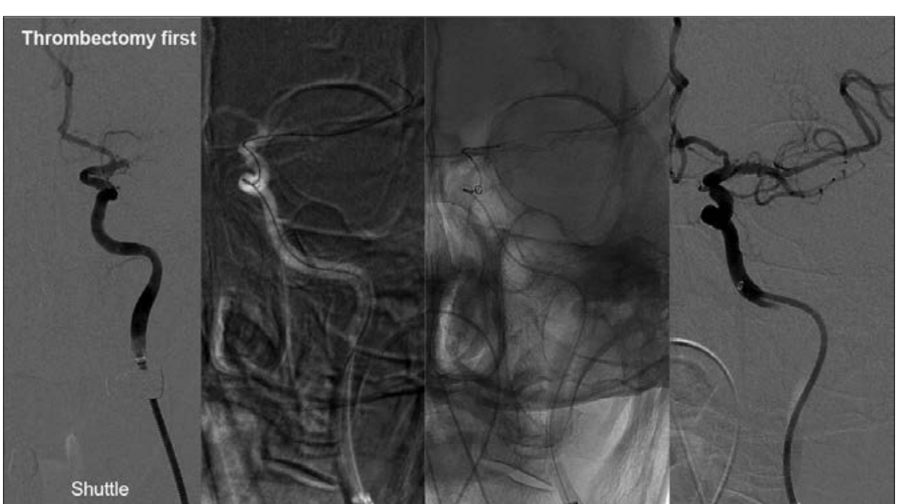
- M/71
- C.C: Rt. side weakness
- 내원 5일전 부터 우측손에 힘이 빠짐. 내원 전날 증상 악화
- Past Hx (+) oCVA, HTN, DM
- Initial BP 120/80, Af(-)
- Rt side motor Gr II, NIHSS 4

