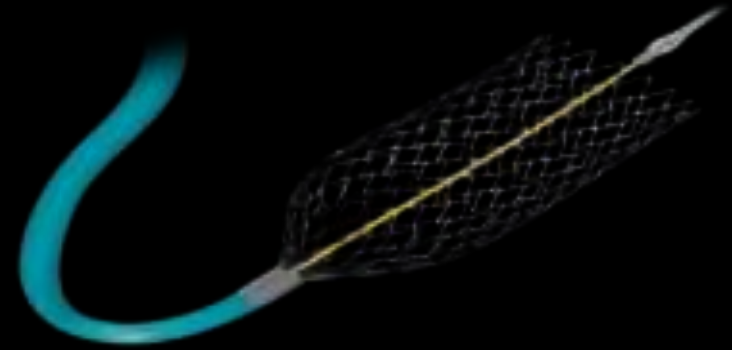
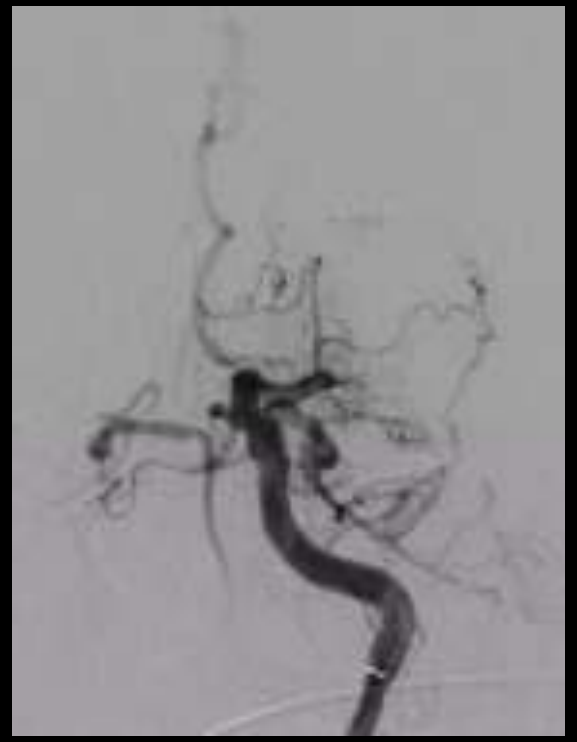


Intervention for Acute Carotid Artery Tandem Lesions



Srihari Sundararajan ('Sri')

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RWJ Barnabas - Robert Wood Johnson University Hospital

University Radiology Group

RUTGERS
Robert Wood Johnson Medical School

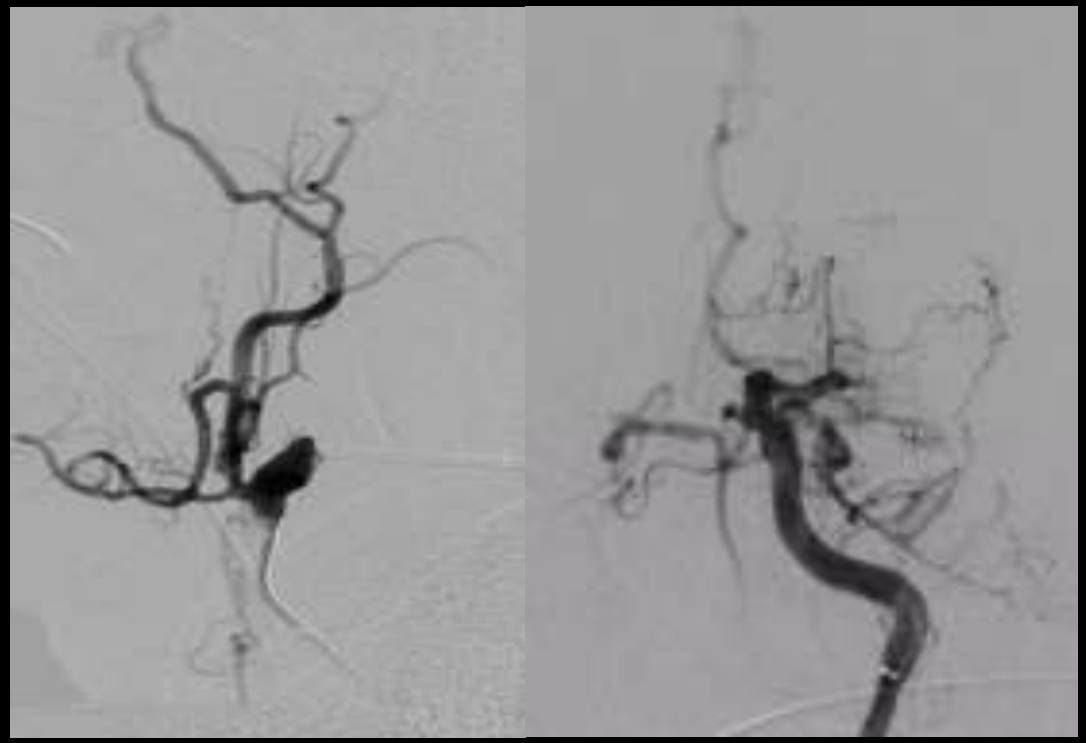
UNIVERSITY RADIOLOGY

Disclosures

- None

Carotid Tandem Occlusion

- A carotid tandem occlusion refers to the simultaneous presence of two blockages (occlusions) within the carotid artery system
- One in the extracranial segment (usually the internal carotid artery near its origin)
- Other in intracranial segment of same artery.

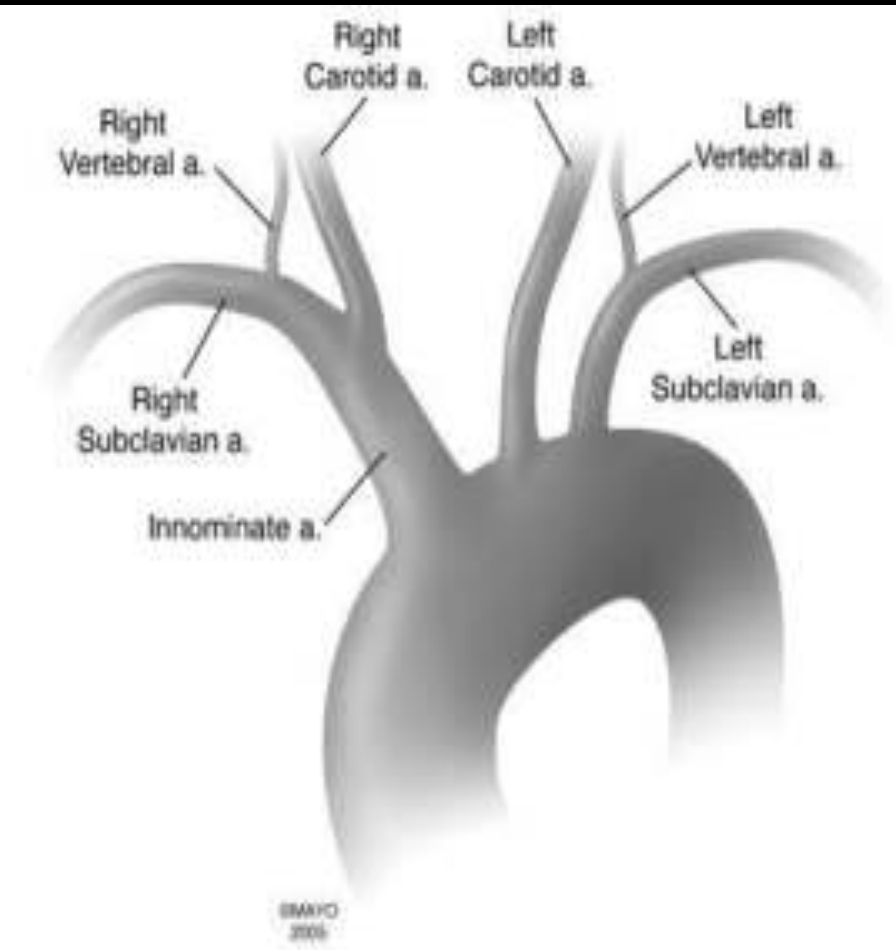


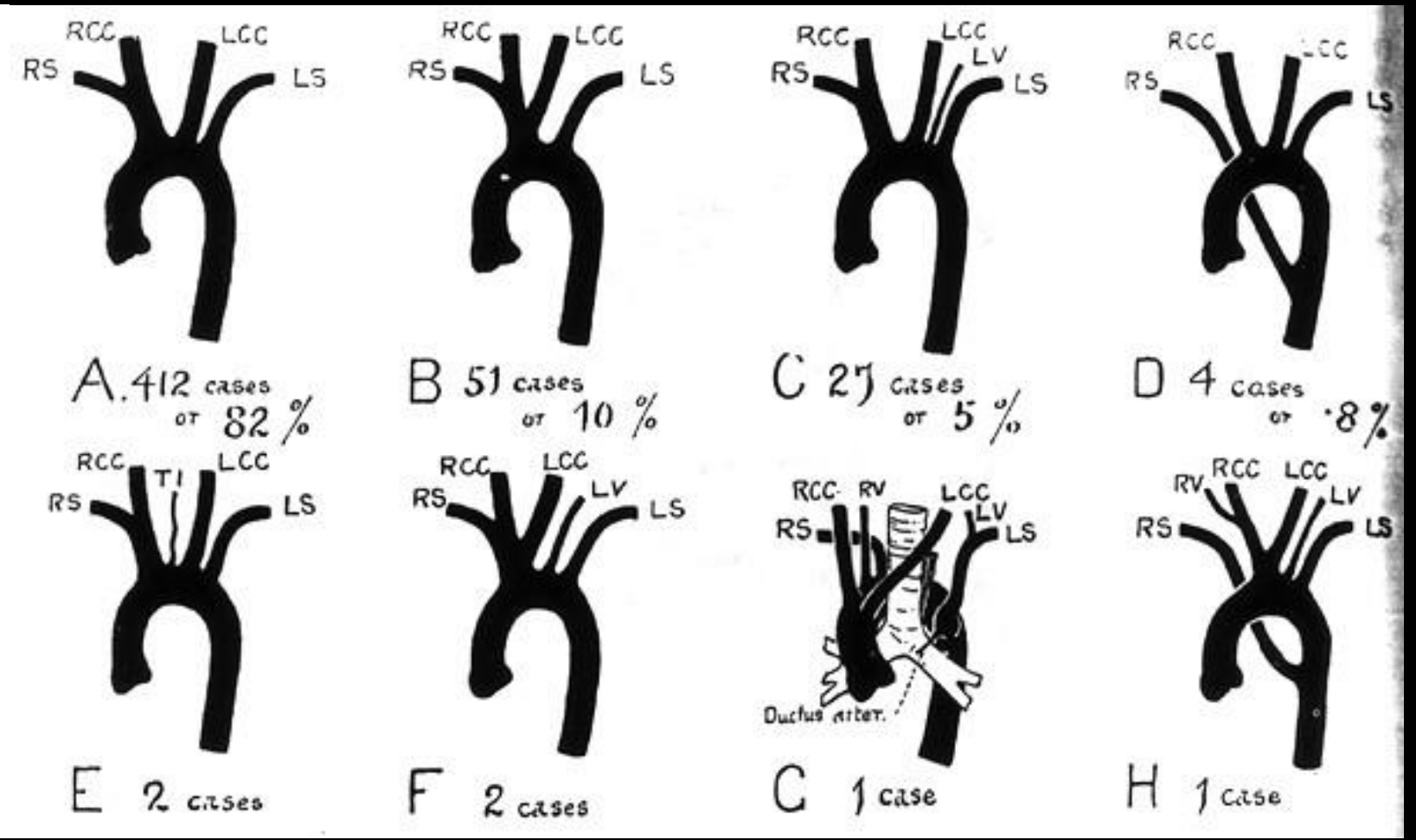
Carotid Tandem Occlusion

- This can be due to:
  - **Atherosclerotic plaques**
  - Dissections
    - Vasculopathy – Fibromuscular dysplasia
    - Traumatic
  - Other causes rarer (vasculitis, etc)

- To this day, it represents a significant challenge in vascular and interventional neurology due to the dual nature of the obstruction.

Aortic Arch

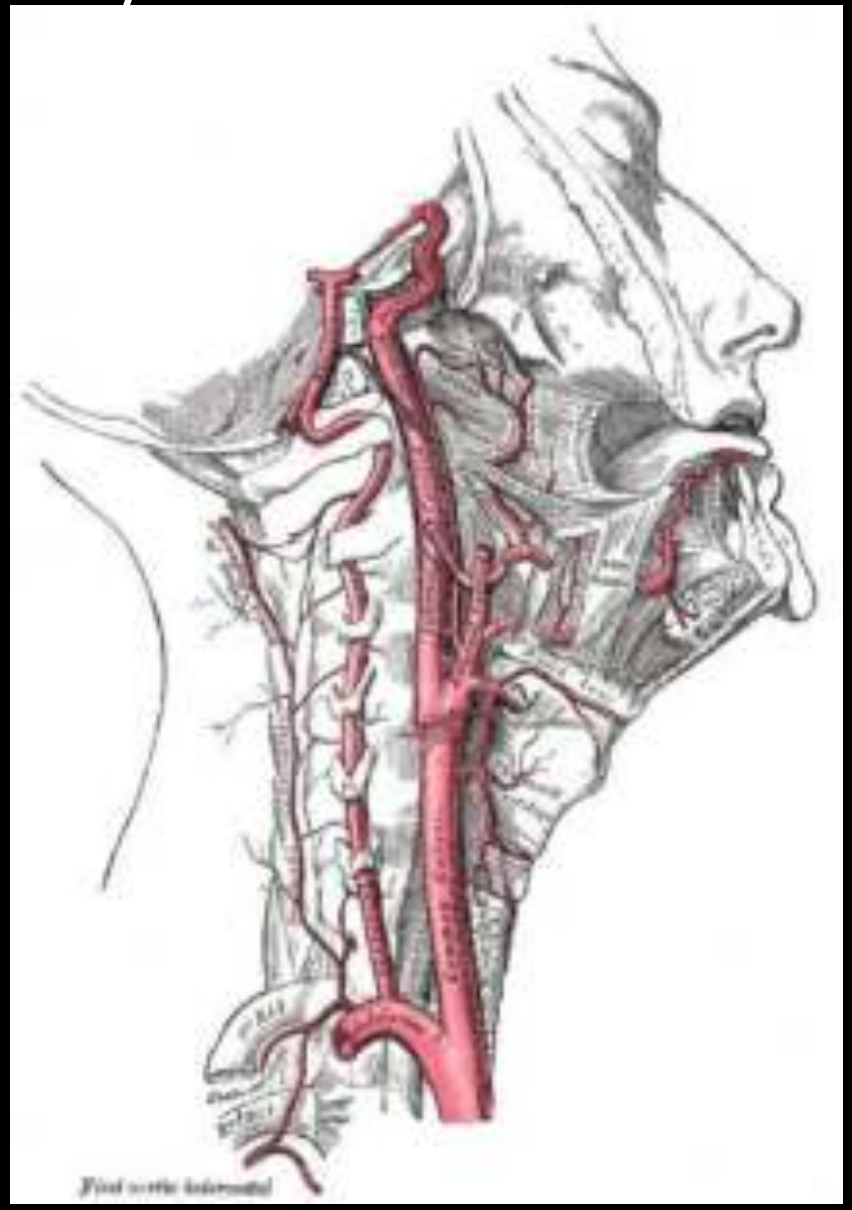




From Thompson, A. Third annual report of the committee of the collective investigation of the Anatomical Society of Great Britain and Ireland for the year 1891-92. J. Anat. Physiol. 27: 183-194, 189

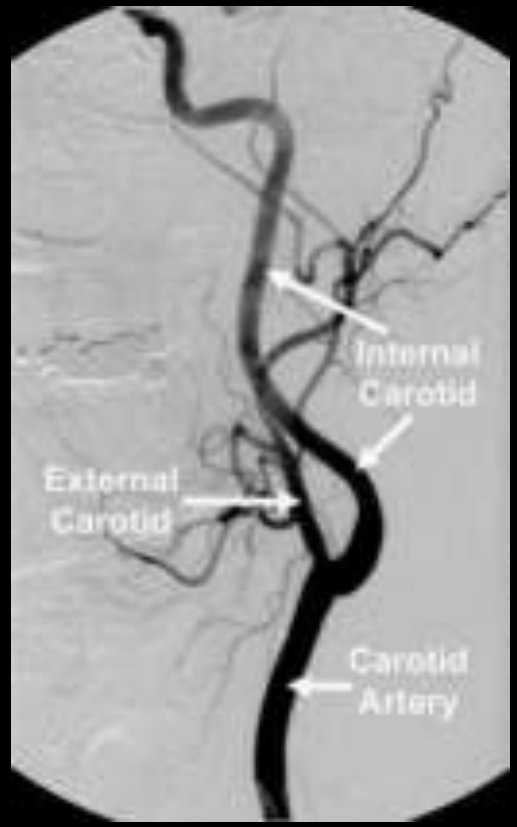
Common Carotid Artery (CCA)

- Thoracic Part
- Cervical Part
- (separated by sternoclavicular joint)



Carotid Bifurcation

- Level of Bifurcation
- C4 (C3-5)
- ICA originates posterolaterally to ECA, courses anteromedially



Carotid Sinus

- Origin of ICA
- **<u>Baroreceptors</u>**
- Stimulus: Pressure
  - ↑ Pressure
    - ↓HR, ↑vasodilation, ↓BP
- Afferent:
  - Nerve of Hering (CN IX)

Baroreceptor Reflex

Caudal ventrolateral medulla (CVLM)

GABA

Nucleus of the Solitary Tract (NST)

Rostral ventrolateral Medulla (RVLM)

Intermediolateral nucleus (Rexed VII) of the SC (T1-L2)
pre-ganglionic sympathetic neurons

CN IX and IX

ACh

Pre-aortic and paravertebral ganglion
post-ganglionic sympathetic neurons

NE

Cardiomyocytes/endothelium

Barorecptors (Aortic and Carotid Sinus)