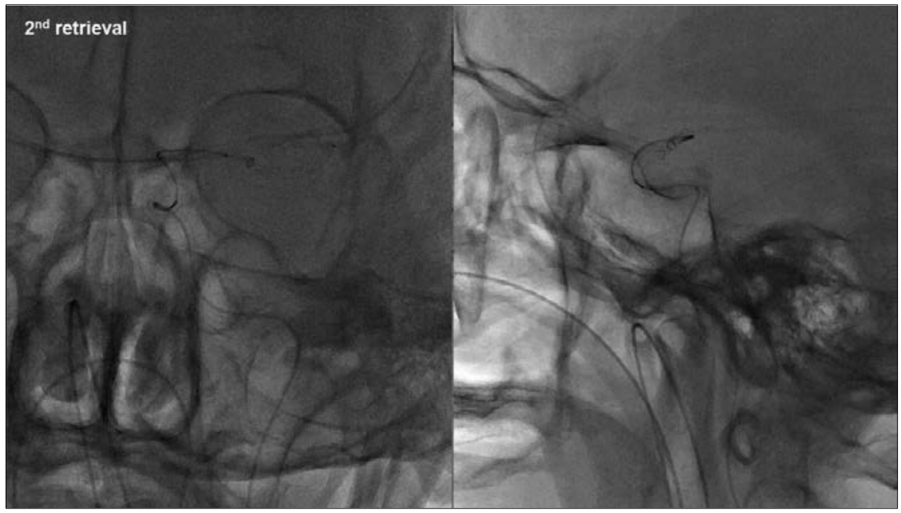
Initial DWI, MRA, Perfusion image

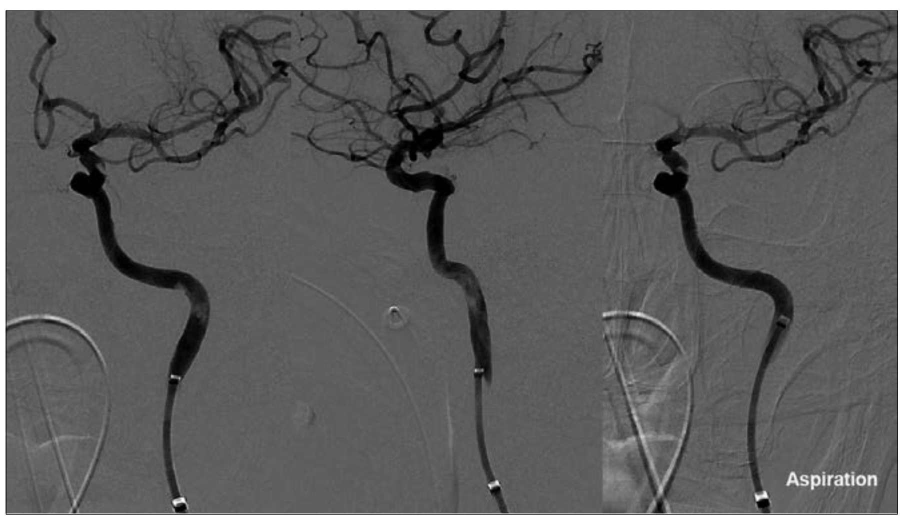



Aggravation, NIHSS 4 >19

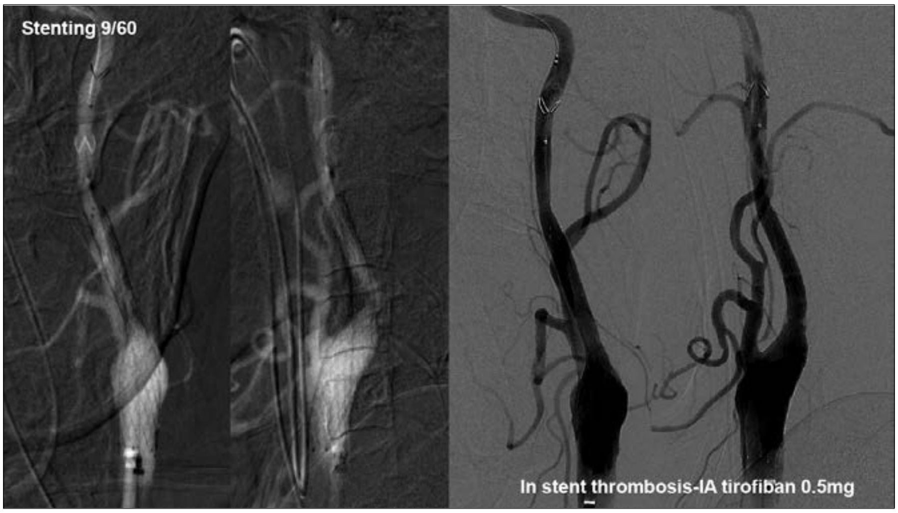

Severe ICA stenosis and M1 occlusion

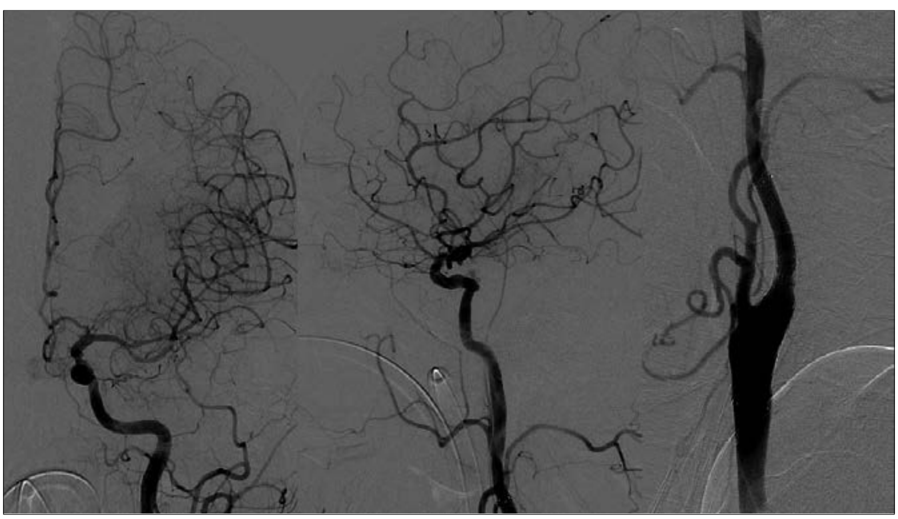

Thrombectomy first
Shuttle

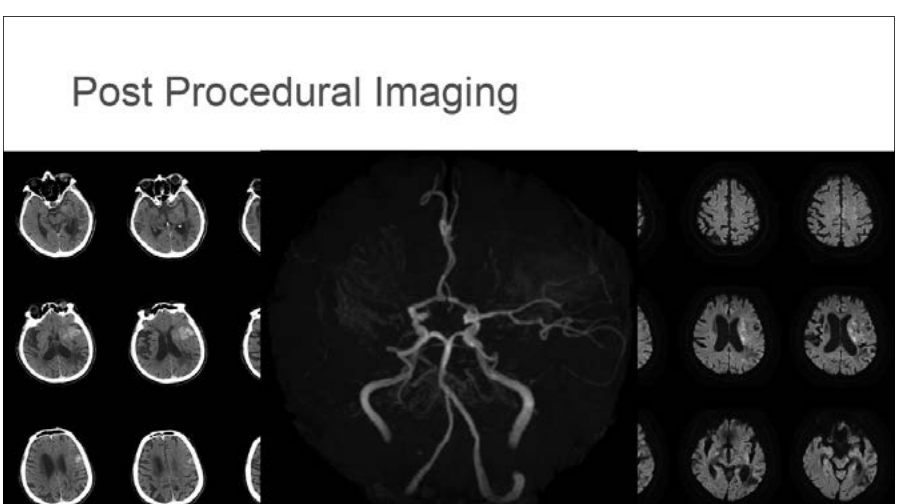

2nd retrieval


Aspiration


Balloon Angioplasty


Stenting 9/60
In stent thrombosis-IA tirofiban 0.5mg




Post Procedural Imaging

Result

- Procedural time: 68 mins
- 6 Fr Shuttle-5Fr Sofia-Trevo stent
- Protégé 9/60, Submarine Balloon 5/30, Emboshield
- mTICI 3
- Hemorrhagic transformation(+)
- NIHSS 7: 16

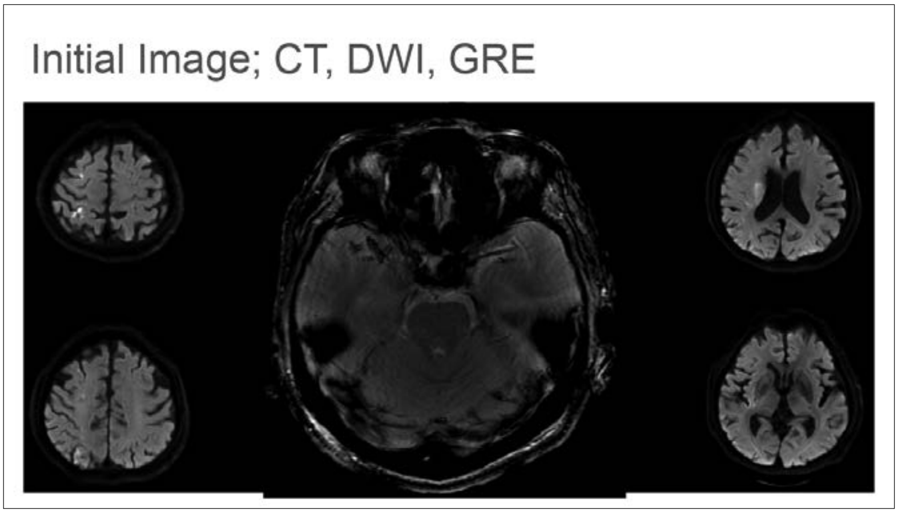
Intracranial first approach

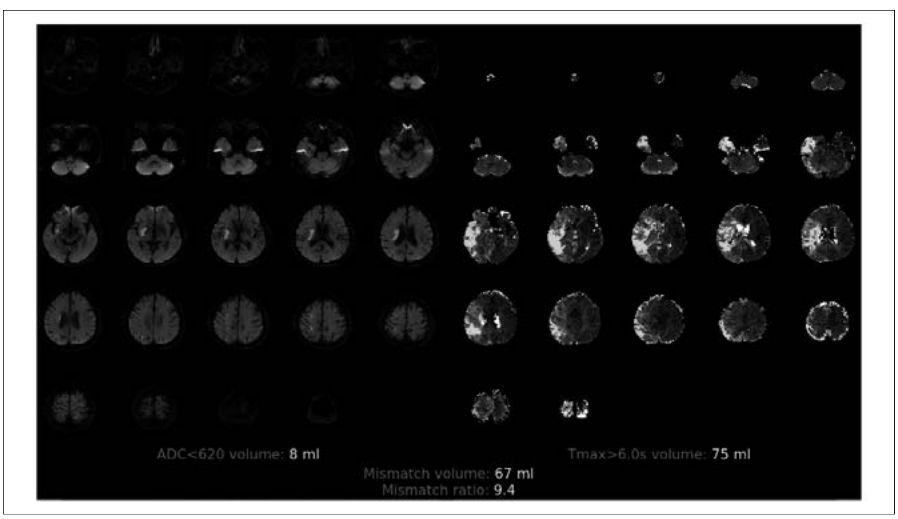
Advantage
- Shorter intracranial recanalization time
- Avoidance of potential snagging of the retrieval stent with carotid stent

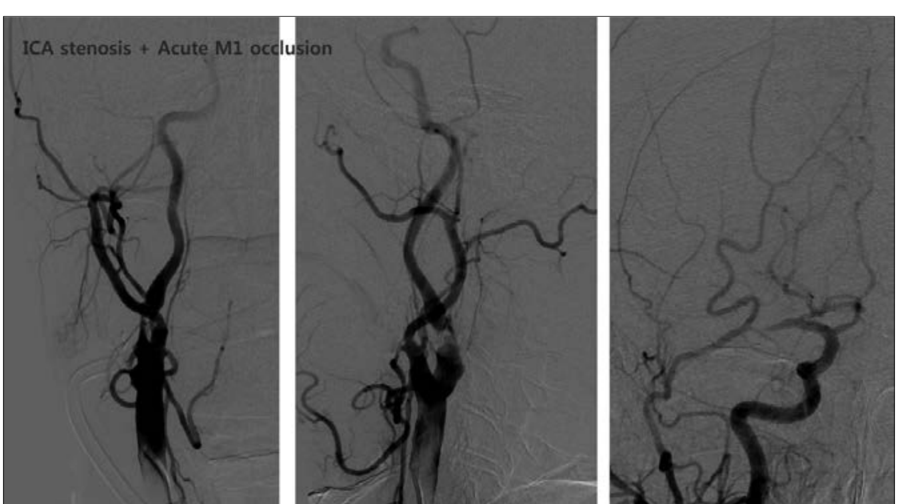
Disadvantage
- Recurrent embolization during stent deployment
- In some cases, specific technical circumstances may mandate an anterograde approach to gain access to the intracranial circulation

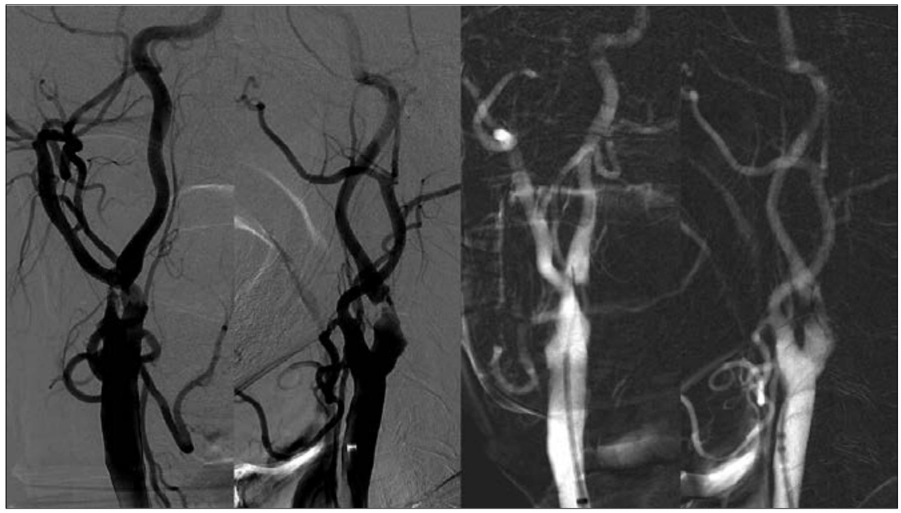
Case 2: Extracranial first approach

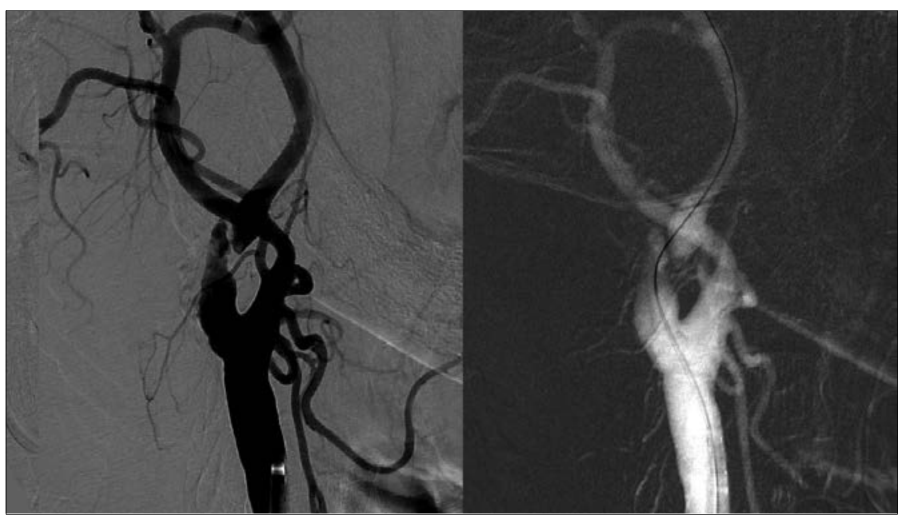
- M/77
- C.C: Lt. side weakness, Dysarthria, Mental change
- 택시 운전사, 14:59 차량이 가드레일 들이박은 채로 발견
- Past Hx: HTN, DL
- LNT: 07:40/ FFT: 14:59/ Arrival Time: 15:48
- Initial BP 160/90, Af(-)
- Lt side motor Gr II, NIHSS 16
- tPA(-)


Initial Image; CT, DWI, GRE


ADC<620 volume: 8 ml
Tmax>6.0s volume: 75 ml
Mismatch volume: 67 ml
Mismatch ratio: 9.4