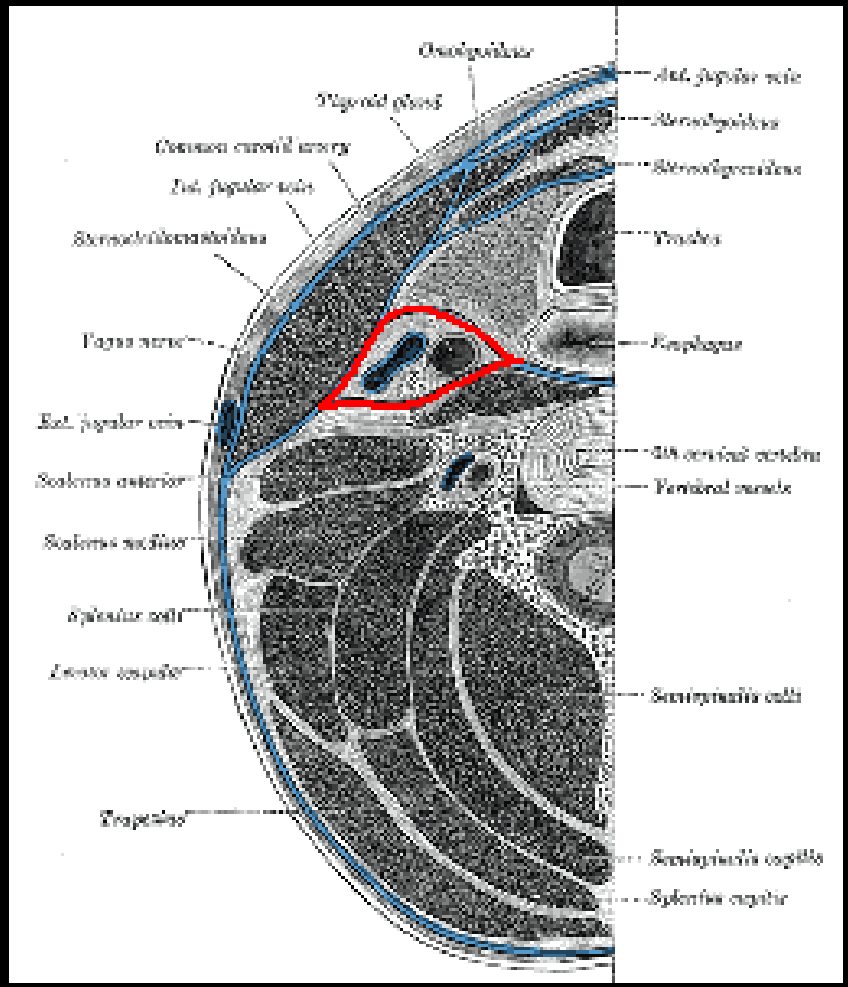
HTN/Volume (“stretch”)

Carotid Body (Glomus Caroticum)

- Carotid Body (glomus caroticum)
- **<u>Chemoreceptors</u>**
- Stimulus:
  - ↓ PaO2
  - ↑PaCO2
  - ↓ pH
- Afferent: CN IX
- Target NST > medullary respiratory centers

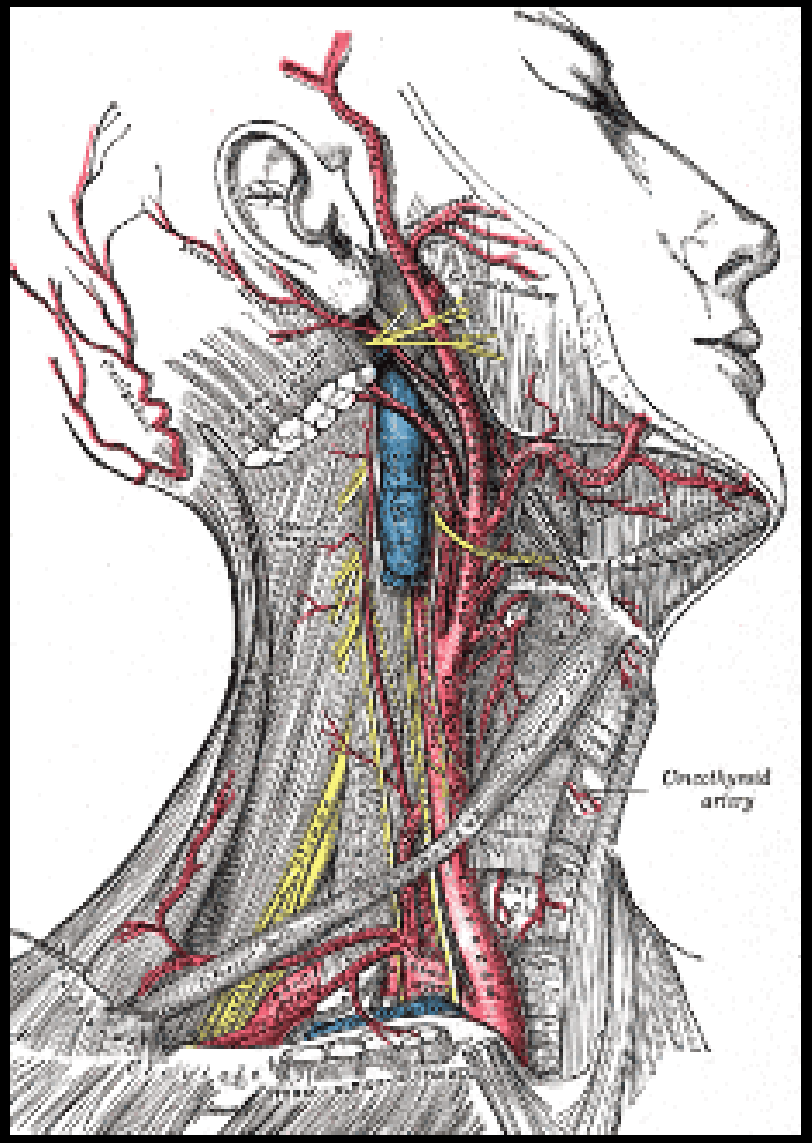
Carotid Sheath

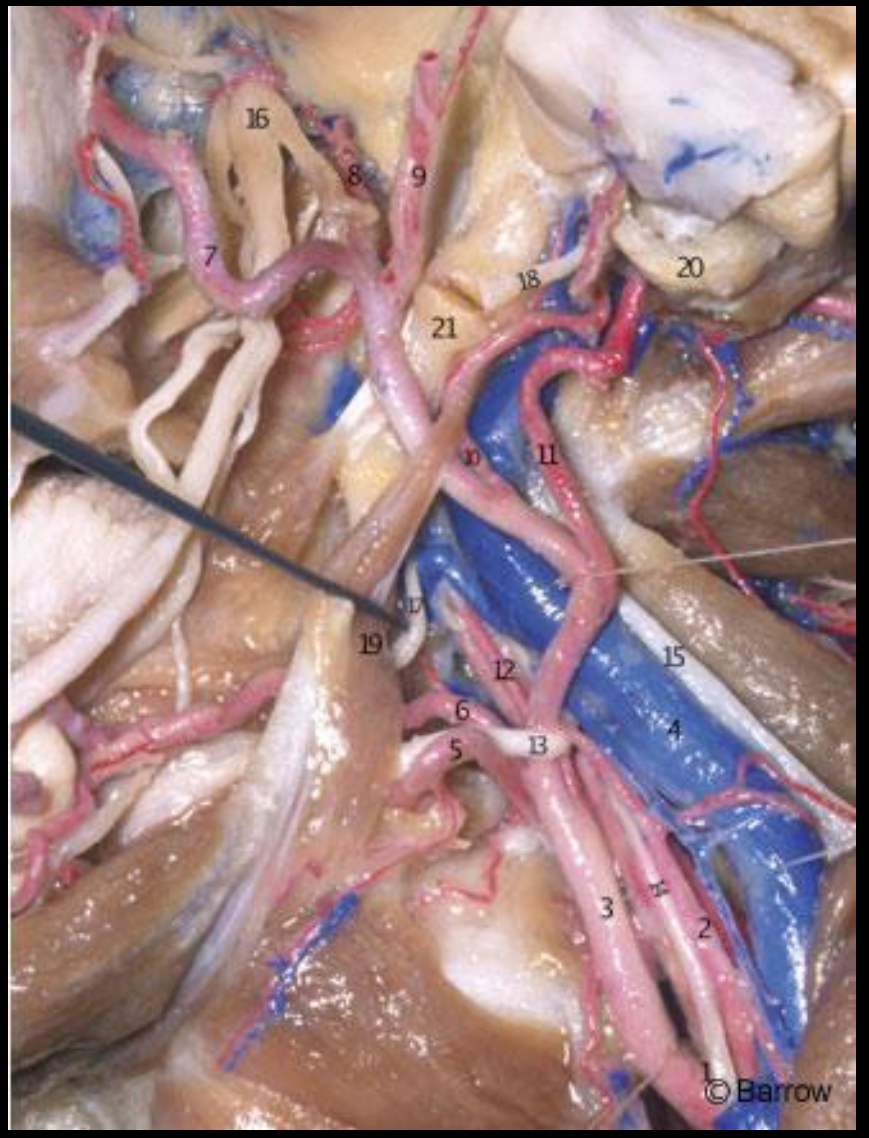
- Carotid Sheath
  - Part of deep cervical fascia
  - Contents:
    - CCA and ICA
    - IJV
    - CN X
    - Deep cervical lymph nodes



External Carotid Artery

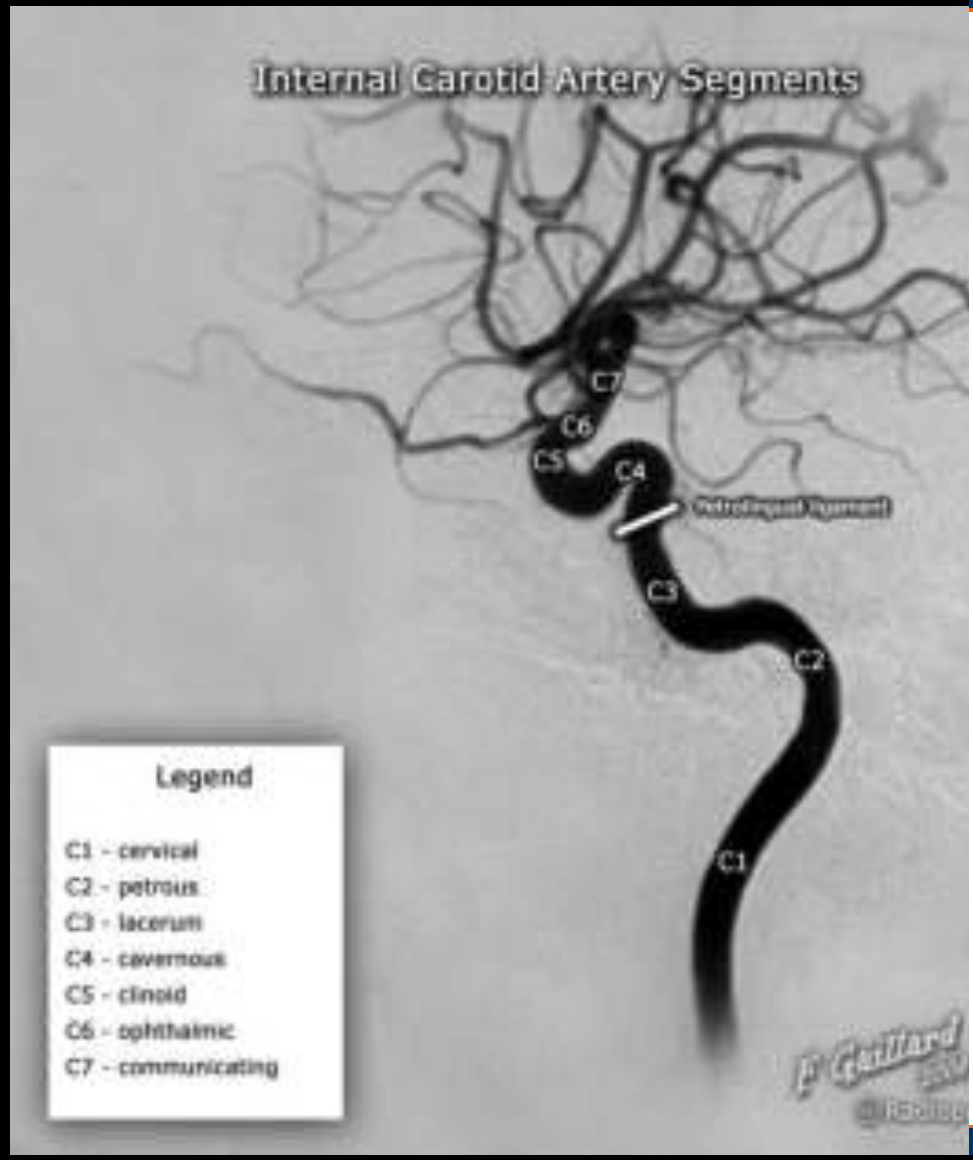
- Superior thyroid a
- Ascending pharyngeal a.
- Lingual a.
- Facial a.
- Occipital a.
- Posterior auricular a.
- Internal maxillary a
- Superficial temporal a.

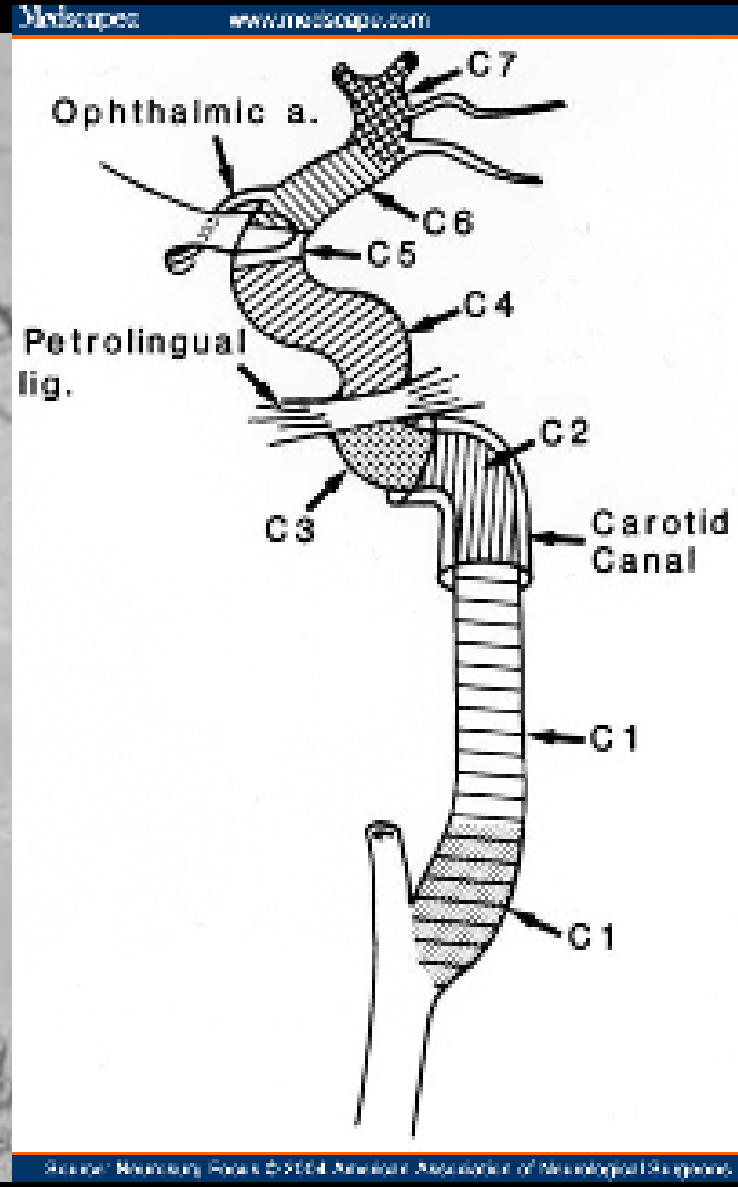




Internal Carotid Artery

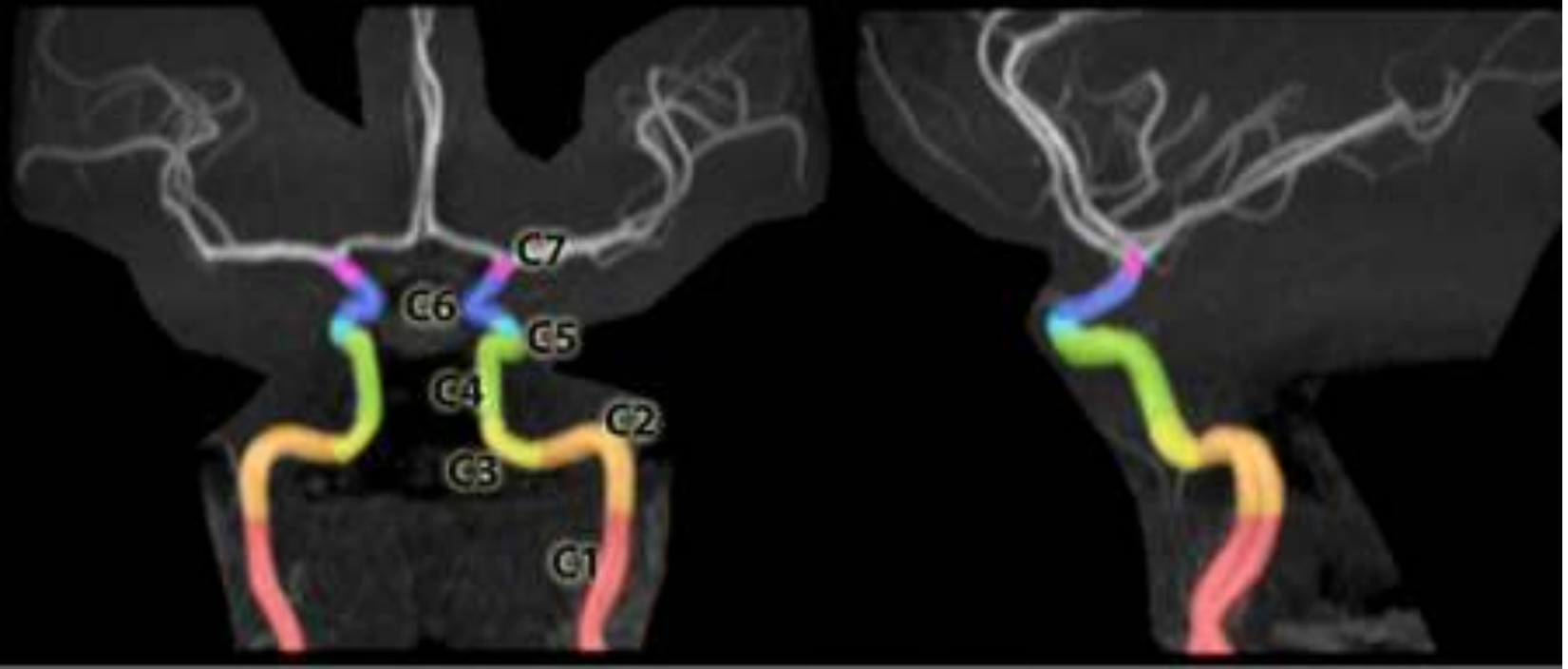
- Bouthillier's Segments (aka Cincinatti system)
- C1: Cervical
- C2: Petrous
- C3: Lacerum
- C4: Cavernous
- C5: Clinoidal
- C6: Ophthalmic
- C7: Communicating