ICA stenosis + Acute M1 occlusion

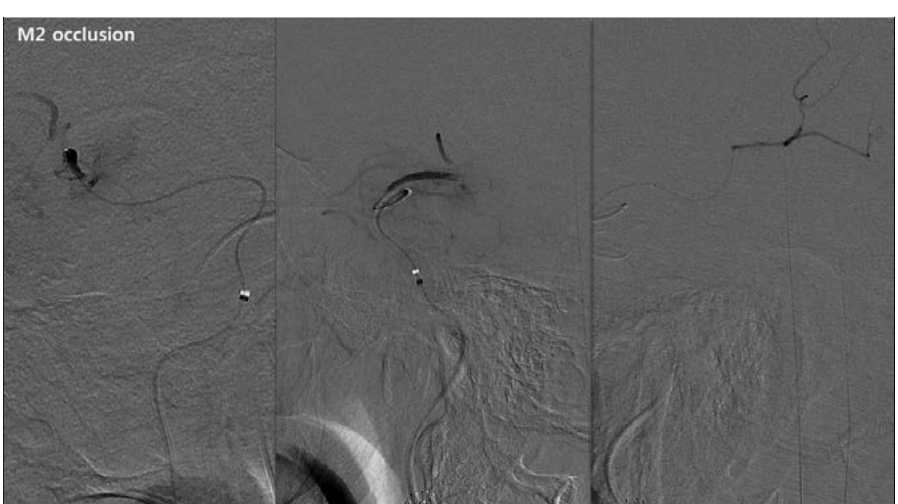


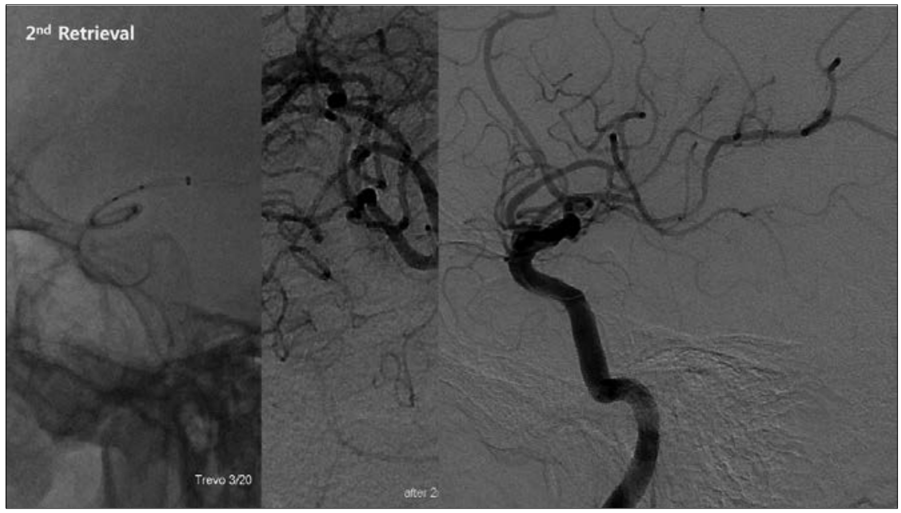


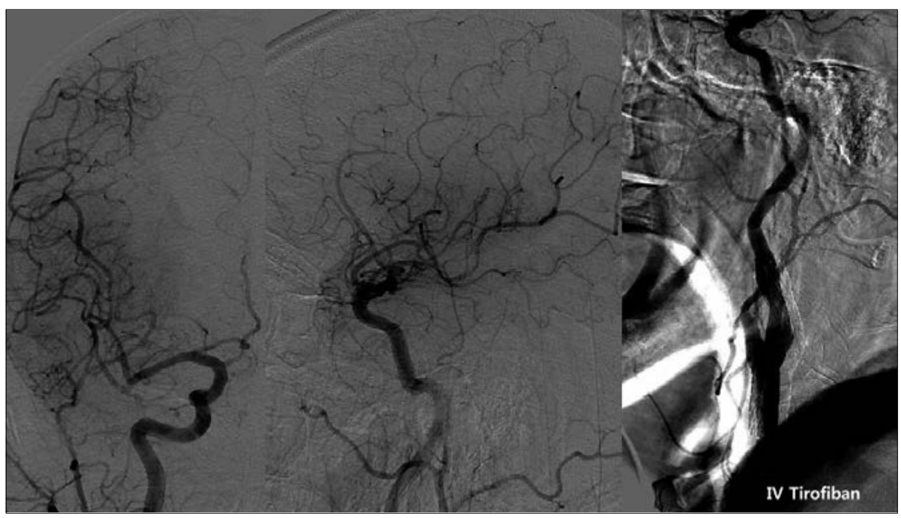

Balloon Angioplasty,
EPD(-)

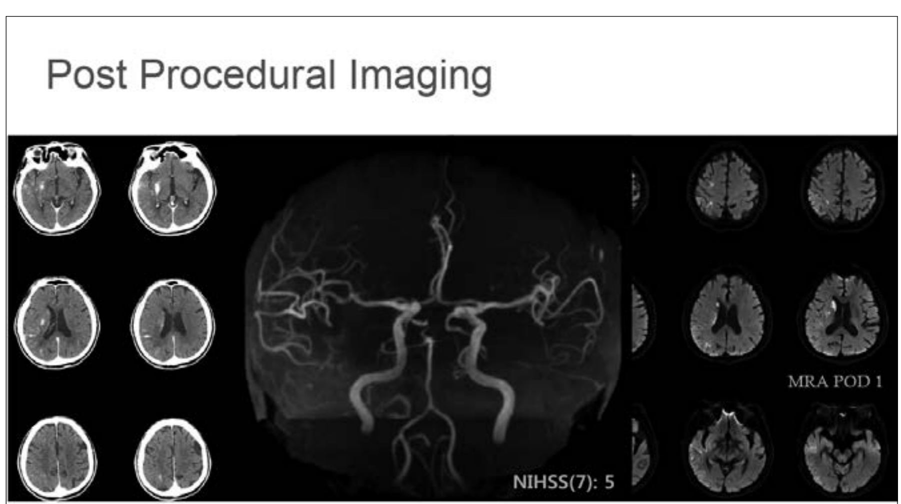

Stent first 9/60


Thrombectomy
Solitaire 4/40
after stent retrieval


M2 occlusion


2nd Retrieval
Trevo 3/20


IV Tirofiban


Post Procedural Imaging
NIHSS(7): 5
MRA POD 1

Result

- Door to Puncture time: 127 mins
- Procedural time: 155 mins
- 6 Fr Shuttle–5Fr Sofia
- Submarine balloon 4/30, Protégé 9/60, Solitaire 4/40, Trevo 3/20
- migration to disatal ACA > No infarction
- mTICI 2b

Extracranial first approach

Advantage
- Jailing the friable plaque > preventing shower of emboli
- Restoration of antegrade blood flow
  > assist in thrombolysis
  > Stabilization of the ICA stenosis
  > up to 26% of pts; partial or complete resolution of distal occlusion
- Create angiographically visible access

Disadvantage
- Restoration of antegrade blood flow > migration
- Potential hemodynamic instability d/t baroreceptor activation

AHA/ASA Guideline

7. Treatment of tandem occlusions (both extracranial and intracranial occlusions) when performing mechanical thrombectomy may be reasonable.	IIb	B-R
Tandem occlusions were included in recent endovascular trials that showed benefit of mechanical thrombectomy over medical management alone. In the HERMES meta-analysis, 122 of 1254 tandem occlusions (RR, 1.81 [95% CI, 0.96–3.4]) and 1132 of 1254 nontandem occlusions (RR, 1.71 [95% CI, 1.40–2.09]) were reported compared with medical management.[189] In THRACE, 24 of 196 tandem occlusions (RR, 1.82 [95% CI, 0.55–6.07]) and 172 of 196 nontandem ... achieved an mRS score of 0 to 2, 13.8% had parenchymal hematoma, and 13.2% were dead.[202] Multiple retrospective reports detail the technical success of mechanical thrombectomy for tandem occlusions but do not provide specifics on comparative approaches. No conclusions about the optimum treatment approach for patients with tandem occlusions are therefore possible.		

- Absence of robust randomized trial data
- No firm recommendation about optimal management
- Treatment decision are often complex, and strategies vary according to clinical, anatomic, and technical considerations in addition to physician preference.

- Two treatment strategies have been used in clinical trial at the discretion of the operators
- Acute c-ICA stenting + antithrombotic therapy vs Intracranial thrombectomy alone

  > intracranial hemorrhage vs Ischemic stroke progression or recurrence

Postulated advantages of each treatment approach for patients with tandem lesions (acute stent placement versus no acute stent placement)

Potential Advantages of Acute Stent Placement	Potential Advantages of No Acute Stent Placement
Treatment of the causative embolic lesion and lower risk of stroke recurrence Improvement of cerebral perfusion with potential attenuation of infarct progression Contribution to spontaneous intracranial clot lysis	Lower risk of intracranial hemorrhage (avoidance of hyperperfusion, acute antiplatelet agents) Lower risk of iatrogenic artery-to-artery embolization during stent deployment No risk of in-stent thrombosis Avoids delays in intracranial recanalization (if stent placement before thrombectomy) Lower risk of procedural bradycardia and hypotension from carotid baroreceptor activation with stent deployment

Tandem Carotid Lesions in Acute Ischemic Stroke: Mechanisms, Therapeutic Challenges, and Future Directions. A Y Poppe at al. AJNR Am J Neuroradiol . 2020 Jul;41(7):1142-1148.

Wilson MP, *et al. J NeuroIntervent Surg* 2018;**10**:721–728.