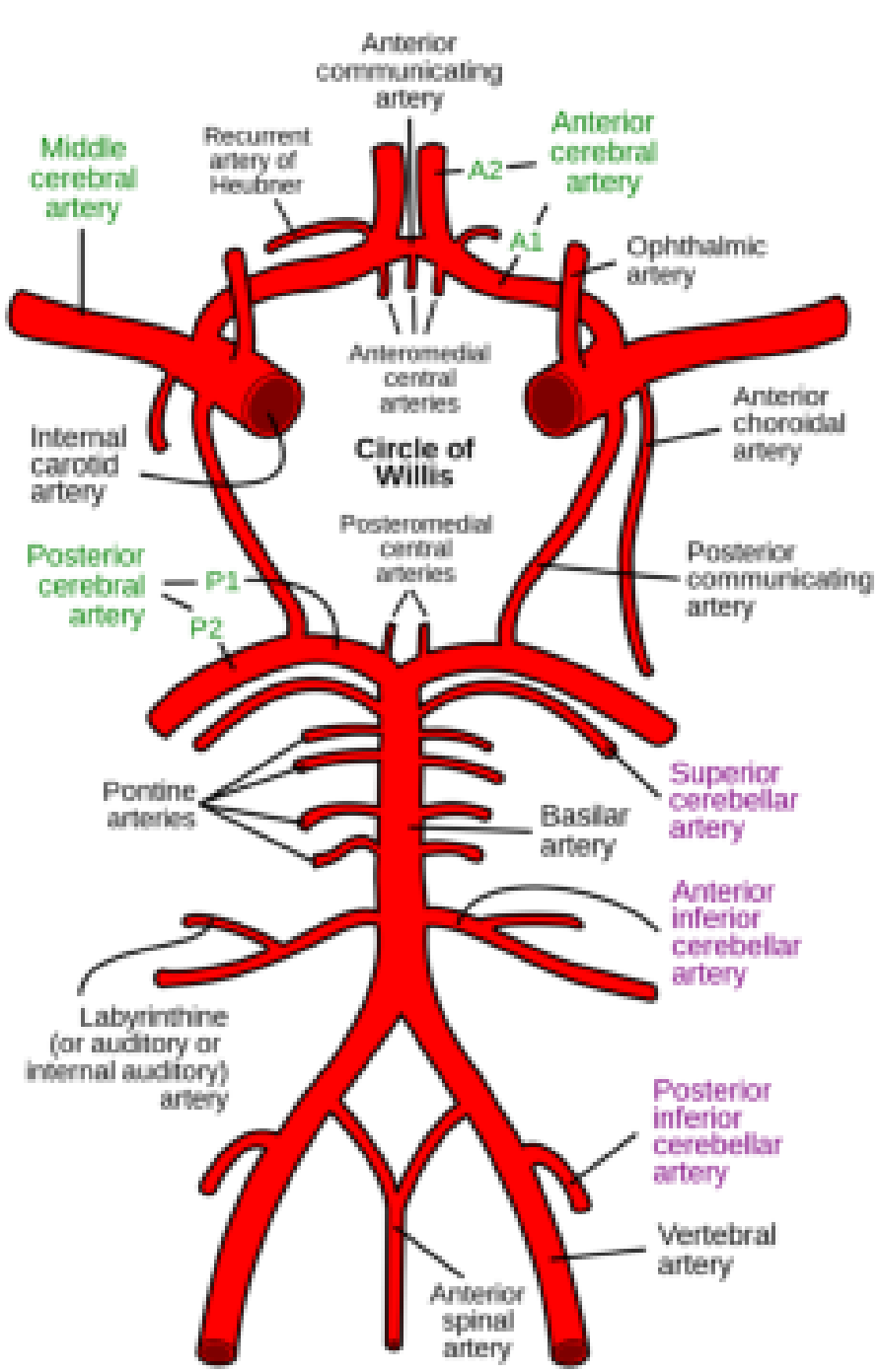




Circle of Willis

- Arterial polygon at the base of the brain.
- Ensures collateral blood flow
- Connects carotid and vertebrobasilar systems



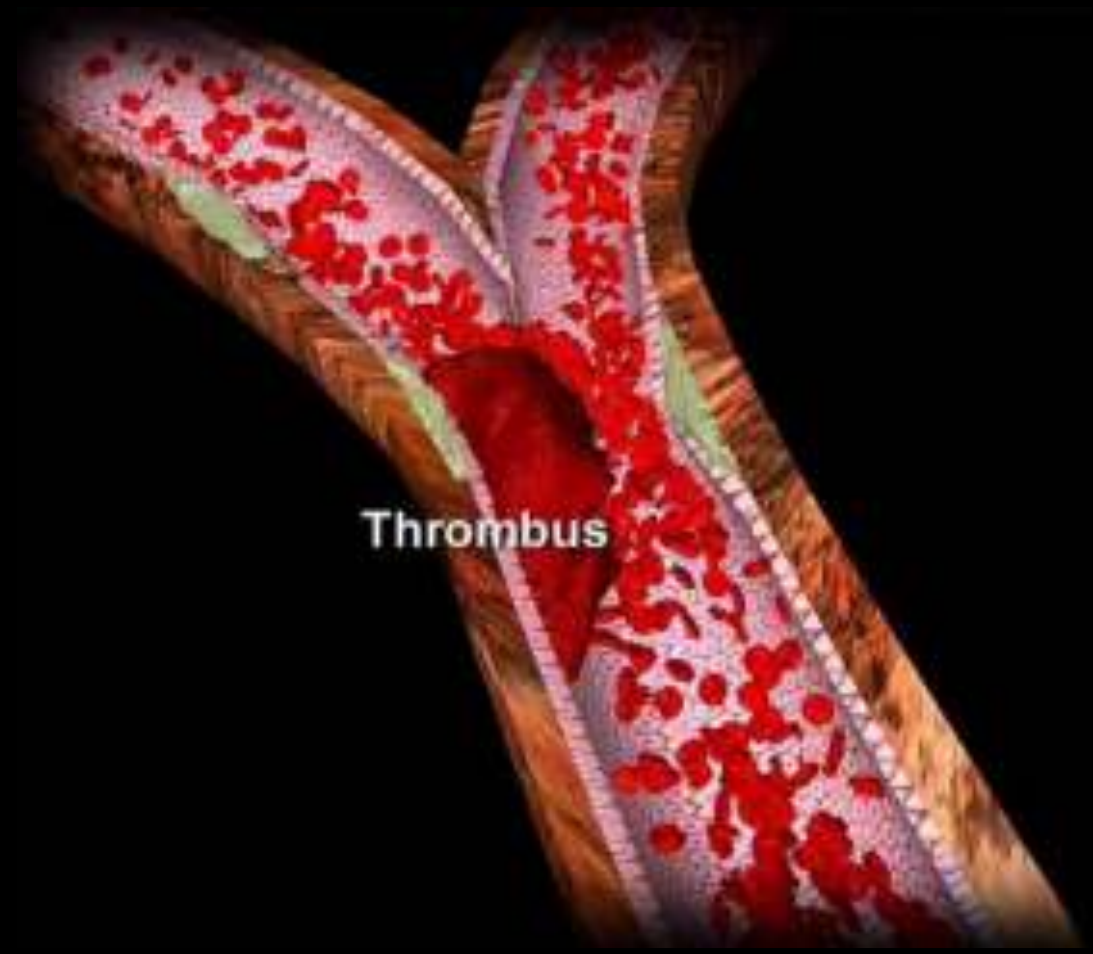


Tandem -> Terrifying?

- The implications of carotid tandem occlusions are severe
- When occlusions happen in tandem, they can significantly compromise the blood supply to the affected brain hemisphere
- Immediate diagnosis and intervention are crucial to prevent catastrophic ischemic strokes.

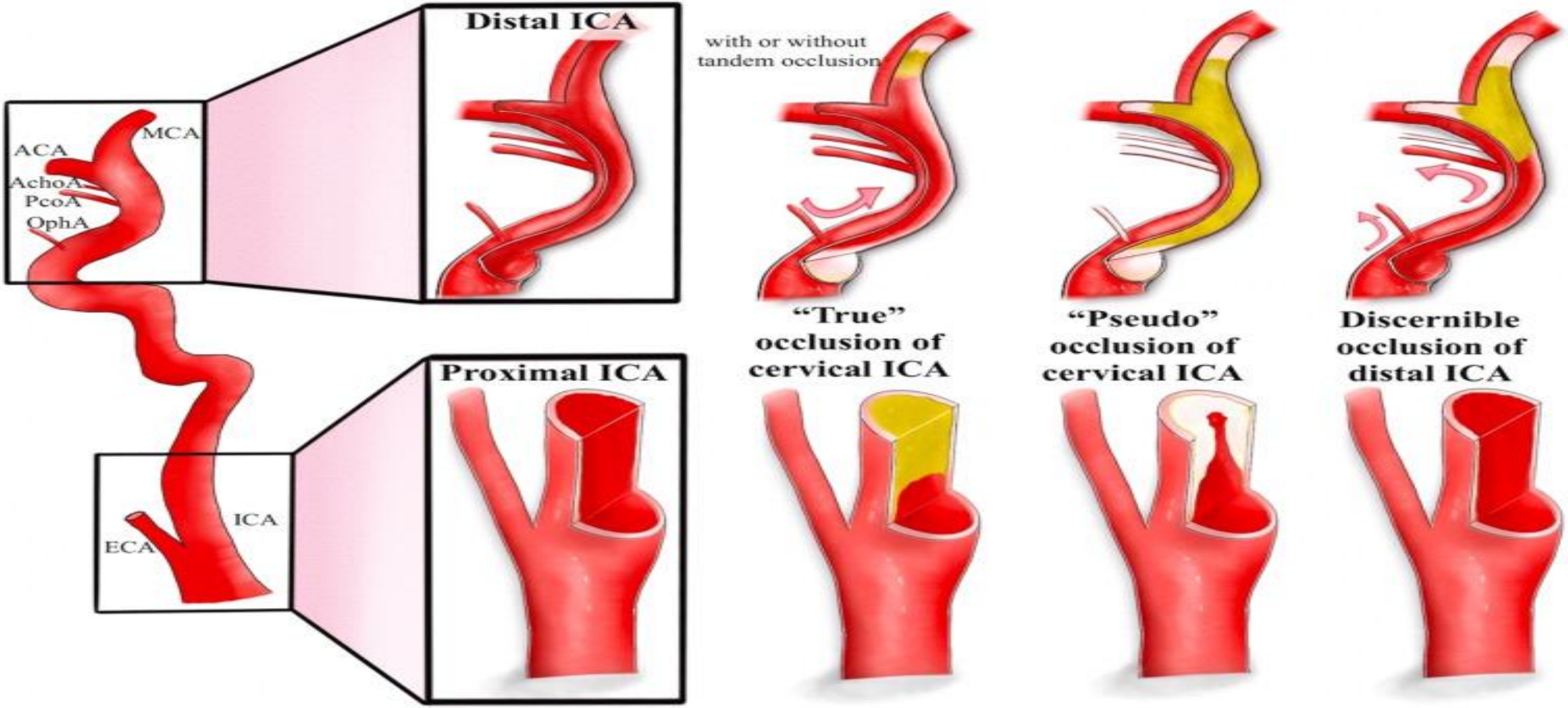
Atherosclerosis

- Primary mechanism for most extracranial carotid occlusions.
- Lipid-laden plaques build up in the arterial wall, leading to narrowing (stenosis) and sometimes complete obstruction (occlusion).
- Plaque rupture can result in clot formation (thrombosis) and embolism. This clot can travel and contribute to intracranial occlusions.



Dissection

- Dissection refers to a tear in the arterial wall, allowing blood to enter and split its layers. This can lead to a pseudoaneurysm or block the arterial lumen, causing occlusion.
- Dissections can be spontaneous, or they can be a result of trauma.



World Neurosurgery
Volume 164, August 2022, Pages e387-e396

Original Article

Acute Ischemic Stroke Caused by Internal Carotid Artery Occlusion: Impact of Occlusion Type on the Prognosis

Jinhee Jang [1], Jung Koo Lee [2], Joseong Koo [1], Bum-soo Kim [1], Yong Sam Shin [2], Joi Ho Choi [2]

Ischemic Cascade

- Decreased blood flow leads to a cascade of cellular events.
- Anaerobic metabolism, acidosis, cellular edema, release of excitotoxic neurotransmitters, and irreversible cell death.
- Compensation attempts through collateral vessels are diminished with tandem occlusions

brain sciences

MDPI

Brain Sci. 2021 Apr; 11(4): 511.
Published online 2021 Apr 16. doi: 10.3390/brainsci11040511

PMCID: PMC8073938
PMID: 33923721

Cerebral Autoregulation in Ischemic Stroke: From Pathophysiology to Clinical Concepts

Ricardo C. Nogueira,[1,2,*] Lucy Beishon,[3] Edson Bor-Seng-Shu,[1] Ronney B. Panerai,[3,4] and Thompson G. Robinson[3,4]

Farzaneh Sorond, Academic Editor, Pedro Castro, Academic Editor, Thorsten Rudroff,

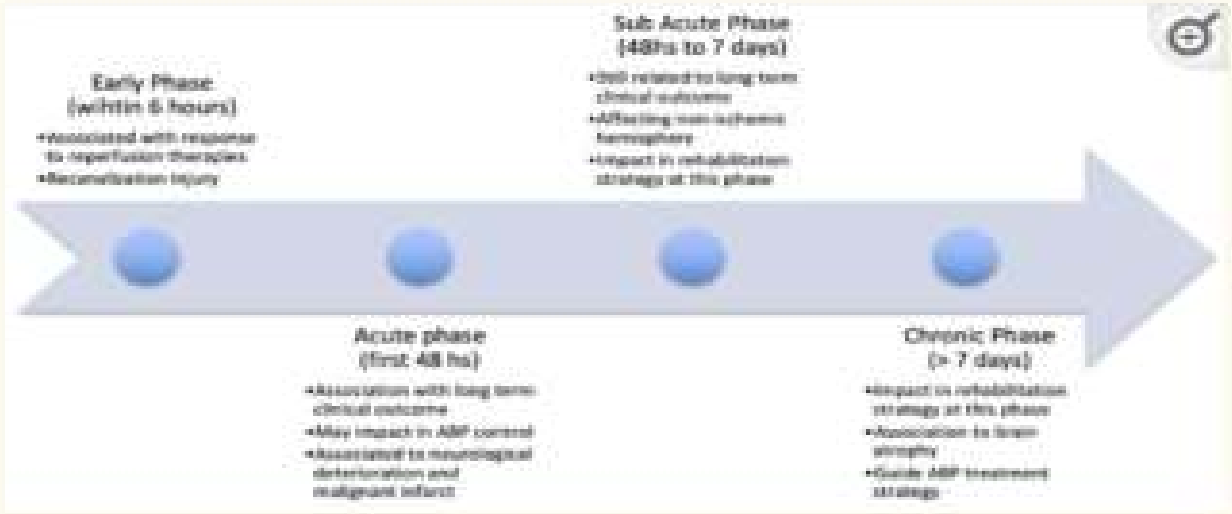


Figure 2

Timeline of the impact of cerebral autoregulation (CA) on ischemic stroke (IS).

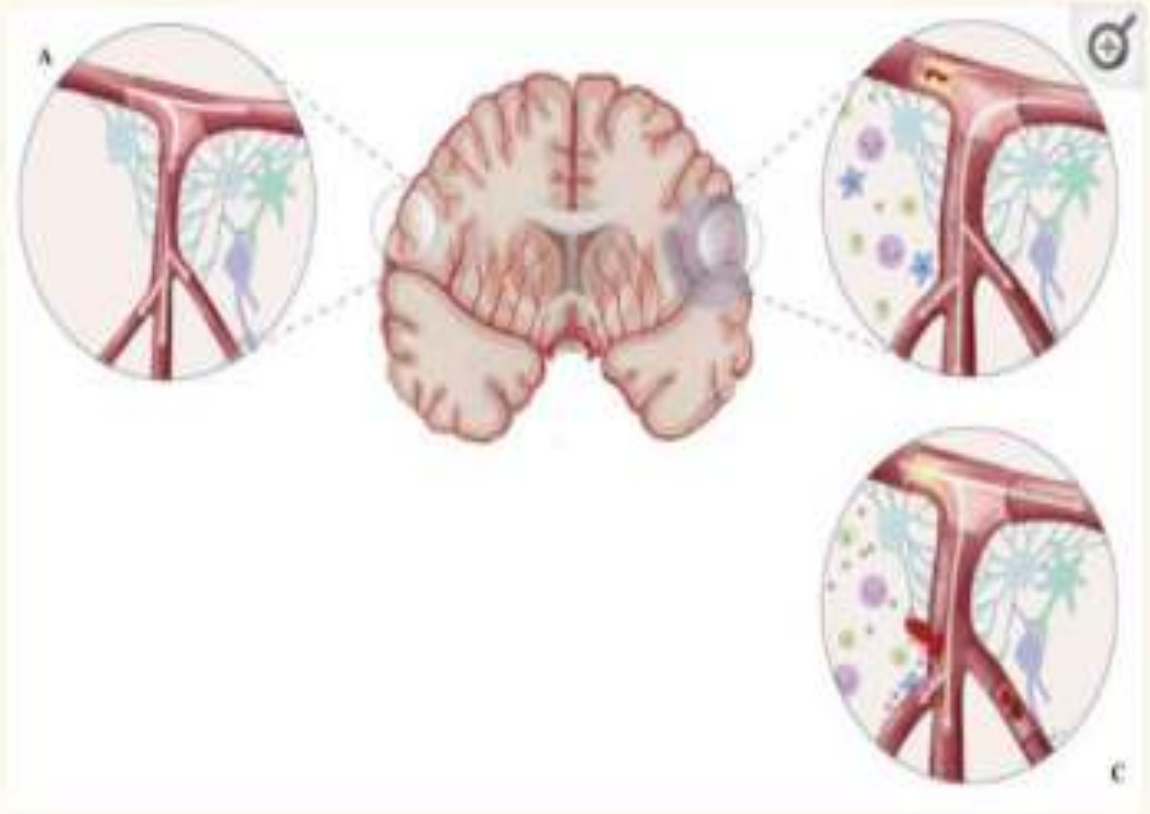


Figure 1

(A) Schematic representation of pial artery with penetrating vessel (intracerebral arteries) and its intraparenchymal components. (B) After vessel occlusion there is a vasodilatory response with flow diversion and inflammatory process in the ischemic area. (C) Perpetuation of ischemic process increases inflammatory response; at this time if the vessel is reperfused, ischemic lesions (ex. hemorrhage) and/or distal occlusion may result in futile recanalization.

Clinical Presentation

- **TIAs**
- **Ischemic Stroke**
- **Hemispheric Symptoms**
- **Visual Symptoms**
- **Bruits**
- Cognitive and Higher Order Dysfunction
- Seizures
- Headache

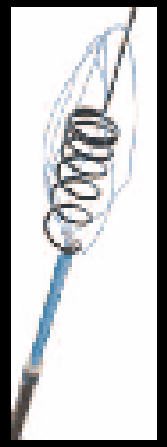
Imaging Tandem Occlusions

- Duplex Ultrasound (DUS)
- Computed Tomography Angiography (CTA)
- Magnetic Resonance Angiography (MRA)
- Digital Subtraction Angiography (DSA)
- Perfusion Imaging
- Transcranial Doppler (TCD)

Intervention Goals

- Rapid restoration of blood flow
- Limitation of infarct size
- Prevention of recurrent ischemic events
- Minimization of procedure-related complications
- Challenge of deciding the sequence of intervention (i.e., which lesion to treat first)

Stroke Therapy Timeline



MR CLEAN
SWIFT PRIME
EXTEND IA
ESCAPE
REVASCAT
THERAPY

IV tPA

PROACT II
IA tPA

Angioplasty
Stenting

MERCI

Penumbra
Bridging IV/IA
IV tPA (4.5h)

Solitaire
Trevo

ACE

Level I
Evidence

Extended
Window
DEFUSE 3
(RAPID)
DAWN

Generation 1

Generation 2

Generation 3

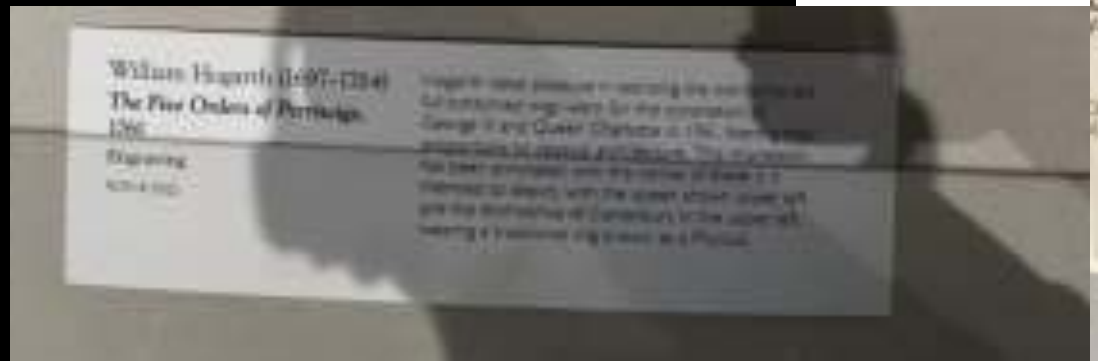
1995 2000 2005 2010 2015 2018

FDA Approved - Yellow

Off-label - Red

Mechanical Thrombectomy

- **Stent Retrievers**:
  - Devices used to engage, capture, and extract clot.
  - Advancing microcatheter beyond the occlusive thrombus, deploying the stent-retriever to integrate clot, then retrieving device with simultaneous aspiration at the guiding catheter or sheath.



Mechanical Thrombectomy

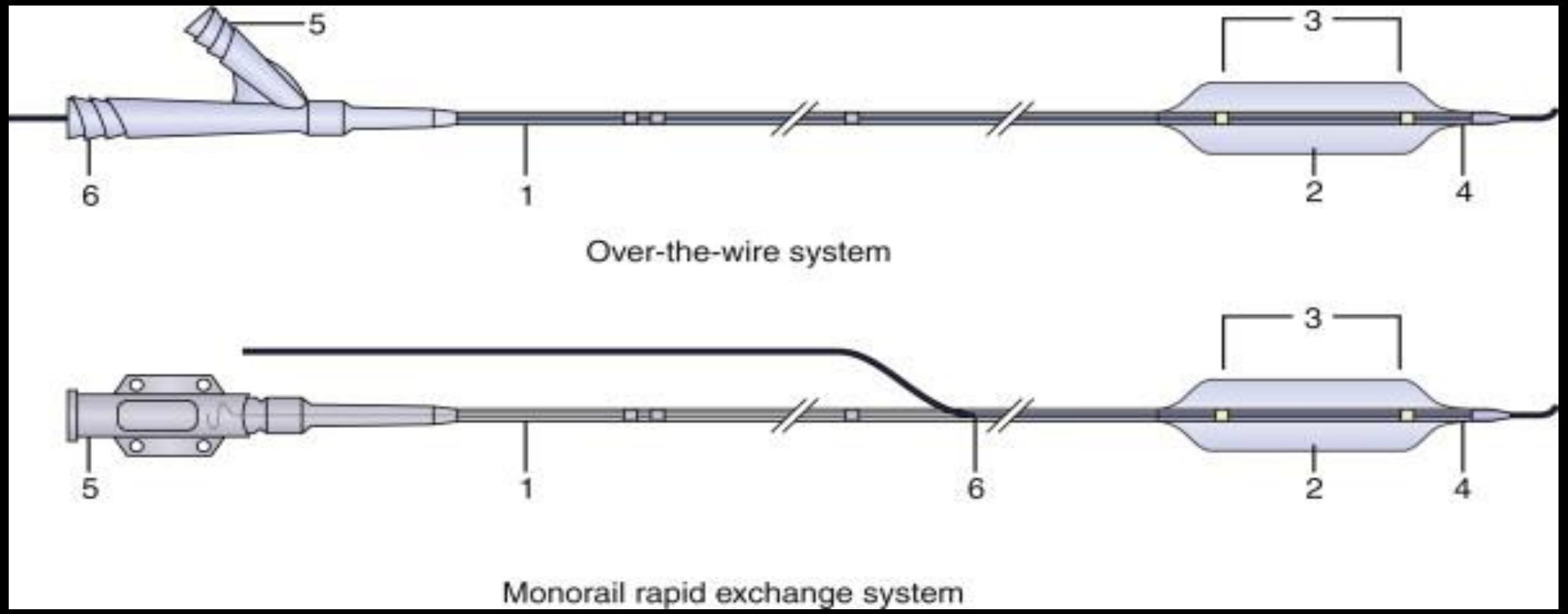
- **Aspiration Systems**:
  - Direct aspiration first pass technique (ADAPT) .
  - Large bore catheter advanced to the face of the clot then aspiration is applied to remove the clot.

Balloon Guide Catheters (BGC)

- These catheters are used in conjunction with stent retrievers or aspiration systems.
- The balloon can be inflated during thrombectomy to temporarily halt antegrade blood flow, which can prevent distal embolization and improve the rate of successful reperfusion.

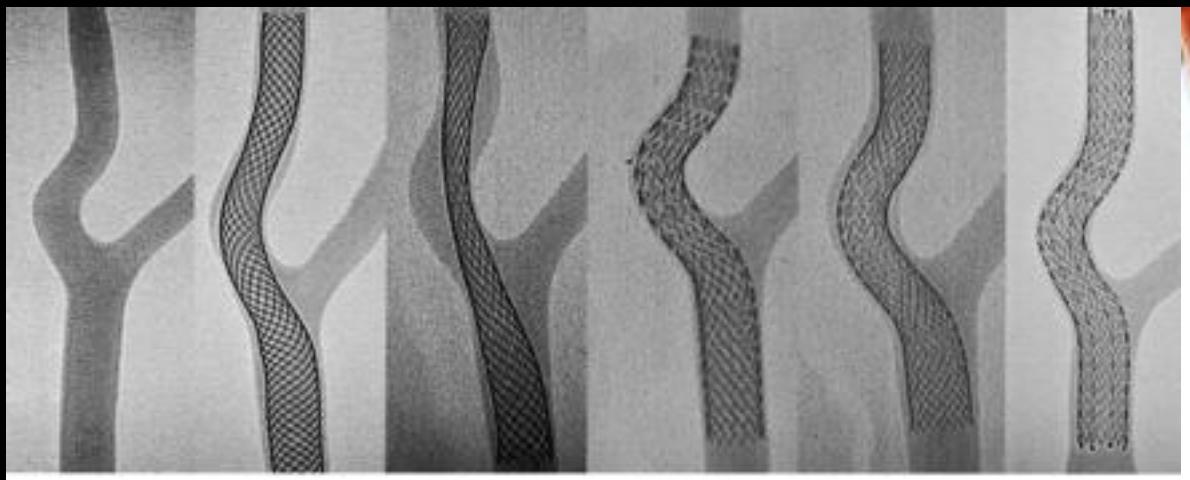
Angioplasty and Stenting for Extracranial Carotid Stenosis

- **Carotid Angioplasty**:
  - Balloon catheter to dilate the stenosed or occluded segment of the extracranial internal carotid artery.

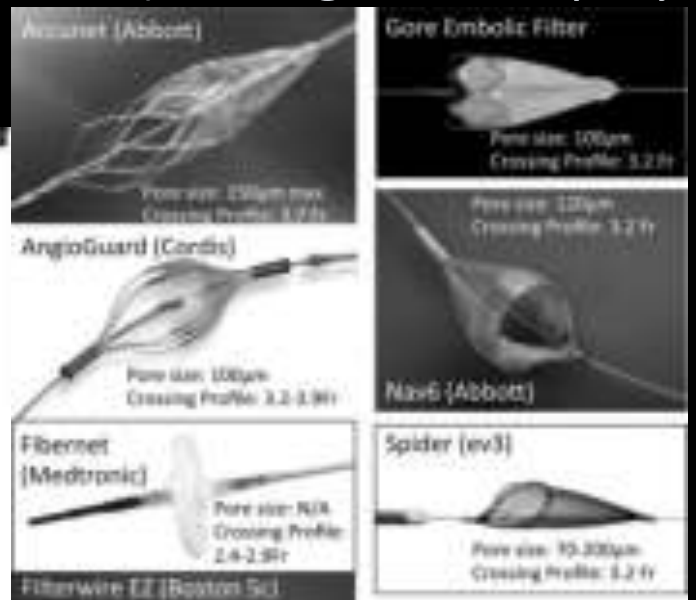


Angioplasty and Stenting for Extracranial Carotid Stenosis

- **Stenting**:
  - After angioplasty, a stent can be deployed to prevent re-occlusion or re-stenosis.
  - Self-expanding stents are typically used.
  - Embolic protection devices (like distal protection filters) during stent deployment to prevent distal embolization.



Conformity of Carotid Stents with Vascular Anatomy: Evaluation in Carotid Models

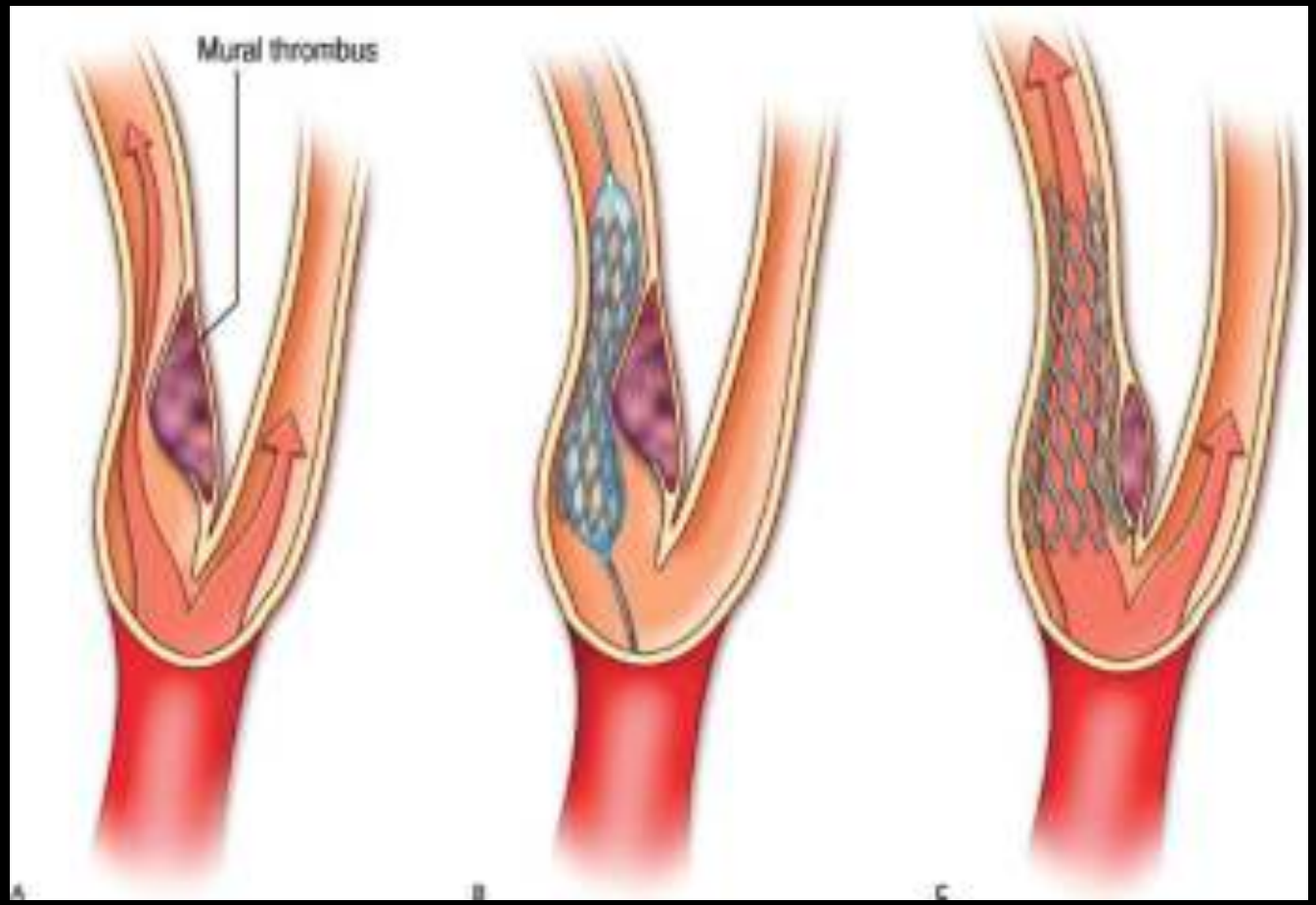


Carotid Artery Stenting for Stroke Prevention

Jacqueline Saw MD, in Canadian Journal of Cardiology, 2004

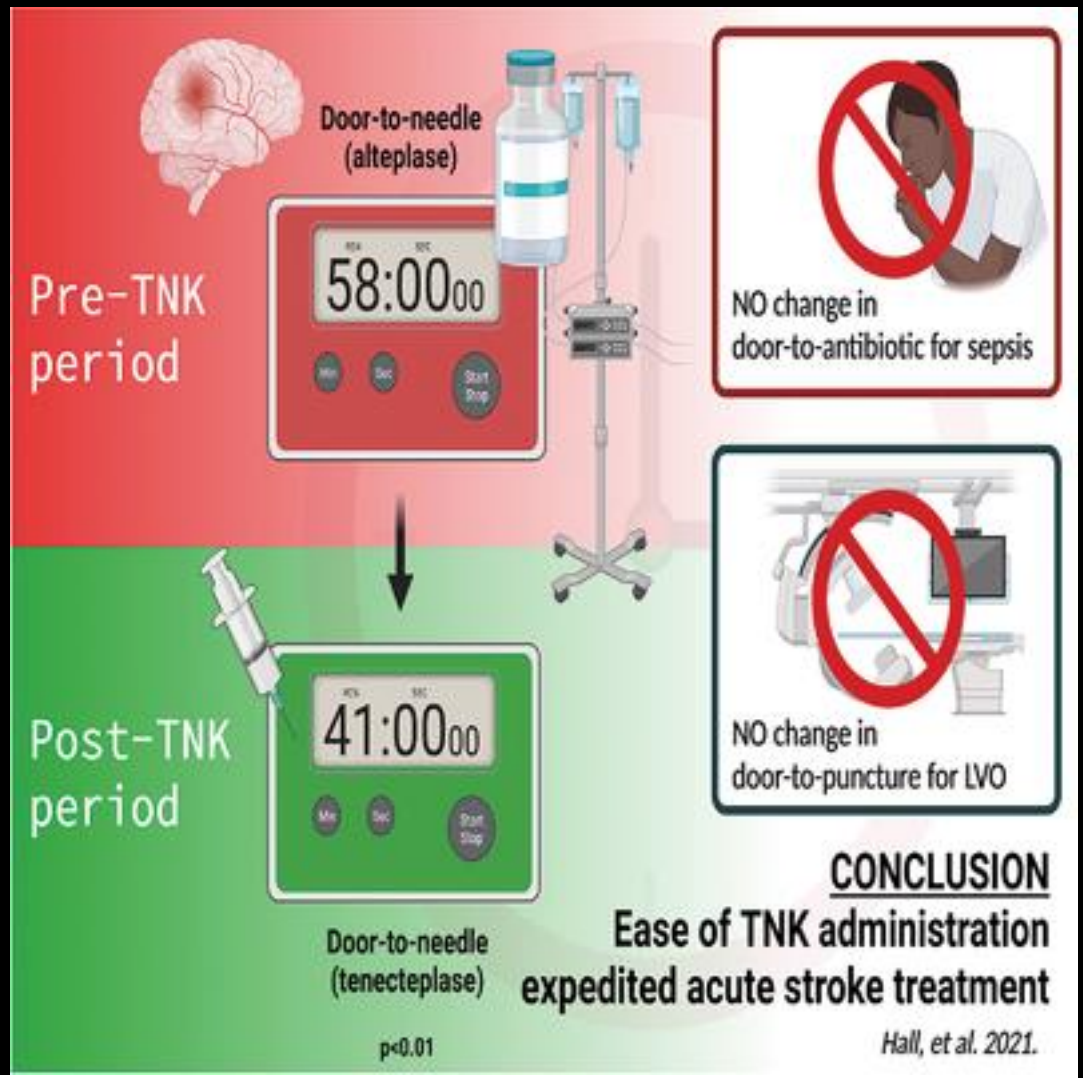
Carotid Stenting for Dissections

- Dissections can cause tandem occlusions and can be treated with stent placement.
- The stent acts as a scaffold, supporting the arterial wall and tacks down the dissection flap, which can prevent further luminal narrowing or thromboembolism.



Bridging Therapy

- Combination of intravenous tissue plasminogen activator (IV tPA) of Tenecteplase (TNK) administration followed by endovascular intervention.
- Start reperfusion with IV tPA or TNK and then remove the larger, more proximal clots endovascularly.
- In the presence of a carotid lesion that requires stenting, there's a risk of hemorrhagic complications with IV tPA.
- Decision to proceed with bridging therapy should be individualized.