REVIEW

Management of tandem occlusions in acute ischemic stroke – intracranial versus extracranial first and extracranial stenting versus angioplasty alone: a systematic review and meta-analysis

Mitchell P Wilson,[1] Mohammad H Murad,[2] Timo Krings,[3] Vitor M Pereira,[3] Cian O'Kelly,[4] Jeremy Rempel,[1] Christopher A Hilditch,[3] Waleed Brinjikji[3,5]

Table 2 Meta-analysis outcome data for overall tandem occlusions treated with mechanical thrombectomy, intracranial first versus extracranial first approaches, and stenting versus angioplasty-only approaches

Outcome	Overall rate (95 CI, I²)	Intracranial first (95 CI, I²)	Extracranial first (95 CI, I²)	P	Stenting (95 CI, I²)	Angioplasty (95 CI, I²)	P
90-day mRS ≤ 0-2	47% (42–51% 48%)	49% (39–60% 31%)	53% (44–61% 11%)	0.58	49% (42–56% 54%)	49% (33–65% 50%)	0.39
90-day mortality	15% (11–19% 48%)	15% (3–32% 41%)	8% (3–15% 22%)	0.28	10% (6–15% 36%)	13% (0–25% 43%)	0.27
TICI 2b/3	78% (73–82% 57%)	79% (60–93% 77%)	79% (69–88% 52%)	0.96	79% (72–86% 59%)	63% (49–96% 34%)	0.38
sICH	8% (6–11% 36%)	7% (2–15% 0%)	8% (3–15% 21%)	0.95	7% (5–30% 24%)	10% (1–19% 0%)	0.38
Procedure Related Complication	9% (4–16% 68%)	8% (1–20% 53%)	20% (9–21% 0%)	0.25	13% (5–22% 71%)	10% (1–18%0%)	0.87
Technical Success Rate of Carotid Revascularization	97% (90–100%71%)	89% (78–98% 0%)	97% (86–100% 71%)	0.31	96% (84–100% 79%)	97% (88–100% 0%)	0.89
TICI 3	36% (26–48% 71%)	26% (6–52% 72%)	18% (2–40% 75%)	0.55	27% (17–39% 41%)	NA	NA
Any ICH	23% (15–32% 82%)	NA	24% (2–54% 82%)	NA	19% (8–33% 84%)	20% (0–40% 60%)	0.39
Procedure Time in minutes	79 (70–88% 93%)	78 (54–101% 90%)	75 (53–97% 95%)	0.67	74% (62–87% 95%)	73 (64–82% 80%)	0.98

Emergent Management of Tandem Lesions in Acute Ischemic Stroke

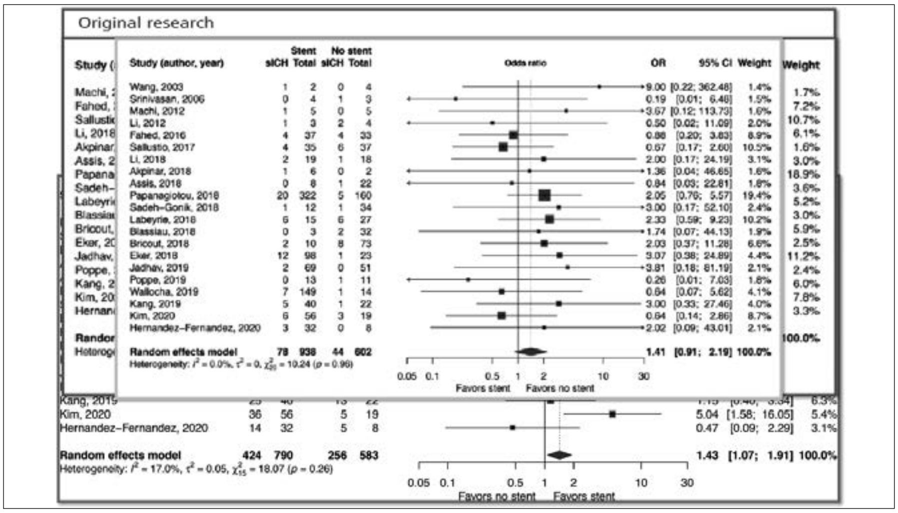
Analysis of the STRATIS Registry

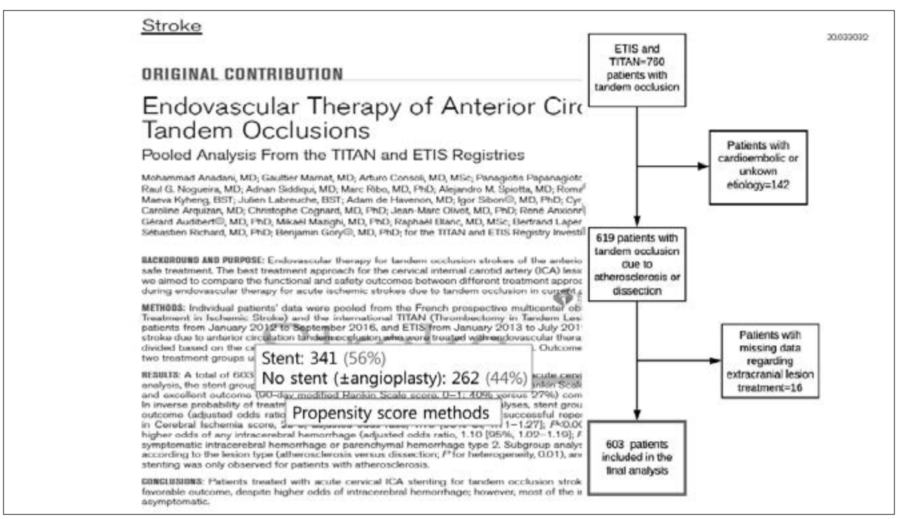
Table 2. Clinical and Radiographic Outcomes in Patients Not Acutely Stented Versus Acutely Stented

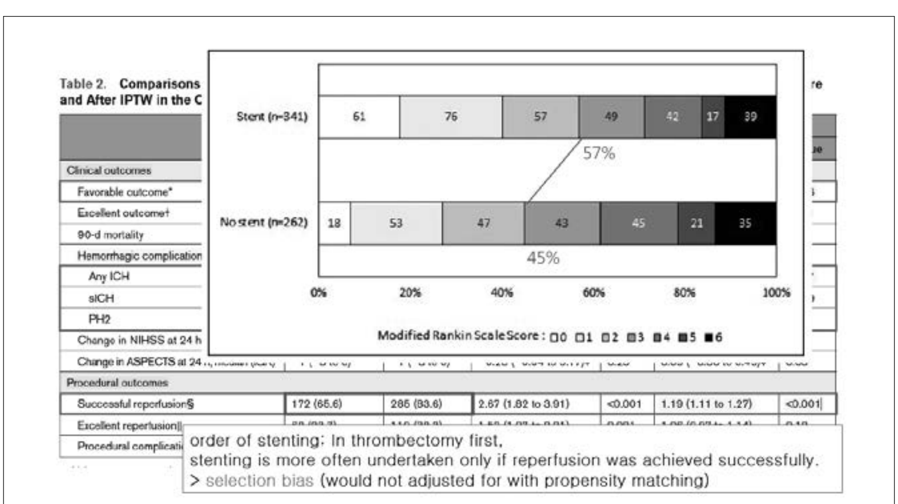
Characteristic	No Stent, Mean±SD (N), Median (Min, Max), or % (n/N)	Angioplasty Only,* Mean±SD (N), Median (Min, Max), or % (n/N)	Stent, Mean±SD (N), Median (Min, Max), or % (n/N)	P Value, Stent vs No Stent
Substantial reperfusion (imaging core lab)	83.7% (41/49)	81.1% (30/37)	87.0% (60/69)	0.791
PH-2	3.9% (2/51)	2.6% (1/38)	2.8% (2/72)	1.000
Symptomatic ICH	0.0% (0/51)	0.0% (0/38)	2.9% (2/69)	0.507
Mortality	10.9% (7/64)	14.6% (6/41)	12.3% (9/73)	1.000
Good outcome (mRS 0–2) at 90 d	42.2% (27/64)	36.6% (15/41)	68.5% (50/73)	0.003

Table 3. Predictors of Good Outcomes (mRS 0–2 at 90 Days) in Patients With Tandem Lesions (Multivariable Analysis)