Tenecteplase Improves Door-to-Needle Time in Real-World Acute Stroke Treatment

Jillian Hall, Jesse M. Thon, Mark Heslin, Lauren Thau, Terri Yeager, Taylor Siegal, Nicholas Vigilante, Scott Kamen, Justin Tiongson, Tudor G. Jovin and James E. Siegler

Originally published 17 Nov 2021 | https://doi.org/10.1161/SVIN.121.000102 | Stroke: Vascular and Interventional Neurology. 2021;1:e000102

Antiplatelet Medication

- In situations where a stent is placed, dual antiplatelet therapy - typically aspirin and clopidogrel (Plavix), ticagrelor (Brelinta), or prasugrel (Effient)- is initiated to prevent in-stent thrombosis.
- The exact duration varies, but typically, clopidogrel / ticagrelor / prasugrel might be continued for several weeks to months, while aspirin is often continued long-term.

Antiplatelet Medication

- Intravenous initiation of antiplatelet effects with medications such as abciximab (ReoPro), cangrelor (Kengreal), and eptifibatide (Integrelin) allows for more rapid intraprocedural use of stents.

Dotter Technique

- Angioplasty or catheter traversal without stent placement.
- Balloon inflated at the site of stenosis or occlusion, compressing the plaque and dilating the vessel.
- Catheter angioplasty with large bore guide catheter following wire traversal and subsequent microcatheter, intermediate catheter, and guide catheter traversal directly across stenosis.

Dotter Technique - Pros

- No foreign body left in the vessel, reducing the need for prolonged antiplatelet therapy.
- May be safer in patients with a high risk of hemorrhage or those who cannot be on dual antiplatelet therapy.

Dotter Technique - Cons

- Higher risk of vessel recoil or re-narrowing compared to stenting.
- May not be as effective for fibrous or calcified lesions.
- The risk of dissection or vessel rupture, though this risk also exists with stenting.

Stent Placement - Pros

- Typically more effective in preventing vessel recoil and re-narrowing.
- Particularly useful for treating dissections, as the stent can help 'tack down' the dissected layers.
- Covered stents can be used to treat pseudoaneurysms or vessel rupture.

Stent Placement - Cons

- ‘Requires’ prolonged antiplatelet therapy to prevent in-stent thrombosis, which might increase the risk of hemorrhagic complications.
- Risk of stent migration, in-stent restenosis, and thrombosis.
- Device-related complications, such as stent kinking / fracture or vessel injury / dissection.

Lack of Consensus Among Stroke Experts on the Optimal Management of Patients With Acute Tandem Occlusion

Gregory Jacquin, MD*, Alexandre Y. Poppe, MD, CM*, Marilyn Labrie, MD, Nicole Daneault, MD, Yan Deschaintre, MD, Laura C. Gioia, MD, Celine Odier, MD, Jean Raymond, MD, Daniel Roy, MD, Alain Weill, MD, and Christian Stapf, MD

BACKGROUND AND PURPOSE— In patients with acute stroke caused by tandem occlusion, the benefit of immediate revascularization (stenting) of the cervical internal carotid artery lesion during endovascular thrombectomy is uncertain. We sought to determine current practice patterns and whether consensus existed among physicians with stroke expertise.

METHODS— We distributed an online survey to stroke experts affiliated with the Canadian Stroke Consortium, the Canadian Interventional Neuro Group, the Society of Vascular and Interventional Neurology, and international ESCAPE trial (Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion With Emphasis on Minimizing CT to Recanalization Times) collaborators. Questions were based on clinical scenarios, and multiple choice responses across a Likert-type scale were provided. The survey was sent out in September 2017. After 2 months, data were extracted and then analyzed using descriptive statistics.

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.

CONCLUSIONS— This survey shows high variability in practice about acute management of tandem occlusion. The existence of community equipoise underscores the importance of a randomized trial evaluating the benefit of acute internal carotid artery stenting in patients with tandem occlusion undergoing endovascular thrombectomy.

Stroke
Volume 50, Issue 5, May 2019; Pages 1254-1256
https://doi.org/10.1161/STROKEAHA.118.023758

Key Words: carotid stenosis ▪ consensus ▪ standard of care ▪ thrombectomy ▪ uncertainty

Table. Characteristics of Respondents Characterized as Stenters Versus Nonstenters (Table view)

	Stenters; N=96	Nonstenters*; N=66	*P* Value
Specialty			
Stroke neurology	43 (44.8%)	22 (33.3%)	0.14
Radiology	25 (26.0%)	13 (19.7%)	0.34
Neurosurgery	11 (11.5%)	14 (21.2%)	0.09
Interventional neuroradiology	43 (44.8%)	31 (47.0%)	0.78
Others	10 (10.4%)	8 (12.1%)	0.73
Country of practice			
Canada	50 (52.1%)	45 (68.1%)	0.04
United States	30 (31.3%)	12 (18.2%)	0.06
Others	16 (16.7%)	9 (13.6%)	0.59
Years of practice			
0–5	34 (35.4%)	15 (22.7%)	0.08
5–15	32 (33.3%)	26 (39.4%)	0.42
>15	30 (31.3%)	25 (37.9%)	0.38

* Nonstenters were defined as respondents who never use stenting for tandem occlusion, whereas stenters use carotid stenting rarely, sometimes, usually, or always.

The most frequently reported factors that would make physicians avoid stenting included the potential risk of intracranial hemorrhage associated with the use of antiplatelet therapy (n=110, 67.9%), the possibility of acute stent thrombosis (n=84, 51.9%), and the absence of evidence in favor of stenting (n=83, 51.2%). On the other hand, 92 (56.8%) respondents suggest that acute stenting would facilitate intracranial recanalization and help cerebral hemodynamics, while 91 (56.2%) agree that stenting would prevent early recurrent ischemic events.

Among stenters, intravenous thrombolysis makes 33.3% (32/96) of respondents less inclined to stent, because of the higher estimated risk of intracranial hemorrhage when combined with antiplatelet agents required for stent patency. The retrograde approach (revascularization of the intracranial occlusion followed by carotid stenting) is adopted most frequently (63/96, 65.6%), and dual antiplatelet therapy is the preferred regimen (n=61/96, 63.5%).

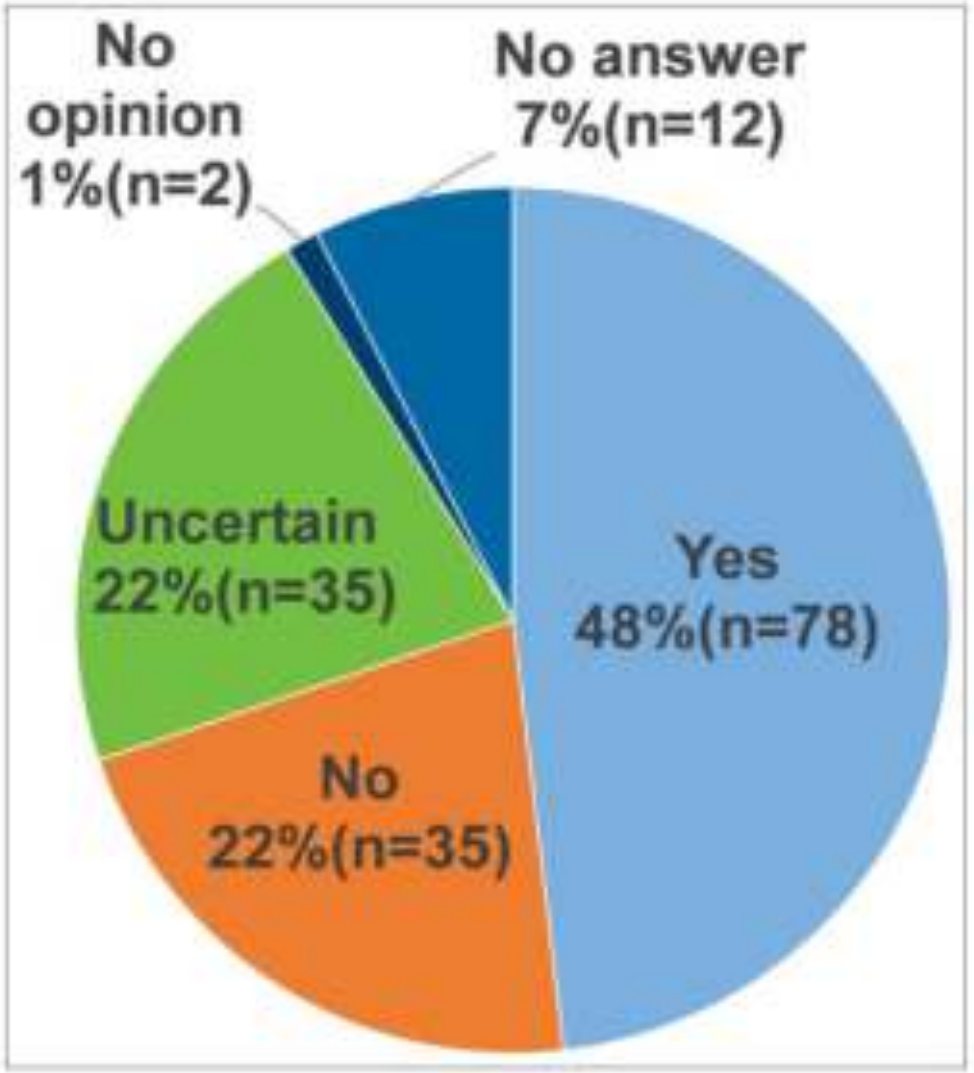


Figure 2. Distribution of responses to the question: "Do you think there exists equipoise regarding the optimal acute management of internal carotid artery lesions for patients with tandem occlusion undergoing endovascular thrombectomy for acute stroke?"

european journal of neurology
the official journal of the european academy of neurology

First published: 25 March 2018 | https://doi.org/10.1111/ene.13633
Original Article

Impact of intravenous thrombolysis and emergent carotid stenting on reperfusion and clinical outcomes in patients with acute stroke with tandem lesion treated with thrombectomy: a collaborative pooled analysis

B. Gory ✉, D. C. Haussen, M. Piotin, H. Steglich-Arnholm, M. Holtmannspötter, J. Labreuche, M. Kyheng, C. Taschner, S. Eiden, R. G. Nogueira, P. Papanagiotou, M. Boutchakova, A. H. Siddiqui, B. Lapergue,

Thrombectomy In TANdem lesions (TITAN) investigators: Claire Jossan, Andreas Kastrup, Jonathan Andrew Grossberg, Adrien Guenego, Julien Darcourt, Isabelle Vukasinovic, Elisa Pomero, Jason Davies, Leonardo Renieri, Corentin Hecker, Maria Muchada, Arturo Consoli, Georges Rodesch, Emmanuel Houdart, Raymond Turner, Aquila Turk, Imran Chaudry, Paul-Emile Labeyrie, Roberto Riva, Johanna Lockau, Raphaël Blanc, Hocine Redjem, Daniel Behme, Hussain Shallwani, Maurer Christopher, Camille Neuillet, René Anxionnat, Serge Bracard, Sébastien Richard

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Background and purpose

Tandem anterior circulation lesions in the setting of acute ischemic stroke (AIS) are a complex endovascular situation that has not been specifically addressed in trials. We determined the predictors of successful reperfusion and good clinical outcome at 90 days after mechanical thrombectomy (MT) in patients with AIS with tandem lesions in a pooled collaborative study.

Methods

This was a retrospective analysis of consecutive patients presenting to 18 comprehensive stroke centers with AIS due to tandem lesion of the anterior circulation who underwent MT.

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Original Article

Impact of intravenous thrombolysis and emergent carotid stenting on reperfusion and clinical outcomes in patients with acute stroke with tandem lesion treated with thrombectomy: a collaborative pooled analysis

B. Gory, D. C. Haussen, M. Piotin, H. Steglich-Arnholm, M. Holmannspötter, J. Labreuche, M. Kyheng, C. Taschner, S. Eiden, R. G. Nogueira, P. Papanagiotou, M. Boutchakova, A. H. Siddiqui, B. Lapergue, F. Dorn, C. Cognard, M. Killer, S. Mangiafico, M. Ribo, M. N. Psychogios, A. M. Spiotta, M. A. Labeyrie, A. Biondi, M. Maiighi, F. Turjman, on behalf of the Thrombectomy in TAndem lesions (TITAN) investigators

Results

A total of 395 patients were included. Successful reperfusion (modified thrombolysis in cerebral infarction score 2b–3) was achieved in 76.7%. At 90 days, 52.2% achieved a good outcome (modified Rankin Scale score 0–2), 13.8% suffered a parenchymal hematoma and 13.2% were dead. Lower National Institutes of Health Stroke Scale score [odds ratio (OR), 1.26; 95% confidence intervals (CI), 1.07–1.48, $P = 0.004$], Alberta Stroke Program Early CT Score ≥7 (OR, 2.00; 95% CI, 1.07–3.43, $P = 0.011$), intravenous thrombolysis (OR, 1.47; 95% CI, 1.01–2.12, $P = 0.042$) and stenting of the extracranial carotid lesion (OR, 1.63; 95% CI, 1.04–2;53, $P = 0.030$) were independently associated with successful reperfusion. Lower age (OR, 1.58; 95% CI, 1.26–1.97, $P < 0.001$), absence of hypercholesterolemia (OR, 1.77; 95% CI, 1.10–2.84, $P = 0.018$), lower National Institutes of Health Stroke Scale scores (OR, 2.04; 95% CI, 1.53–2.72, $P < 0.001$), Alberta Stroke Program Early CT Score ≥7 (OR, 2.75; 95% CI, 1.24–6.10, $P = 0.013$) and proximal middle cerebral artery occlusion (OR, 1.59; 95% CI, 1.03–2.44, $P = 0.035$) independently predicted a good 90-day outcome.

Conclusions

Intravenous thrombolysis and emergent stenting of the extracranial carotid lesion were predictors of a successful reperfusion after MT of patients with AIS with tandem lesion of the anterior circulation.

frontiers in Neurology

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

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Introduction: Endovascular therapy has been shown to be an effective and safe treatment for tandem occlusion. The endovascular therapeutic strategies for tandem occlusions strokes have not been adequately evaluated and the best approach is still controversial. The TITAN (Thrombectomy in TANdem occlusions) registry was a result of a collaborative effort to identify the best therapeutic approach for acute ischemic stroke due to tandem lesion. In this review, we aim to summarize the main findings of the TITAN study and discuss the challenges of treatment for tandem occlusion in the era of endovascular thrombectomy.

Methods: A review of the data from the multicenter international observational and non-randomized TITAN registry was performed. The TITAN registry included acute ischemic stroke patients with tandem lesions (proximal intracranial occlusion and cervical carotid artery occlusion or stenosis>90%) who were treated with thrombectomy with or without carotid artery stenting.

Results: Prior intravenous thrombolysis and emergent cervical carotid stenting were associated with higher reperfusion (mTICI 2b-3 and mTICI 3) rates at the end of the intervention. Poor outcome did not occur more frequently after stenting than after conservative treatment of the cervical carotid lesion. Emergent carotid stenting with antithrombotic agents and intracranial thrombectomy yielded higher reperfusion rate and good outcome (90 day mRS 0–2) compared to other strategies (carotid artery stenting and thrombectomy without antithrombotic, angioplasty and thrombectomy, or thrombectomy alone). Pretreatment intravenous thrombolysis was not associated with increased risk of hemorrhagic complications. Likewise, periprocedural unfractionated heparin did not modify the efficacy and safety results. Etiology of carotid artery lesion (atherosclerosis vs. dissection) did not emerge as predictor of outcome or recanalization.

Conclusion: Emergent stenting of the cervical carotid lesion with antithrombotic agents in conjunction to thrombectomy appears to be the best treatment strategy for acute ischemic strokes with tandem lesions. These findings will be further investigated in the ongoing randomized controlled TITAN trial.

Keywords: tandem occlusion, stroke, carotid stenting, endovascular treatment, thrombectomy, emergent stenting in tandem occlusion

Analysis of TITAN Registry Data

- Successful reperfusion, expressed in terms of modified thrombolysis in cerebral infarction score 2b-3 was achieved in 79.4%
- 90 days, 53.4% achieved a good outcome, expressed in terms of modified Rankin Scale score 0–2
- Intravenous thrombolysis and emergent carotid artery stenting were predictors of a successful reperfusion, as independently associated with the latter
- Lower age, absence of hypercholesterolemia, lower NIHSS scores, ASPECT Score ≥ 7 and proximal middle cerebral artery occlusion independently predicted a good 90-day outcome
- Patients treated with acute antiplatelet medications and stenting have more favorable outcomes than patients treated with angioplasty alone or those with no acute ICA intervention

ORIGINAL RESEARCH article

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Direct dotterising or angioplasty of acute stroke due to tandem atherosclerotic occlusions

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Background: Tandem occlusions cause 10–15% of LVO acute ischemic strokes but are difficult to treat endovascularly and frequently excluded from clinical trials. The optimum endovascular method is still debated, however going directly through the carotid occlusion can speed up the procedure and reduce procedural risk by eliminating an exchange maneuver.

Method: Using retrospective data from three centers, we compared treating atherosclerotic tandem occlusions using a 0.035"-guidewire and direct dotterisation or angioplasty with a peripheral vascular balloon suitable for the wire, vs. the usual technique of an 0.014"wire. We compared the successful recanalization (mTICI 2b-3) rates, 90 days' functional outcomes (mRS 0–2), and puncture-to-recanalization times between both procedures.

Results: Forty-two consecutive patients with atherosclerotic tandem occlusions were included. 25 were treated with the 0.014"wire technique and 17 with the 0.035"-guidewire and direct dotterisation or angioplasty with a peripheral vascular balloon technique. The direct technique achieved a higher rate of successful recanalization (100 vs. 72%, $P = 0.018$), better functional outcome (88.4 vs. 48.0%, $P = 0.044$), and faster procedure times (mean 83.1 mins vs. 114.8 mins, $P < 0.001$). The number of attempts was similar between both groups (median 2 vs 3 attempts, $P = 0.101$). There was no significant difference in the complication rate between both groups (5.9 vs. 12.0%, $P = 0.462$).

Conclusion: Compared to previous endovascular techniques for treating atherosclerotic tandem occlusions, the direct technique using standard 0.035" guidewires and dotterisation or a peripheral vascular balloon is significantly faster with better outcomes. However, this will require further external validation in larger cohorts.

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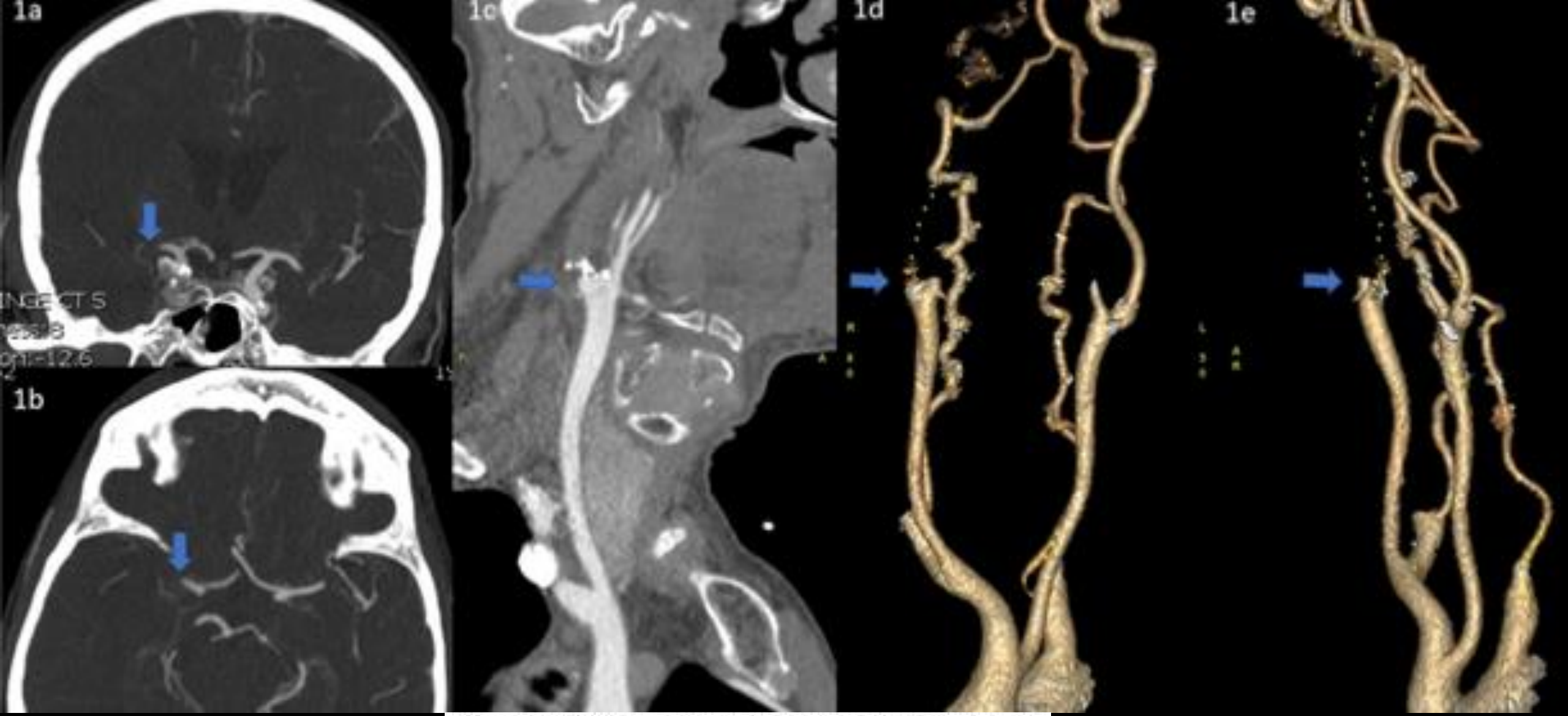

Figure 1. **(a, b)** CT-A images of the terminal ICA/proximal MCA occlusion. **(c)** The heavily calcified ICA occlusion at the bifurcation suggestive of an atherosclerotic lesion **(d, e)** 3d-reconstructions of the same ICA occlusion.

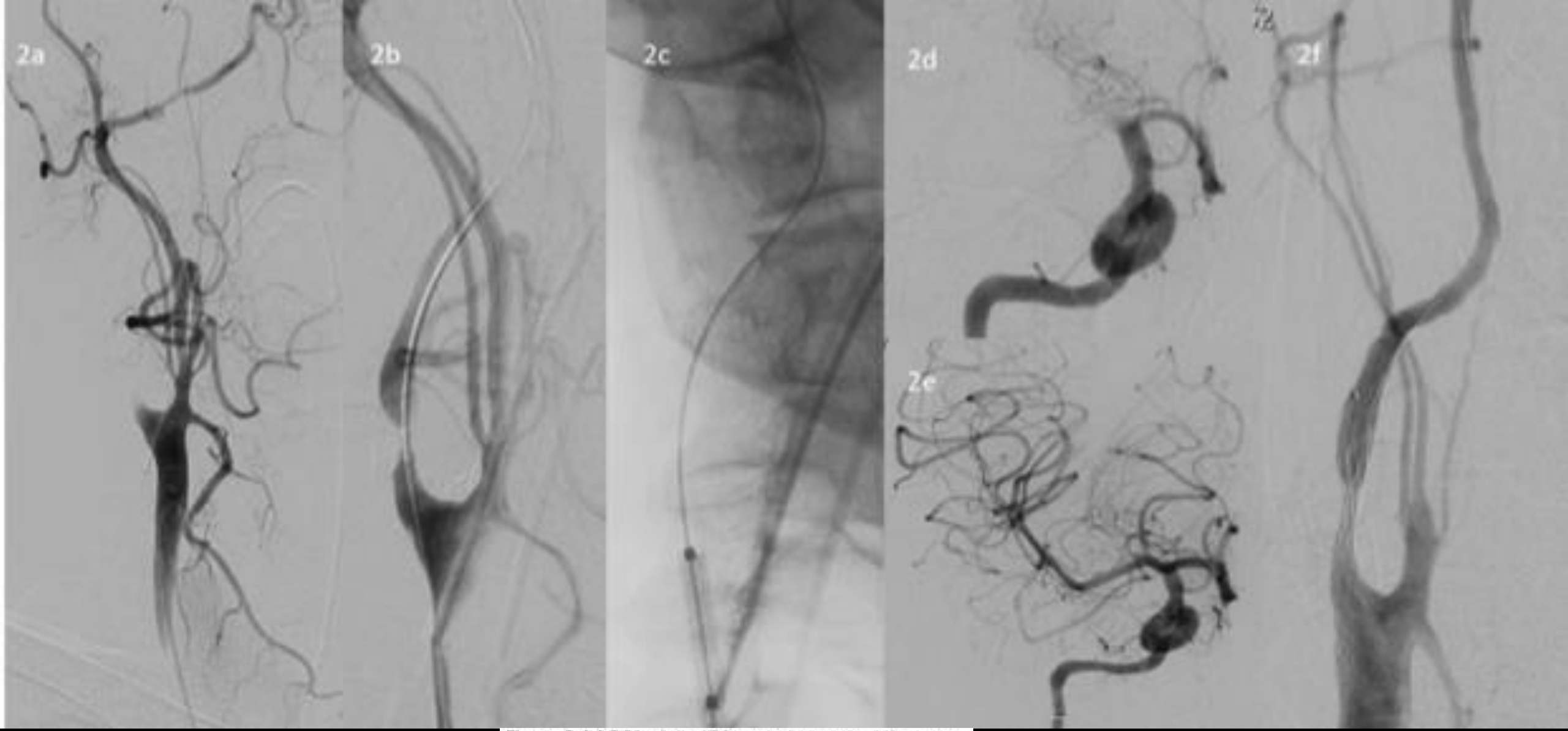

Figure 2: **(a)** DSA of the ICA occlusion at the bifurcation **(b)** Crossing the occlusion with a 260 cm 0.035-inch guidewire, **(c)** Angioplasty of the ICA occlusion with a 5 mm over-the-wire balloon, typically used for peripheral vessels, in this case a Passeo-35 5 x 20 mm balloon, **(d)** DSA showing the TICA/proximal MCA occlusion, **(e)** Post-thrombectomy DSA of the intracranial proximal MCA occlusions, **(f)** Subsequent stenting of the residual ICA stenosis with a stenting with Roadsaver 8 x 20 mm stent.

Antegrade or Retrograde?

- Antegrade: Emergently treating the extracranial carotid lesion before intracranial carotid lesion
  - Dotterising
  - Stent placement
  - Ensure patency for safe access to the intracranial occlusion

- Retrograde: Emergently treating the intracranial carotid lesion before extracranial carotid lesion
  - Stent retriever and/or Aspiration
  - Usually involves exchange length wires
  - Improve collateral circulation to the ischemic penumbra

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Ischemic stroke
Original research

Proximal to distal approach in the treatment of tandem occlusions causing an acute stroke

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Abstract

Introduction A tandem occlusion is a rare presentation of acute stroke that involves an occlusion of the internal carotid artery at the bifurcation with an intracranial middle cerebral artery occlusion. This study describes the experience at our institution in treating tandem occlusions with a proximal to distal approach in the acute stroke setting.

Methods A retrospective review of acute strokes caused by tandem occlusions requiring thrombectomy were performed.

Results 16 cases were identified with a mean National Institutes of Health Stroke Scale score at presentation of 13.1±3.9. The proximal occlusion was crossed initially with a microwire in all cases. All carotid occlusions were treated with stenting, and intracranial vessel thrombectomy was performed with a variety of devices. Procedure related complications occurred in two (12.5%) patients. Eight patients (50%) achieved a good outcome (modified Rankin Scale score of 0–2).

Conclusions A tandem occlusion of the carotid artery at the bifurcation with a concomitant intracranial occlusion is a relatively rare and complex presentation of acute stroke. We have found that addressing the proximal lesion first and covering it with a stent prior to performing distal thrombectomy appears to be a safe and effective option in the treatment algorithm.

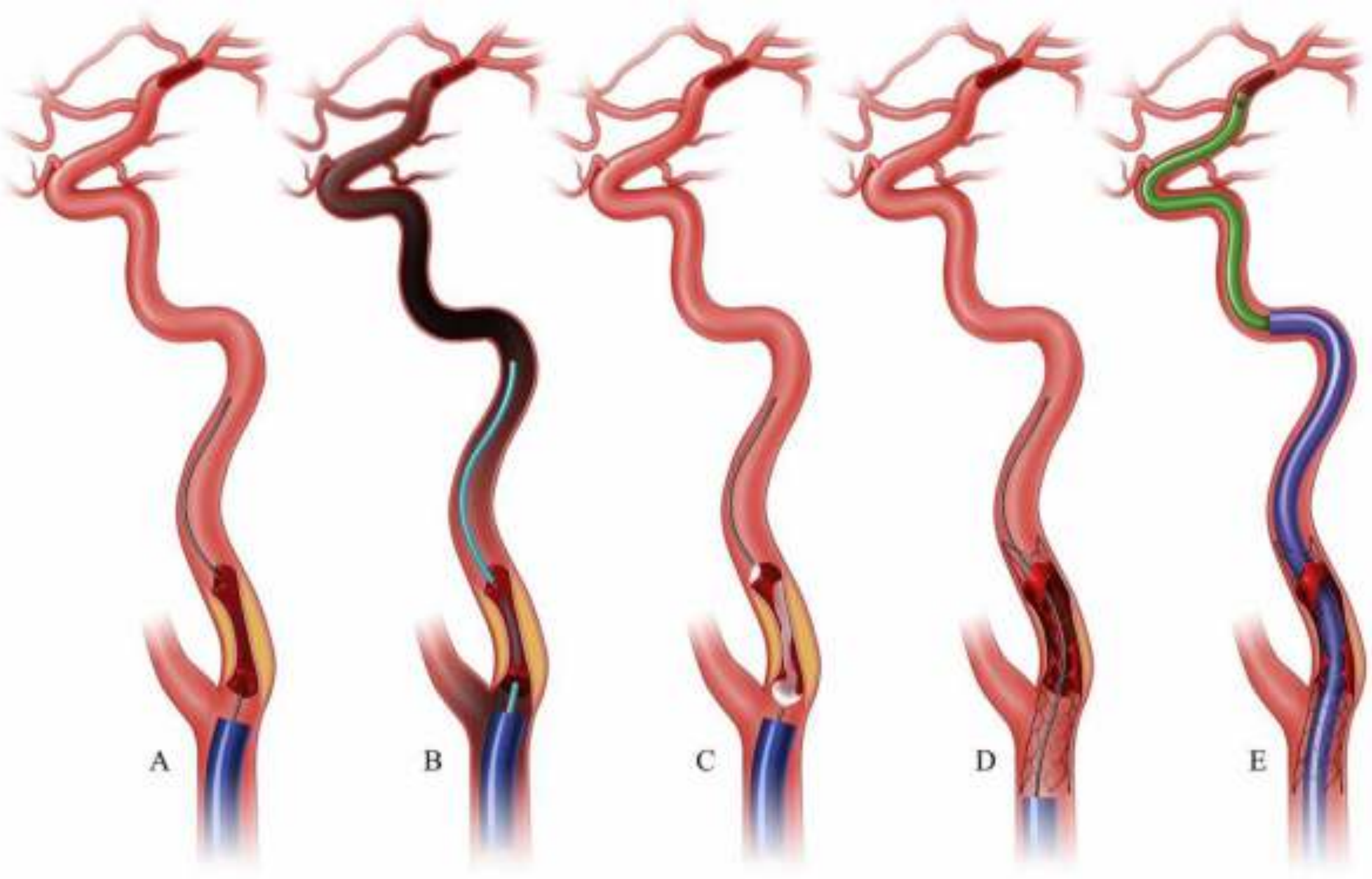
A
B
C
D
E

Table 1 Summary of patient demographics, site of occlusion, devices used to cross and treat the occlusion, time to recanalization, and outcome

Patient NIHSS, time from onset (h), IV tPA (+/−)	Site of occlusion	Guide catheter	Devices used to cross proximal occlusion	Balloon/stent	Embolic protection device	Thrombectomy devices	Time to TICI 2b or III flow for distal occlusion (min)	Complications	NIHSS at discharge	mRS at 90 days
61, 8, 5.5, (−)	RICA, right MV	6 F Neuron MAX 088 sheath	Transend EX 0.014 inch, Velocity 025 microcatheter	3×20 mm Sterling, Minivast8×40 mm Precise	5 mm Spider FX	SMAX XC3	60	Small amount of SAH	3	1*
55, 18, 3.8, (+)	RICA, right MV	6 F Neuron MAX 088 sheath	Transend EX 0.014 inch, Precise stent delivery catheter	4×20 mm Apex/Tx40 mm Precise	–	SMAX, 8MAX, 4×18 mm Solitaire	45	Large ICH/IVH; WOC 4 days after intervention	NA	6
63, 15, 8.4, (+)	RICA, right MV	6 F Neuron MAX 088 sheath	Transend EX 0.014 inch, 4×20 mm Sterling balloon catheter	4×20 mm Sterling, Minivast8×40 mm Precise	–	SMAX XC3, 8MAX	35	None	4	3
86, 19, Wake up stroke—unknown last normal time, (−)	LICA, left MV	6 F Neuron MAX 088 sheath	Fathom 0.016 inch, FX 35m 025 microcatheter	4×20 mm Sterling, Minivast8×40 mm Precise, 6×40 mm Precise, 7×40 mm Precise	–	SMAX, Trevo stent retriever	90	None	NR	3*
85, 12, 9.3, (−)	RICA, Right MV	6 F Neuron MAX 088 sheath	Transend EX 0.014 inch, Velocity 025 microcatheter	4×20 mm Apex/Tx40 mm Precise	–	SMAX XC3	30	None	1	1*
59, 11, 24.8, (−)	LICA, left MV, left A2	6 F Neuron MAX 088 sheath	Transend EX 0.014 inch, Velocity 025 microcatheter	4×20 mm Sterling, Minivast7×40 mm Precise	–	SMAX XC3, 8MAX	80	Petrous segment ICA dissection requiring 4.0×17 mm Enterprise stent; 1 mm left basal ganglia hemorrhage	3	2*
67, 9, 12.5, (−)	RICA, right MV	6 F Shuttle sheath	Traxcess, SL-10 microcatheter	3×15 mm Apex/Tx40 mm Precise	4 mm Spider FX	041 Penumbra reperfusion catheter and separator	71	Small amount of SAH	0	1
90, 15, 4.3, (+)	Left CCA, left MV, left A2	6 F Neuron MAX 088 sheath	Traxcess, Echelon-14 027 microcatheter	4×20 mm Apex/8×40 mm Precise	4 mm Spider FX	041 Penumbra reperfusion catheter and separator, 026 Penumbra reperfusion catheter and separator	102	Small amount of SAH	15	4
70, 14, 7.7, (+)	RICA, right MV	6 F Neuron MAX 088 sheath	Transend EX 0.014 inch, SL-10 (F35) microcatheter	4×20 mm Sterling, Minivast5×40 mm Precise, 7×40 mm Precise	4 mm Spider FX	041 Penumbra reperfusion catheter and separator	95	None	11	1
54, 6, 12.7, (+)	LICA, left supraclinoid ICA, left MV,	6 F Neuron MAX 088 sheath	Fathom 0.016 inch, 026 Penumbra reperfusion catheter and separator	4×20 mm Sterling, Minivast8×40 mm Precise	–	032 Penumbra reperfusion catheter and separator, 026 Penumbra reperfusion catheter and separator	140	Perforation of left M2 anterior division branch; small parenchymal hemorrhage	14	3
73, 16, 3.7, (+)	RICA, right supraclinoid ICA	6 F Shuttle sheath	Transend EX 0.014 inch, SL-10 (F35) microcatheter	5×20 mm Apex/10×40 mm Precise	–	054 Penumbra reperfusion catheter and separator	77	None	14	3
68, 11, 7.5, (−)	RICA, right MV	6 F Envoy XB guide catheter	Traxcess, Headway 021 microcatheter	3×8 mm Apex/Tx40 mm Precise, 6×28 mm Precise	–	None required, reconstituted distally after proximal lesion addressed	71	Small parietal hemorrhage	11	1
88, 17, 15.2, (+)	RICA, right MV	6 F Shuttle sheath	Synchro, SL-10 (F35) microcatheter	5×40 mm Precise, 6×20 mm Precise, 5×20 mm Precise	–	032 Penumbra reperfusion catheter and separator	123	None	0	1
55, 7, 23.3, (−)	RICA, right MV	6 F Shuttle sheath	Traxcess, Prowler 14 (F35) microcatheter	4×20 mm Sterling, Minivast7×40 mm Precise	4 mm Spider FX	032 Penumbra reperfusion catheter and separator	87	Asymptomatic 3 cm×2 cm right parietal ICH	0	1
82, 16, 4.8, (+)		6 F Shuttle sheath		2.5×15 mm Apex/ 4.5×28 mm Enterprise	–	054 Penumbra reperfusion catheter and separator, 026	77	WOC 4 days after intervention	NA	6
	RICA, right supraclinoid ICA, right MV		Transend EX 0.014 inch, SL-10 (F35) microcatheter			Penumbra reperfusion catheter and separator				
69, 17, 6.2, (+)	RICA, right MV	6 F Neuron MAX 088 sheath	Fathom 0.016 inch, Velocity 025 microcatheter	4×20 mm Sterling, Minivast7×40 mm Precise	–	SMAX, 4MAX	28	WOC 3 days after intervention	NA	6

*mRS at the time of discharge data acquired prior to 90 day post intervention follow-up.
AC, anterior cerebral artery; AC segment; CCA, common carotid artery; ICA, internal carotid artery; ICH, intracerebral hemorrhage; IVH, intraventricular hemorrhage; LICA, left cervical ICA; MV, middle cerebral artery M1 segment; MC, middle cerebral artery M2 segment; mRS, modified Rankin Scale; NA, not applicable; NIHSS, National Institutes of Health Stroke Scale; NR, not recorded; RICA, right cervical ICA; SAH, subarachnoid hemorrhage; TICI, Thrombolysis in Cerebral Infarction; tPA, tissue plasminogen activator; WOC, withdraw of care

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Multicentric Experience in Distal-to-Proximal Revascularization of Tandem Occlusion Stroke Related to Internal Carotid Artery Dissection

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ABSTRACT

BACKGROUND AND PURPOSE: Internal carotid dissection is a frequent cause of ischemic stroke in young adults. It may cause tandem occlusions in which cervical carotid obstruction is associated with intracranial proximal vessel occlusion. To date, no consensus has emerged concerning endovascular treatment strategy. Our aim was to evaluate our endovascular "distal-to-proximal" strategy in the treatment of this stroke subtype in the first large multicentric cohort.