Predictor	Odds Ratio	LCL	UCL	P Value
Age, y	0.98	0.94	1.01	0.135
NIHSS at baseline	0.90	0.83	0.97	0.010
Atrial flutter/fibrillation	0.92	0.27	3.08	0.888
Carotid artery disease	1.05	0.25	4.40	0.950
M1 occlusion (vs ICA)	0.92	0.37	2.25	0.848
M2/other occlusion (vs ICA)	0.71	0.17	3.01	0.642
tPA administered (vs no)	1.47	0.55	3.95	0.441
ASPECTS at baseline	1.40	1.03	1.89	0.031
Prestroke mRS	1.05	0.40	2.72	0.923
High-volume site	1.41	0.64	3.10	0.390
Onset to arterial puncture (per 60 min)	0.82	0.62	1.08	0.158
Stent (vs no)	2.41	1.09	5.32	0.029


Original research
Random effects model
Favors stent
Favors no stent
Favors no stent
Favors stent


Stroke
ORIGINAL CONTRIBUTION
Endovascular Therapy of Anterior Circ
Tandem Occlusions
Pooled Analysis From the TITAN and ETIS Registries
ETIS and TITAN=760 patients with tandem occlusion
Patients with cardioembolic or unkown etiology=142
619 patients with tandem occlusion due to atherosclerosis or dissection
Patients with missing data regarding extracranial lesion treatment=16
603 patients included in the final analysis
Stent: 341 (56%)
No stent (±angioplasty): 262 (44%)
Propensity score methods


Stent (n=341)
No stent (n=262)
57%
45%
Modified Rankin Scale Score: 0 1 2 3 4 5 6
order of stenting: In thrombectomy first,
stenting is more often undertaken only if reperfusion was achieved successfully.
> selection bias (would not adjusted for with propensity matching)

	No stent (n=262)	Stent (n=341)	IPTW adjusted* OR (95%CI)	p.value	p.het
Overall	118/262 (45.0)	194/341 (57.0)	1.09 (1.01 to 1.19)	0.036	
Subgroups					
IVT					
No	37/96 (38.5)	63/127 (49.6)	1.40 (0.95 to 2.07)	0.091	0.88
Yes	81/166 (48.8)	131/214 (61.2)	1.46 (1.05 to 2.03)	0.027	
Etiology					
Atherosclerosis	68/175 (38.9)	151/264 (57.2)	1.74 (1.30 to 2.35)	<0.001	0.013
Dissection	50/87 (57.5)	43/77 (55.8)	0.88 (0.55 to 1.40)	0.59	
Procedural antiplatelet					
No	106/223 (44.8)	15/34 (44.1)	0.96 (0.42 to 2.20)	0.92	0.87
Yes	18/39 (46.2)	179/307 (58.3)	1.05 (0.59 to 1.85)	0.87	
Age					
<75	104/211 (49.2)	164/267 (61.4)	1.44 (1.09 to 1.91)	0.010	0.94
≥75	14/51 (27.4)	30/74 (41.1)	1.48 (0.84 to 2.62)	0.18	
NIHSS score					
<10	20/32 (61.1)	57/65 (87.9)	3.93 (1.49 to 10.34)	0.006	0.018
≥10	98/230 (42.8)	137/276 (49.5)	1.21 (0.94 to 1.57)	0.14	
ASPECTS score					
<8	65/164 (39.7)	70/153 (46.1)	1.26 (0.90 to 1.77)	0.18	0.21
8-10	53/98 (54.0)	124/188 (65.8)	1.72 (1.18 to 2.51)	0.005	
Onset to puncture time					
<180	42/82 (51.1)	105/168 (62.6)	1.53 (1.04 to 2.26)	0.031	0.45
>180	76/180 (42.2)	89/173 (51.5)	1.27 (0.91 to 1.75)	0.16	
Study					
ETIS	62/133 (46.6)	43/78 (55.1)	1.22 (0.78 to 1.89)	0.38	0.31
TITAN	56/129 (43.4)	151/263 (57.4)	1.59 (1.19 to 2.14)	0.002	

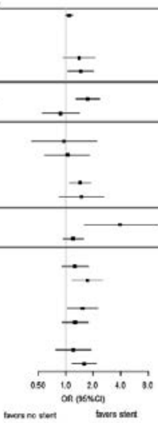


Figure 3. **Comparisons in favorable outcome (90-d modified Rankin Scale score, 0–2) rate according to the use of cervical internal carotid artery stent and key subgroups before and after inverse probability treatment weighting (IPTW).**

Lack of benefit of stenting

- 1. Dissection

: more favorable natural history

- 2. NIHSS ≥10

: disabled outcome > Recurrence may not alter their level of 90-day mRS

- 3. Large infarction core volume

: high risk of symptomatic ICH

Factors may favor acute stent placement

	Favours no stenting ⟵	⟶ Favours stenting
ICA lesion etiology	Dissection	Atherosclerosis
Infarct core volume	Large infarct/low ASPECTS	Small infarct/high ASPECTS
Quality of final intracranial recanalization	None or poor (mTICI 0-1)	Complete or near-complete (mTICI 2b-3)
Collateral circulation via circle of Willis	Good collaterals/complete circle of Willis	Poor collaterals/incomplete circle of Willis
Dynamic ICA re-occlusion on angiography	No active re-occlusion	Active re-occlusion
Use of IV thrombolysis	Yes	No
Systemic bleeding risk	Higher risk	Lower risk
Indication for long-term anticoagulation	Present	Absent

Tandem Carotid Lesions in Acute Ischemic Stroke: Mechanisms, Therapeutic Challenges, and Future Directions

Wilson MP, *et al. J NeuroIntervent Surg* 2018;**10**:721–728.

REVIEW

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sICH	8% (6–11% 36%)	7% (2–15% 0%)	8% (3–15% 21%)	0.95	7% (5–30% 24%)	10% (1–19% 0%)	0.38
Procedure Related Complication	9% (4–16% 66%)	8% (1–20% 53%)	20% (9–21% 0%)	0.25	13% (5–22% 71%)	10% (1–18%0%)	0.87
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TICI 3	36% (26–48% 71%)	26% (6–52% 72%)	18% (2–40% 75%)	0.55	27% (17–39% 41%)	NA	NA
Any ICH	23% (15–32% 82%)	NA	24% (2–54% 82%)	NA	19% (8–33% 84%)	20% (0–40% 60%)	0.39
Procedure Time in minutes	79 (70–88% 93%)	78 (54–101% 90%)	75 (53–97% 95%)	0.67	74% (62–87% 95%)	73 (64–82% 80%)	0.98

Order of stenting

Original research

Acute carotid stenting in patients undergoing thrombectomy: a systematic review and meta-analysis

Gabrielle Dufort,[1,2] Bing Yu Chen,[3] Grégory Jacquin,[1,2,4] Mark Keezer,[1,2,4] Marilyn Labrie,[1] Bastien Rioux,[1,2] Christian Stapf,[1,2,4] Daniela Ziegler,[5] Alexandre Y Poppe[1,2,4]

- order of stenting relative to thrombectomy among stented patients (≥50% of stented patients in study stented before thrombectomy vs >50% of patients stented after thrombectomy)
- the order of stenting relative to thrombectomy was not associated with functional outcome in the study.