MATERIALS AND METHODS: Prospectively managed stroke data bases from 2 separate centers were retrospectively studied between 2009 and 2014 for records of tandem occlusions related to internal carotid dissection. Atheromatous tandem occlusions were excluded. The first step in the revascularization procedure was intracranial thrombectomy. Then, cervical carotid stent placement was performed depending on the functionality of the circle of Willis and the persistence of residual cervical ICA occlusion, severe stenosis, or thrombus apposition. Efficiency, complications, and radiologic and clinical outcomes were recorded.

RESULTS: Thirty-four patients presenting with tandem occlusion stroke secondary to internal carotid dissection were treated during the study period. The mean age was 52.5 years, the mean initial NIHSS score was 17.29 ± 6.23, and the mean delay between onset and groin puncture was 3.58 ± 1.1 hours. Recanalization TICI 2b/3 was obtained in 21 cases (62%). Fifteen patients underwent cervical carotid stent placement. There was no recurrence of ipsilateral stroke in the nonstented subgroup. Twenty-one patients (67.65%) had a favorable clinical outcome after 3 months.

CONCLUSIONS: Endovascular treatment of internal carotid dissection–related tandem occlusion stroke using the distal-to-proximal recanalization strategy appears to be feasible, with low complication rates and considerable rates of successful recanalization.

ABBREVIATIONS: ICD = internal carotid dissection; sICH = symptomatic intracranial hemorrhage

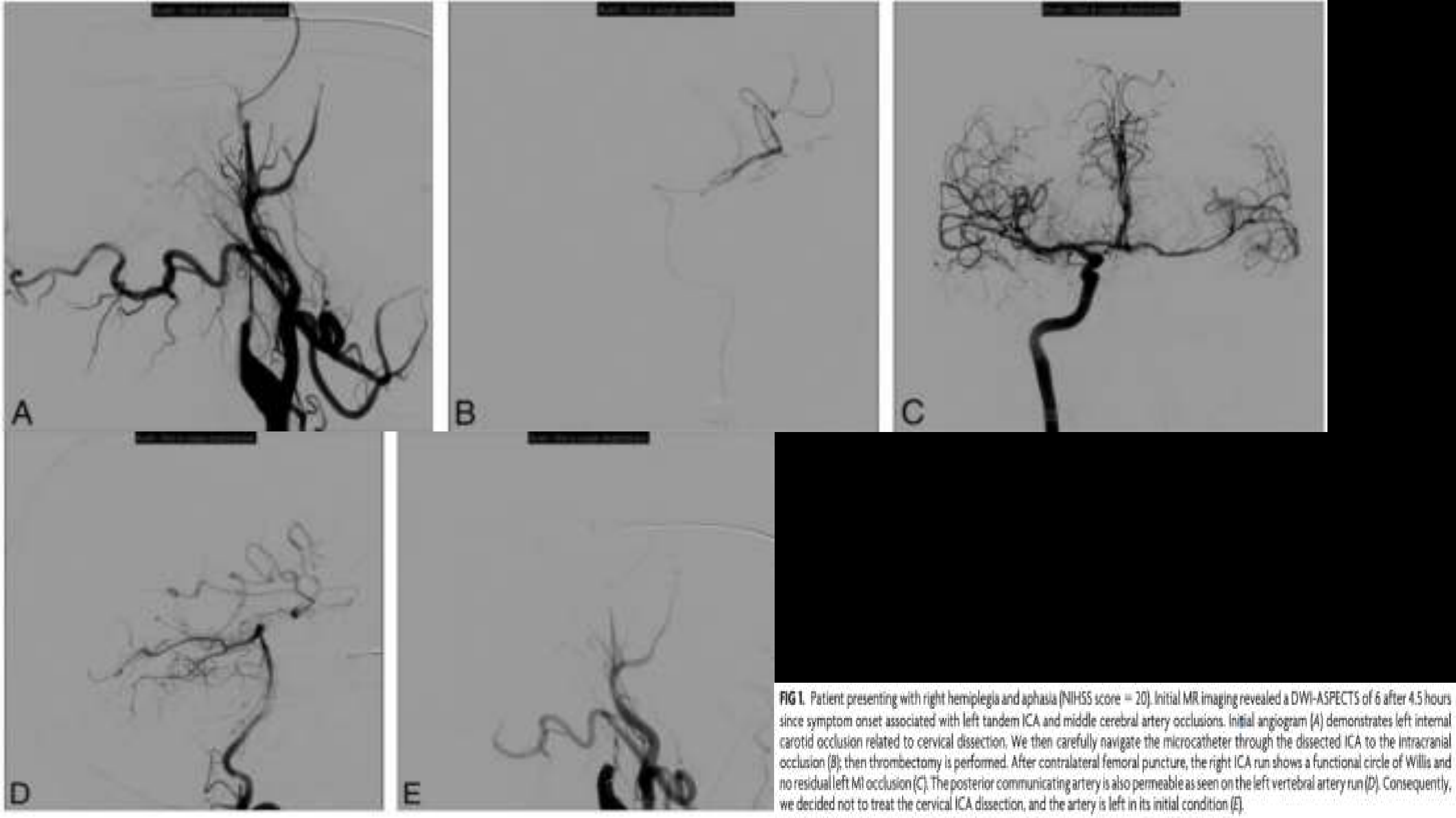

FIG 1. Patient presenting with right hemiplegia and aphasia (NIHSS score = 20). Initial MR imaging revealed a DWI-ASPECTS of 6 after 4.5 hours since symptom onset associated with left tandem ICA and middle cerebral artery occlusions. Initial angiogram (*A*) demonstrates left internal carotid occlusion related to cervical dissection. We then carefully navigate the microcatheter through the dissected ICA to the intracranial occlusion (*B*); then thrombectomy is performed. After contralateral femoral puncture, the right ICA run shows a functional circle of Willis and no residual left MI occlusion (*C*). The posterior communicating artery is also permeable as seen on the left vertebral artery run (*D*). Consequently, we decided not to treat the cervical ICA dissection, and the artery is left in its initial condition (*E*).

Table 1: Baseline characteristics of the population

Baseline Characteristics	Values
Age (mean) (range) (yr)	52.47 (30–73)
Sex (No.) (%)	
Female	12 (35.3%)
Male	22 (64.7%)
Initial NIHSS score (mean) (range)	17.29 (4–36)
High blood pressure (No.) (%)	14 (41.2%)
Associated IVT (No.) (%)	21 (61.8%)

Note:—IVT indicates intravenous thrombolysis.

Table 2: Clinical results

Procedural and Follow-Up Data	Values
Timing: onset-to-puncture (mean) (range) (min)	215.8 (142–360)
Intracranial occlusion topography (No.) (%)	
Internal carotid terminus	8 (23.5%)
M1	24 (70.6%)
M2	2 (5.9%)
No. of stent retriever passes (mean) (range)	2.03 (1–4)
Cervical ICA stenting (No.) (%)	15 (44.1%)
TICI 2b/3 (No.) (%)	23 (67.65%)
Timing: onset-to-revascularization (mean) (range) (min)	329.71 (180–855)
Favorable outcome (No.) (%)	23 (67.65%)
Mortality (No.) (%)	3 (8.8%)

Note:—Stentriever is trademarked technology of Stryker (Trevo).

Antegrade or Retrograde Approach for the Management of Tandem Occlusions in Acute Ischemic Stroke: A Systematic Review and Meta-Analysis

frontiers in Neurology

SYSTEMATIC REVIEW
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Background: Acute ischemic stroke (AIS) caused by tandem intracranial and extracranial occlusions is not rare. However, optimal strategy between antegrade (extracranial first) or retrograde (intracranial first) approaches still remains elusive. This systematic review and meta-analysis aim to compare the two approaches to provide updated clinical evidence of strategy selection.

Methods: PubMed, Ovid, Web of Science, and the Cochrane Library were searched for literature comparing antegrade and retrograde approaches for patients with AIS with concomitant tandem occlusions. Outcomes including successful reperfusion [Thrombolysis in Cerebral Infarction (TICI) 2b–3] and 90-day favorable outcome [modified Rankin Scale (mRS) 0–2], any intracerebral hemorrhage, symptomatic intracerebral hemorrhage, procedural complications, and mortality were evaluated. The risk of bias was assessed using the Newcastle–Ottawa Scale and illustrated in the Funnel plot. Heterogeneity was assessed by I^2 statistic. Subgroup and sensitivity analyses were also performed.

Results: A total of 11 studies accounting 1,517 patients were included. 831 (55%) patients were treated with an antegrade approach and 686 (45%) patients were treated with the retrograde approach. A higher successful reperfusion rate was achieved in retrograde group than that of antegrade group [83.8 vs. 78.0%; odds ratio (OR): 0.63, 95% CI: 0.40–0.99, $p = 0.04$]. 90-day favorable outcome (mRS 0–2 at 90 days) also showed significantly higher in retrograde group compared with antegrade group (47.3 vs. 40.2%; OR: 0.72, 95% CI: 0.58–0.89, $p = 0.002$). The incidence of any intracranial hemorrhage (ICH), symptomatic intracranial hemorrhage, 90-day mortality, and other complications did not differ between two groups.

Conclusion: In AIS with tandem occlusions, the retrograde approach might achieve a higher successful reperfusion rate and better functional outcome with a comparable safety profile when compared with an antegrade approach. Further prospective controlled studies with more meticulous design and a higher level of evidence are needed to confirm these results.

Need for Prospective Trials

- The optimal technical approach still needs clarification in prospective studies with meticulous design.
- In AIS due to tandem occlusions, distal vascular revascularization is favored to be more important than the proximal lesion treatment.
- Early reperfusion shortens the ischemic duration and could bring more beneficial for poor leptomeningeal collateral circulation in the acute phase of stroke, leading to theoretical better clinical outcomes for patients with TLs.
- For these reasons, to date, the retrograde approach is the one of choice in many centers; however, must be kept in mind that in some cases the retrograde approach is not feasible, due to high-grade stenosis and the anterograde approach seems to be the only choice.

First single-center randomized care trial trying to randomly allocate patients with tandem lesions.

In this trial, performed before the MR CLEAN results, patients were randomized to best medical treatment (BMT) alone versus BMT with endovascular thrombectomy (EVT), and patients allocated to EVT with tandem lesions underwent a second randomization, allocating them to acute stent placement or not.

Randomized allocation was interrupted when other trials showed the benefits of endovascular therapy.

U.S. National Library of Medicine

ClinicalTrials.gov

Recruitment Status : Recruiting
First Posted : February 7, 2020
Last Update Posted : November 14, 2022

See Contacts and Locations

Home > Search Results > Study Record Deta...

Endovascular Acute Stroke Intervention - Tandem OCclusion Trial (EASI-TOC)

Phase III multicenter prospective, randomized, open-label, blinded endpoint (PROBE) controlled trial with 458 patients enrolled and randomized (1:1) to undergo acute ICA stenting during the thrombectomy procedure (EITHER BEFORE OR AFTER MECHANICAL THROMBECTOMY AT DISCRETION OF PHYSICIAN)

The trial will seek to determine if in patients undergoing acute intracranial thrombectomy for anterior circulation stroke with concurrent ipsilateral symptomatic high-grade (≥70%) atherosclerotic stenosis or occlusion of the extracranial ICA, endovascular ICA revascularization with stenting is superior to intracranial thrombectomy alone with regards to functional outcome at 90 days (measured using the Modified Rankin Scale).

Study Type :	Interventional (Clinical Trial)
Estimated Enrollment :	458 participants
Allocation:	Randomized
Intervention Model:	Parallel Assignment
Intervention Model Description:	A multi-centre, prospective, randomized, open-label, blinded endpoint (PROBE) controlled trial (1:1 allocation).
Masking:	Single (Outcomes Assessor)
Masking Description:	Open-label, blinded endpoint (PROBE)
Primary Purpose:	Treatment
Official Title:	A Multi-centre, Prospective, Randomized, Open-label, Blinded Endpoint (PROBE) Controlled Trial Comparing Cervical Internal Carotid Artery Stenting to no Stenting During Thrombectomy for Tandem Occlusion Stroke
Actual Study Start Date :	August 31, 2020
Estimated Primary Completion Date :	June 2026
Estimated Study Completion Date :	March 2027

U.S. National Library of Medicine

ClinicalTrials.gov

Home > Search Results > Study Record Detail

Thrombectomy In TANdem Occlusion (TITAN)

Recruitment Status : Recruiting
First Posted : June 7, 2019
Last Update Posted : September 18, 2023

See Contacts and Locations

Investigator-initiated, multicenter, prospective, randomized, open-label, blinded-endpoint (PROBE) study, with 432 patients enrolled and randomized after tandem occlusion confirmation on angiogram

Compare the two types of treatment (Intracranial Thrombectomy and Extracranial Carotid Stenting VERSUS Intracranial Thrombectomy ALONE) in patients with acute ischemic stroke due to anterior circulation tandem occlusion, especially assessing the safety and efficacy of emergent internal carotid artery stenting associated with at least one antiplatelet therapy in the acute phase of stroke reperfusion.

Study Type :	Interventional (Clinical Trial)
Estimated Enrollment :	432 participants
Allocation:	Randomized
Intervention Model:	Parallel Assignment
Masking:	None (Open Label)
Primary Purpose:	Other
Official Title:	Intracranial Thrombectomy and Extracranial Carotid Stenting Versus Intracranial Thrombectomy Alone in Acute Anterior Circulation Strokes With TANdem Occlusion : the Randomized Controlled TITAN Trial
Actual Study Start Date :	April 29, 2020
Estimated Primary Completion Date :	October 30, 2025
Estimated Study Completion Date :	October 30, 2025

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Diagnosis and management of *tandem* occlusion in acute ischemic stroke

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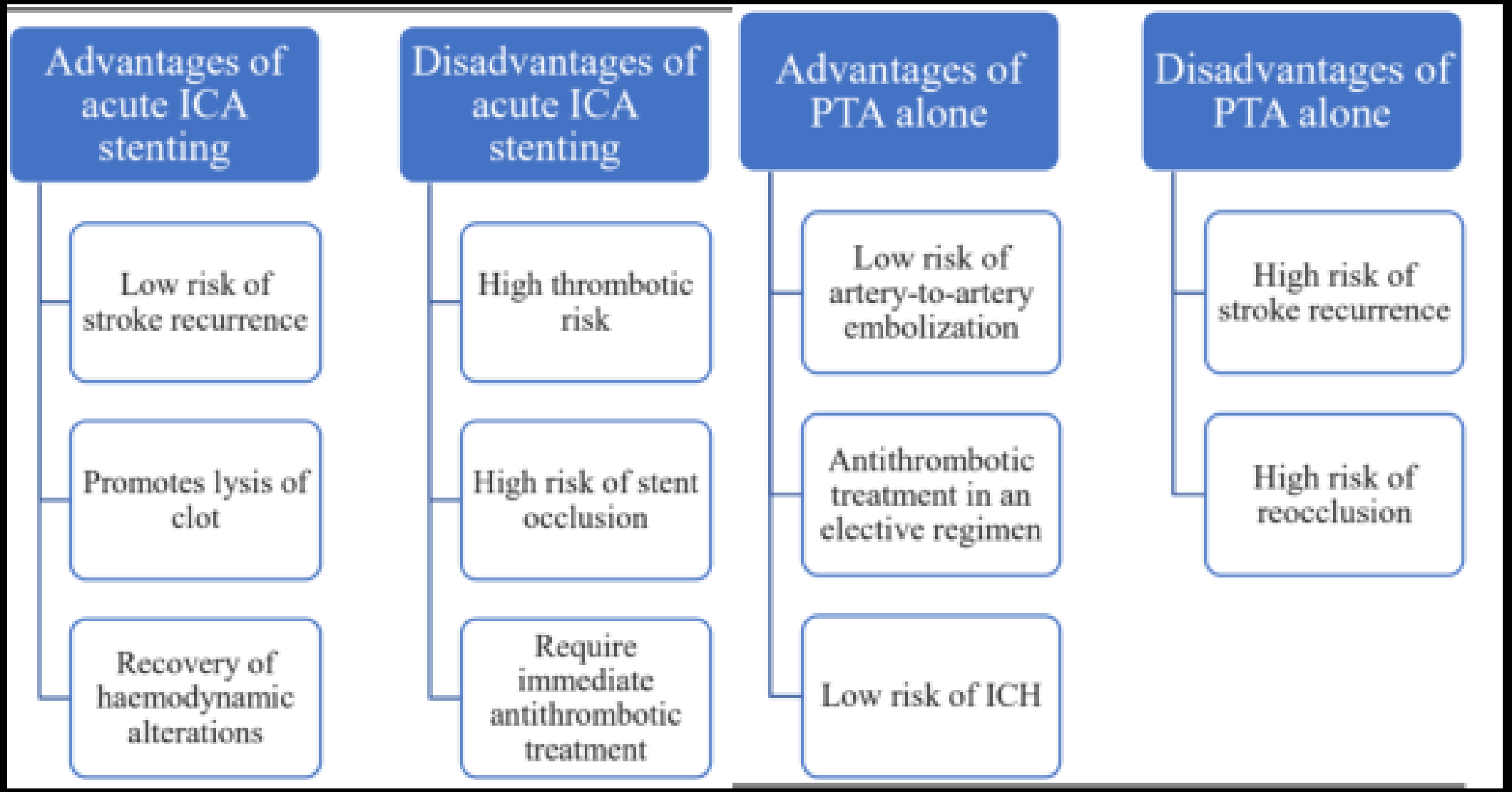
ARTICLE INFO

Keywords:
Acute Ischemic Stroke
Tandem lesion
Endovascular Thrombectomy
Tandem Occlusion
Stenting

ABSTRACT

Approximately 20–30% of patients with acute ischemic stroke, caused by large intracranial vessel occlusion, have a tandem lesion, defined as simultaneous presence of high-grade stenosis or occlusion of the cervical internal carotid artery and thromboembolic occlusion of the intracranial terminal internal carotid artery or its branches, usually the middle cerebral artery. Patients with tandem lesions have usually worse outcomes than patients with single intracranial occlusions, and intravenous thrombolysis is less effective in these patients. Although endovascular thrombectomy is currently a cornerstone therapy in the management of acute ischemic stroke due to large vessel occlusion, the optimal management of extracranial carotid lesions in tandem occlusion remains controversial. Acute placement of a stent in the cervical carotid artery lesion is the most used therapeutic strategy compared with stented balloon angioplasty and thrombectomy alone without carotid artery revascularization; however, treatment strategies in these patients are often more complex than with single occlusion, so treatment decisions can change based on clinical and technical considerations. The aim of this review is to analyze the results of different studies and trials, investigating the periprocedural neurointerventional management of patients with tandem lesions and the safety, efficacy of the different technical strategies available as well as their impact on the clinical outcome in these patients, to strengthen current recommendations and thus optimize patient care.