Dufort G, *et al. J NeuroIntervent Surg* 2021;**13**:141–145. doi:10.1136/neurintsurg-2020-015817

CLINICAL AND POPULATION SCIENCES

Tandem Lesions in Anterior Circulation Stroke

Analysis of the German Stroke Registry–Endovascular Treatment

Katharina Feil, MD*; Moriz Herzberg, MD*; Franziska Dorn, MD; Steffen Tiedt, MD, PhD; Clemens Küpper, MD; Dennis C. Thunstedt, MD; Panagiotis Papanagiotou, MD; Lukas Meyer, MD; Andreas Kastrup, MD; Konstantinos Dimitriadis, MD; Thomas Liebig, MD; Marianne Dieterich, MD; Lars Kellert, MD; for the GSR Investigators†

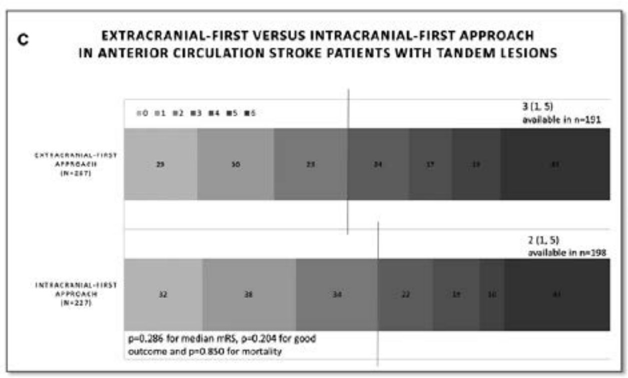
BACKGROUND AND PURPOSE: Tandem lesions in the anterior circulation account for up to 30% of all large vessel occlusion strokes. The optimal periprocedural approach in these lesions is still a matter of debate.

METHODS: Data from the German Stroke Registry–Endovascular Treatment between June 2015 and December 2019 were analyzed. The German Stroke Registry–Endovascular Treatment is an academic, independent, prospective, multicenter, observational registry study with 25 participating stroke centers from all over Germany enrolling consecutive mechanical thrombectomy patients. Tandem lesions were defined as a combination of a relevant extracranial internal carotid artery (ICA) pathology (ipsilateral stenosis >70% or occlusion) and concomitant intracranial large vessel occlusion. Successful reperfusion was defined as modified Thrombolysis in Cerebral Infarction score of 2b-3. The modified Rankin Scale score of 0 to 2 at 3 months indicated good outcome. The aim of this study was to investigate the safety and efficacy of different technical strategies in tandem lesions.

RESULTS: Out of 6635 patients, 874 (13.2%) presented with tandem lesions. Of these, 607 (69.5%) underwent acute treatment of the extracranial ICA. Acute treatment of the extracranial ICA lesion led to a higher probability of successful reperfusion (odds ratio, 40.63 [95% CI, 30.03–70.06]) compared with patients who did not undergo acute treatment of the extracranial ICA lesion and was associated with good clinical outcome (39.5% versus 29.3%, $P<0.001$) and a lower rate of mortality (17.1% versus 27.1%, $P<0.001$) at 3 months. Further significant predictors of successful reperfusion were age (odds ratio, 0.98 [95% CI, 0.96–0.99]; $P=0.035$) and intravenous thrombolysis (odds ratio, 10.58 [95% CI, 10.04–20.4]; $P=0.033$). Intracranial-first approach ($n=227$) compared with extracranial-first approach ($n=267$) resulted in a shorter time to flow restoration (53.5 versus 72.0 minutes, $P<0.001$) and a higher nonsignificant probability of good outcome (45.8% versus 33.0%, $P=0.24$) without differences in periprocedural complications.

CONCLUSIONS: In tandem lesions in the anterior circulation, acute treatment of the extracranial ICA lesion is associated with better clinical outcome and lower mortality. The intracranial-first approach might provide advantages.

	Acute treatment of ICA in tandem lesions (anterior circulation), n=607		
	Extracranial-first approach (n=267)	Intracranial-first approach (n=227)	P value
Age, y (SD)	69.3±11.9	67.5±11.2	0.091
Sex, female, n (%)	83 (31.1%)	64 (28.2%)	0.484
Clinical characteristics at admission			
pmRS, median (IQR)	0 (0–0)	0 (0–0)	0.059
Baseline NIHSS, median (IQR)	14 (9–18)	14 (10–18)	0.912
Time intervals			
Symptom onset/last seen well to IVT	183.0 (153.0–544.5)	195.0 (150.0–264.5)	0.059
Admission to groin	71.0 (43.5–105.0)	60.0 (45.0–85.0)	0.042
Groin to first passage	40.0 (20.0–58.3)	26.0 (15.0–38.0)	<0.001
Groin to flow restoration	72.0 (50.0–101.5)	53.5 (36.0–78.0)	<0.001
IVT treatment, n (%)	145 (54.3)	141 (62.1)	0.080
Imaging data			
ASPECTS, median (IQR)	8 (7–10)	8 (7–10)	0.338
			0.303
ICA extra + MCA	172 (64.4%)	157 (69.2%)	
ICA extra + Carotis-T	94 (35.2%)	68 (30.0%)	
ICA extra + ACA		2 (0.9%)	
ICA extra + PCA (embryonic)	1 (0.4%)		
Type of anesthesia			0.277
Conscious sedation, n (%)	56 (21.0)	64 (28.2)	
General anesthesia, n (%)	202 (75.7)	151 (66.5)	
Conversion, n (%)	4 (1.5)	9 (4.0)	
Additive medication, n (%)	162 (60.7%)	115 (50.7%)	0.025
Treatment approaches for intracranial LVO			
Aspiration catheter only, n (%)	14 (5.2)	17 (7.5)	0.358
Stent retriever only, n (%)	107 (40.1)	74 (32.6)	0.041
Aspiration and stent retriever, n (%)	133 (49.8)	132 (58.1)	0.150
Unknown, n (%)	13 (4.9)	3 (1.3)	0.383
Number of passages	2.3±1.9	2.4±2.8	0.685
Acute extracranial ICA treatment			
Stenting	228 (85.4%)	209 (92.1%)	0.021
PTA	241 (90.3%)	197 (86.8%)	0.225
Other	1 (0.4%)	0 (0%)	0.358
Periprocedural complications, n (%)	64 (24.0)	46 (20.3)	0.338
Device malfunction	1 (0.4)	1 (0.4)	0.909
Dissection, perforation	11 (4.1)	10 (4.4)	0.876
Clot migration, embolization	15 (5.6)	7 (3.1)	0.174
ICH	18 (6.7)	11 (4.8)	0.373
Vasospasm	25 (9.4)	13 (5.7)	0.131
Resuscitation	3 (1.1)	2 (0.9	0.799
Other	19 (17.1)	19 (8.4)	0.603
Successful reperfusion mTICI2b/3, n (%)	230 (86.1)	209 (92.1)	0.086
Hospital stay			
Malignant MCA infarction, n (%)	14 (5.2)	15 (6.6)	0.521
Recurrent stroke, n (%)	9 (3.4)	16 (7.0)	0.063
ICH, n (%)	68 (25.5)	49 (21.6)	0.313
Myocardial infarction, n (%)	3 (1.1)	2 (0.9)	0.789
Groin hematoma	4 (1.5)	4 (1.8)	0.817
Groin aneurysm	2 (0.7)	0 (0)	0.192
Other complications during hospital stay	49 (18.4%)	68 (30.0%)	0.002
Duration of hospital stay (days±SD)	10.9±9.5	11.4±10.4	0.603



In intracranial first group

- Higher rate of stenting (92.1% vs 85.4% p=0.021)
- selection bias

(stenting is more often undertaken only if reperfusion was achieved successfully.)

Summary

C-ICA stenting or thrombectomy alone

- Absence of findings from RCT….
- Observational evidences > supporting a possible benefit of acute-ICA stenting.
  More successful recanalization, better outcome, higher rate of any ICH(not sICH)
- Lack of benefit: dissection / severe stroke / large infarction core

Intracranial first (Retrograde) or Extracranial first (Anterograde)

- similar functional outcomes
  : tendency towards better outcomes in retrograde approach group
  : theoretical advantages to retrograde approach (shorter recanalization time)
  > Decision is left discretion of interventionist

대한뇌혈관내치료의학회/
대한뇌혈관외과학회 합동연수교육
(2021 대한뇌혈관내치료의학회 추계보수교육 및 ARCS)

인　　쇄	2021년 09월 30일
발　　행	2021년 10월 01일
발 행 처	**대한뇌혈관내치료의학회**
회　　장	윤 석 만
총무이사	박 석 규
학술이사	권 순 찬
주　　소	서울시 서초구 서초대로 350 (서초동 동아빌라트 2타운) 407호
제　　작	**마이스티엘**
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	TEL) 02-6952-5824

samyang Hanmi 한미헬스케어

Q-Guard

Topical Hemostatic Dressing / Bleeding Control / Kaolin

큐가드는 체내에 알레르기나 면역 반응을 유발하지 않고 지혈을 촉진시키는 카올린(Kaolin)이
거즈에 특수 코팅되어 광범위한 영역의 출혈을 억제하기 위해 사용하는 지혈용 드레싱입니다

품 목 명	국소지혈용드레싱
제 품 명	Q-Guard / 큐가드
원 재 료	카올린(Kaolin), 거즈(레이온)
가 격	법정비급여
포장단위	10EA / Box

2 x 2
Hemostatic Dressing

4 x 4
Hemostatic Dressing

Z-Fold
Hemostatic Dressing

3 x 10
Hemostatic Dressing

EMBOTRAP®II
revascularization device

EMBOTRAP® II Revascularization Device is designed to engage and grip clots differently, to remove various thrombus types and is engineered to maximize the **First Pass Effect** (FPE)

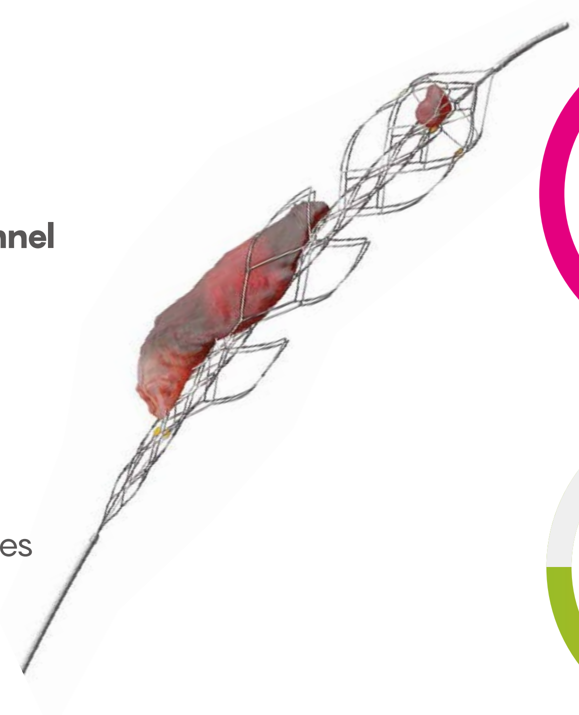
CERENOVUS KOREA팀은 EmboTrap2 를 포함하여, 앞으로도 Acute Ischemic Stroke 치료에 도움이 되는 여러 제품으로 선생님 여러분들께 찾아 뵙겠습니다.

Designed to engage and grip differently - Dual Layer Design Design

Open Outer Cage

Inner Channel

Closed End-Mash



- Works on a **broad range** of **clot** types
- A next generation stent retriever form advanced clot research

52%
First Pass Success[1]
mTICI≥ 2b

93%
clot successfully removed at end of procedure1
mTICI≥ 2b

EMBOTRAP®II revascularization device	NAME	CATALOG #	RECOMMENDED VESSEL DIAMETER	MICRO CATHETER COMPATIBILITY	DIAMETER	WORKING LENGTH	DEVICE LENGTH	TIP LENGTH
	5x21	ET007521	1.5-5.0 mm	0.021" ID	5.0 mm	21 mm	194 cm	4 mm
	5x33	ET007533				33 mm	195 cm	

* The FPE is a direct correlation of the ability thrombectomy device to restore complete recanalization (TICI 2c-3) in a single pass through clot.

References:
Zaidat OO, et al (2018). Primary Results of the Multicenter ARISE II Study (Analysis of Revascularization in Ischemic Stroke With EmboTrap). Stroke.

CERENOVUS
PART OF THE Johnson & Johnson FAMILY OF COMPANIES
COPY-20001-C3


ILDONG 일동제약
High Purity
Rosuvastatin
Rovetin Tab.
이상지질혈증을 처음 진단받은 환자에게,
일동제약이 직접 생산하는 로베틴으로
지질관리를 시작하세요.
로베틴정
Rosuvastatin
5mg, 10mg, 20mg
전문의약품
[성분 · 함량] Rosuvastatin Calcium 5.2mg, 10.4mg, 20.8mg(5mg, 10mg, 20mg as rosuvastatin) [효능 · 효과] 1. 원발성 고콜레스테롤혈증, 복합형 고지혈증 2. 동형접합 가족성 고콜레스테롤혈증 3. 고콜레스테롤혈증 환자에서 총콜레스테롤과 LDL-콜레스테롤을 목표 수준으로 낮추어 죽상동맥경화증의 진행을 지연 4. 식이요법에도 불구하고 여전히 아래의 기준에 해당되는, 이형 가족형 고콜레스테롤혈증을 가진 만10세-만17세의 소아환자(여성의 경우 초경 이후 적어도 1년이 지난 환자)의 총콜레스테롤, LDL-콜레스테롤, 아포-B 단백 수치를 감소시키기 위한 식이요법의 보조제 * LDL-콜레스테롤이 여전히 190 mg/dL을 초과하는 경우 (LDL-C 〉190 mg/dL) * LDL-콜레스테롤이 여전히 160 mg/dL을 초과하면서 (LDL-C 〉160 mg/dL), 조기 심혈관 질환의 가족력이 있거나 두가지 이상의 심혈관 질환 위험 인자가 있는 경우 5. 원발성 이상베타리포프로테인혈증 환자의 식이요법 보조제 6. 심혈관 질환에 대한 위험성 감소 : 관상동맥 심질환에 대한 임상적 증거는 없으나, 만 50세 이상의 남성 및 만 60세 이상의 여성으로 고감도 C-반응단백이 2 mg/L 이상이며, 적어도 하나 이상의 추가적인 심혈관질환 위험 인자를 가진 환자의 뇌졸중, 심근경색, 동맥 혈관재형성술에 대한 위험성 감소 [용법 · 용량] 1일 1회 1정. 식사와 상관없이 하루 중 아무때나 투약 가능 ※ 자세한 사항은 제품설명서 전문을 참조하시기 바랍니다.
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식약처 허가사항 기준 (2020.02)