Advantages of acute ICA stenting
Low risk of stroke recurrence
Promotes lysis of clot
Recovery of haemodynamic alterations
Disadvantages of acute ICA stenting
High thrombotic risk
High risk of stent occlusion
Require immediate antithrombotic treatment
Advantages of PTA alone
Low risk of artery-to-artery embolization
Antithrombotic treatment in an elective regimen
Low risk of ICH
Disadvantages of PTA alone
High risk of stroke recurrence
High risk of reocclusion

Advantages of antegrade approach

- Increased distal recanalization
- Avoid recurrent distal occlusion due to slow-flow
- Low risk of dissection

Disadvantages of antegrade approach

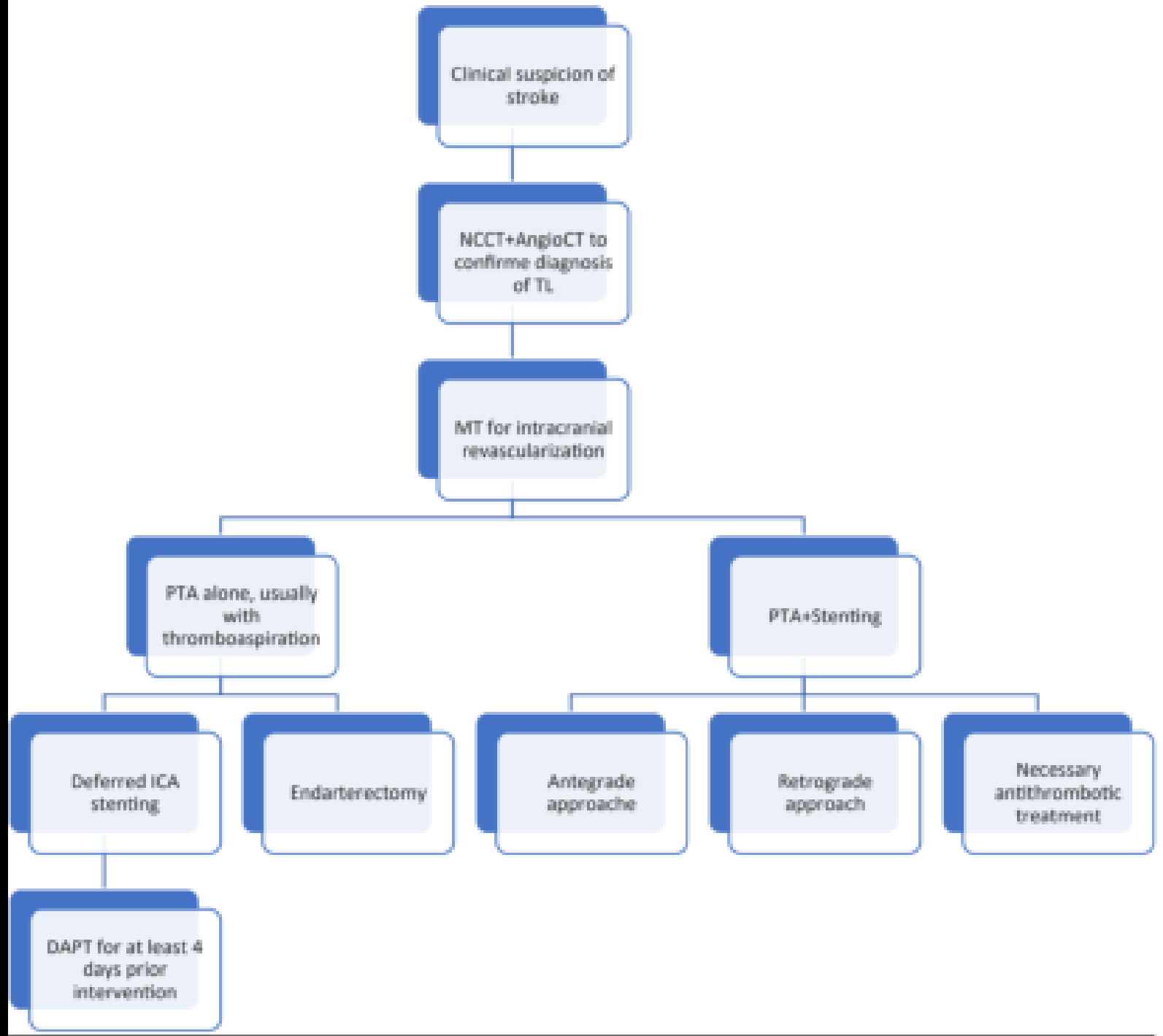
- Increased time for recanalization
- Possible increase infarct volume
- Entrapment within carotid stent

Advantages of retrograde approach

- Shorter intracranial recanalization time
- Avoid snagging of stent-retriever

Disadvantages of retrograde approach

- Distal embolization


Clinical suspicion of stroke
NCCT+AngioCT to confirme diagnosis of TI
MT for intracranial revascularization
PTA alone, usually with thromboaspiration
PTA+Stenting
Deferred ICA stenting
Endarterectomy
Antegrade approache
Retrograde approach
Necessary antithrombotic treatment
DAPT for at least 4 days prior intervention

Stroke Vasc Interv Neurol. 2023;3:e000825. DOI: 10.1161/SVIN.122.000825

CLINICAL PERSPECTIVE

- **What Is New?**
  A new bridging therapy, including balloon-expandable stents with less-aggressive antiplatelet therapy and subsequent definitive self-expanding stents, is proposed for endovascular treatment of patients with acute ischemic stroke and tandem occlusions.
- **What Are the Clinical Implications?**
  For patients with tandem occlusions and high hemorrhagic risk (eg, low Alberta Stroke Program Early CT [Computed Tomography] Score), using balloon-expandable bridging therapy may decrease the need for antiplatelet therapy during postoperative clinical management and potentially result in a reduction in symptomatic intracranial hemorrhage.

Deferred ICA intervention

Deferred ICA intervention refers to a staged approach, in long term which carotid recanalization is usually performed a few days after intracranial EVT and represents an additional treatment option.

Stroke: Vascular and Interventional Neurology

ORIGINAL RESEARCH

Balloon-Expandable Stenting as a Bridging Therapy in Patients With Acute Stroke and Tandem Occlusions

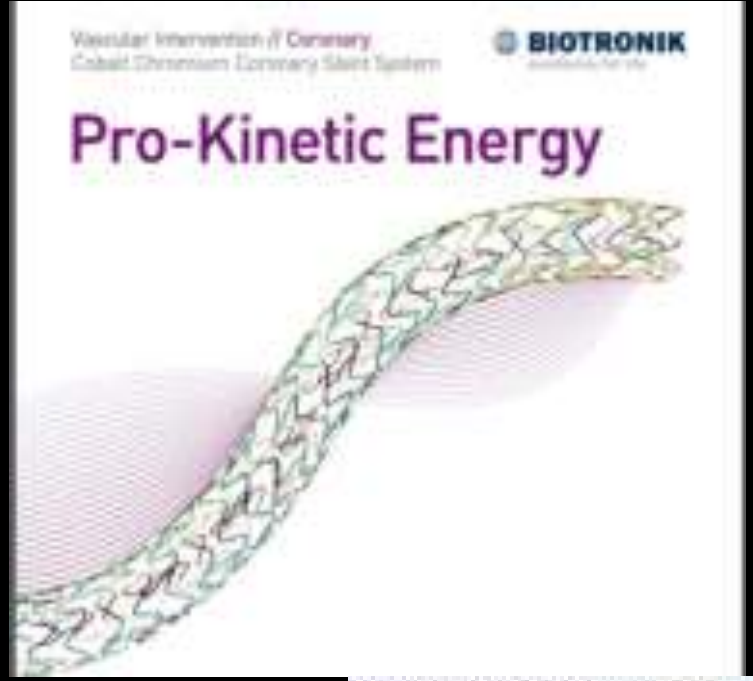
Noelia Rodriguez-Villatoro, MD, PhD; David Rodríguez-Luna, MD, PhD; Marian Muchada, MD, PhD; Olalla Pancorbo, RN; Matías Deck, MD; Prudencio Lozano, MD; Sandra Boned, MD, PhD; Álvaro García-Tornel, MD, PhD; Marta Olivé, MD, PhD; Jesús Juega, MD, PhD; Jorge Pagola, MD, PhD; Marta Rubiera, MD, PhD; David Hernández, MD; Carlos Molina, MD, PhD; Carlos Piñana, MD; Isabel Rodriguez, MD, PhD; Marta De Dios, MD; Jose Luis Cuevas, MD; Manuel Requena, MD, PhD; Laura Ludovica Gramegna, MD, PhD; Marc Ribó, MD, PhD; Alejandro Tomasello, MD

BACKGROUND: Stenting extracranial internal carotid artery (ICA) lesions in acute ischemic stroke with tandem lesions is technically challenging. Its safety is highly debated because of the requirement of dual-antiplatelet therapy. The optimal stenting device, timing, and periprocedural antiplatelet therapy for extracranial ICA stenting in the setting of acute tandem occlusion are still unclear.

METHODS: We performed a retrospective study of patients with acute ischemic stroke attributable to tandem lesions who underwent endovascular treatment during a 5-year period receiving either conventional self-expanding carotid stents (SX) or balloon-expandable carotid stent (BX). BX stents were restented with an SX in the subacute phase. Primary outcomes of interest were extracranial ICA patency at follow-up and symptomatic intracranial hemorrhage.

RESULTS: A total of 112 patients admitted from April 2016 to April 2021 were included. Dual-antiplatelet therapy immediately following endovascular treatment was more frequently administered in the SX group (35/39 [89.7%]) compared with the BX group (20/73 [27.4%]) ($P<0.001$). Patients in the BX stent group (3/73 [4.1%]) developed a lower rate of symptomatic intracranial hemorrhage compared with patients in the SX stent group (7/39 [17.9%]) ($P=0.031$). No differences in extracranial ICA high-grade restenosis or reocclusion were found between groups at 24 hours after procedure (BX: 20/73 [27.4%]; SX: 9/39 [23.1%]; $P=0.673$).

CONCLUSIONS: In patients with acute ischemic stroke and tandem occlusions, a bridging therapy including BX stents with less-aggressive antiplatelet therapy and subsequent definitive SX stenting to treat extracranial ICA lesions resulted in a lower rate of symptomatic hemorrhagic transformation and no differences in stent patency.



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- Best in Class Clinical Results

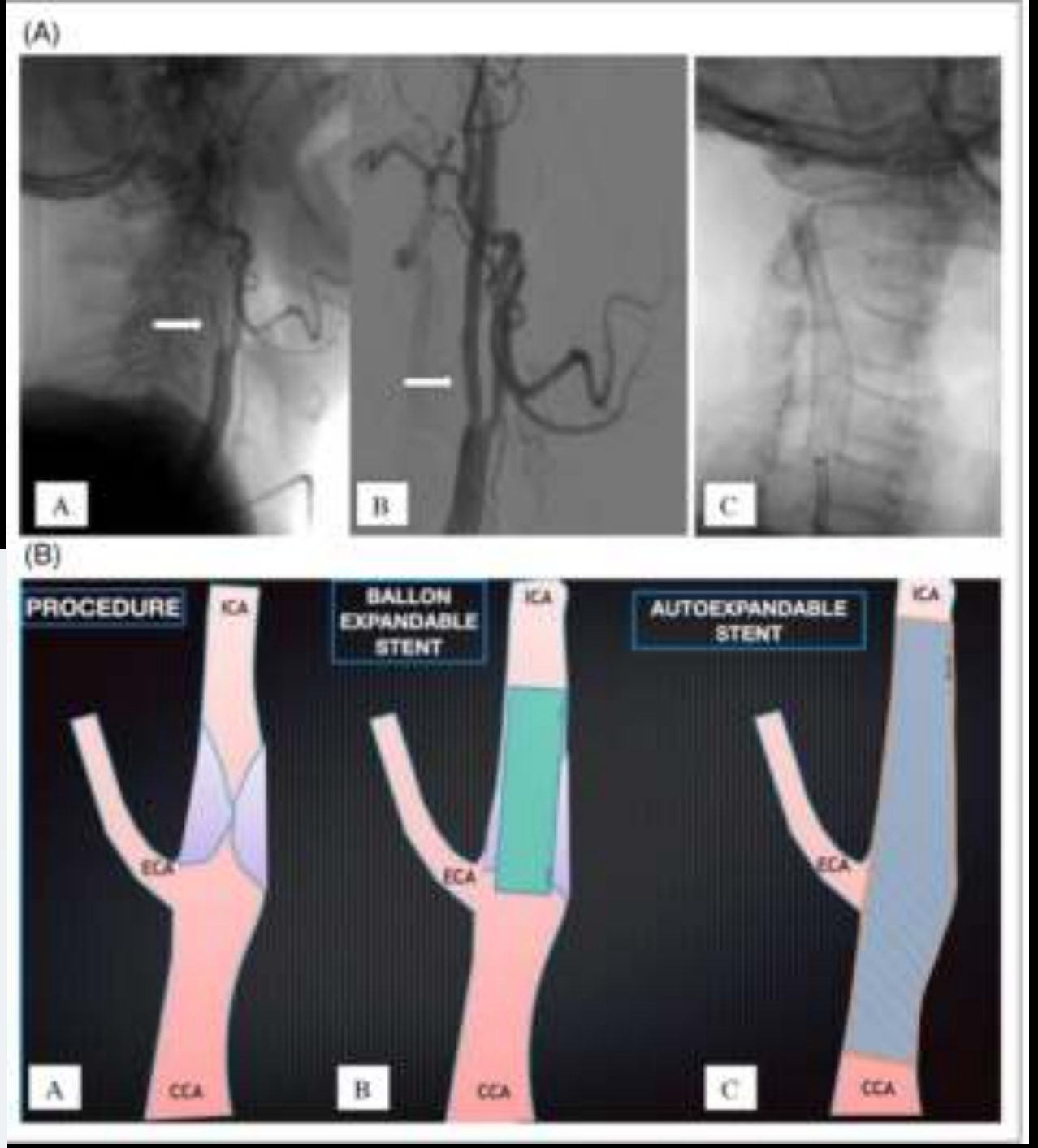


Table 2. Antiplatelet Treatment According to Extracranial ICA Treatment

Variables	Overall (N=112)	Balloon-expandable stents (n=73)	Self-expanding stents (n=39)	*P* value*
Antiplatelet treatment before stroke onset				
No antiplatelet treatment	82 (73.2)	55 (75.3)	27 (69.2)	0.488
Aspirin	25 (22.3)	16 (21.9)	9 (23.1)	0.890
Clopidogrel	3 (2.7)	1 (1.4)	2 (5.1)	0.226
Dual-antiplatelet treatment	2 (1.8)	1 (1.4)	1 (2.6)	0.687
Antiplatelet treatment periprocedural				
Any (single or dual) antiplatelet agent during or immediately after EVT	55/112 (49.1)	20/73 (27.4)	35/39 (89.7)	<0.001
Dual-antiplatelet treatment during or immediately after EVT	29/112 (25.9)	2/73 (2.7)	27/39 (69.2)	<0.001
Aspirin	44/112 (39.3)	19/73 (26.0)	25/39 (64.1)	<0.001
Clopidogrel	25/112 (22.3)	3/73 (4.1)	22/39 (56.4)	<0.001

Data are given as number (percentage) or number/total (percentage), as appropriate. EVT indicates endovascular treatment; and ICA, internal carotid artery.
*P values are from Pearson χ^2 and Mann-Whitney *U* test.

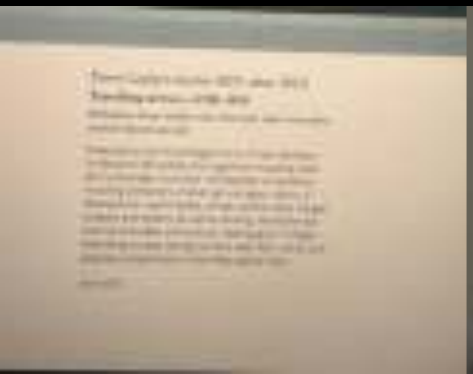
Table 3. Clinical Outcomes by Type of Implanted Stent

Variables	Overall (N=112)	Balloon-expandable stents (n=73)	Self-expanding stents (n=39)	*P* value*
HT of any grade	32/112 (28.6)	21/73 (28.8)	11/39 (28.2)	0.950
Symptomatic HT		3/73 (4.1)	7/39 (17.9)	0.031
High-grade restenosis at 24 h	29/111 (26.1)	20/73 (27.4)	9/39 (23.1)	0.673
Patency at 90 d	79/99 (79.8)	52/65 (80.8)	27/34 (79.5)	0.923

Data are given as number/total (percentage). HT indicates hemorrhagic transformation.
*P values are from Pearson χ^2 test.

My Set Up for Tandems

- 8 French x 80 cm Shuttle Sheath
- Zoom 88, 5 French Berenstein, 0.035 Glidewire Advantage
- Zoom 71/Red 68, Velocity microcatheter, Aristotle 24/Aristotle 14/Synchro 14 wire
- Ready both a 035 wire compatible balloon (Mustang) or an microwire compatible monorail balloon (Viatrac) depending on which wire I can get across & if I can't Dotter through
- Post intracranial thrombectomy, swap out microwire for exchange length 014 wire (Zoom/Aristotle or Synchro) in event I need to stent
- Above set-up is fluid and may change as needed, such as 8 French sheath with Walrus balloon guide catheter and Red 72 SendIt instead of 8x80 Shuttle + Zoom 88, etc*



73 yo, left MCA syndrome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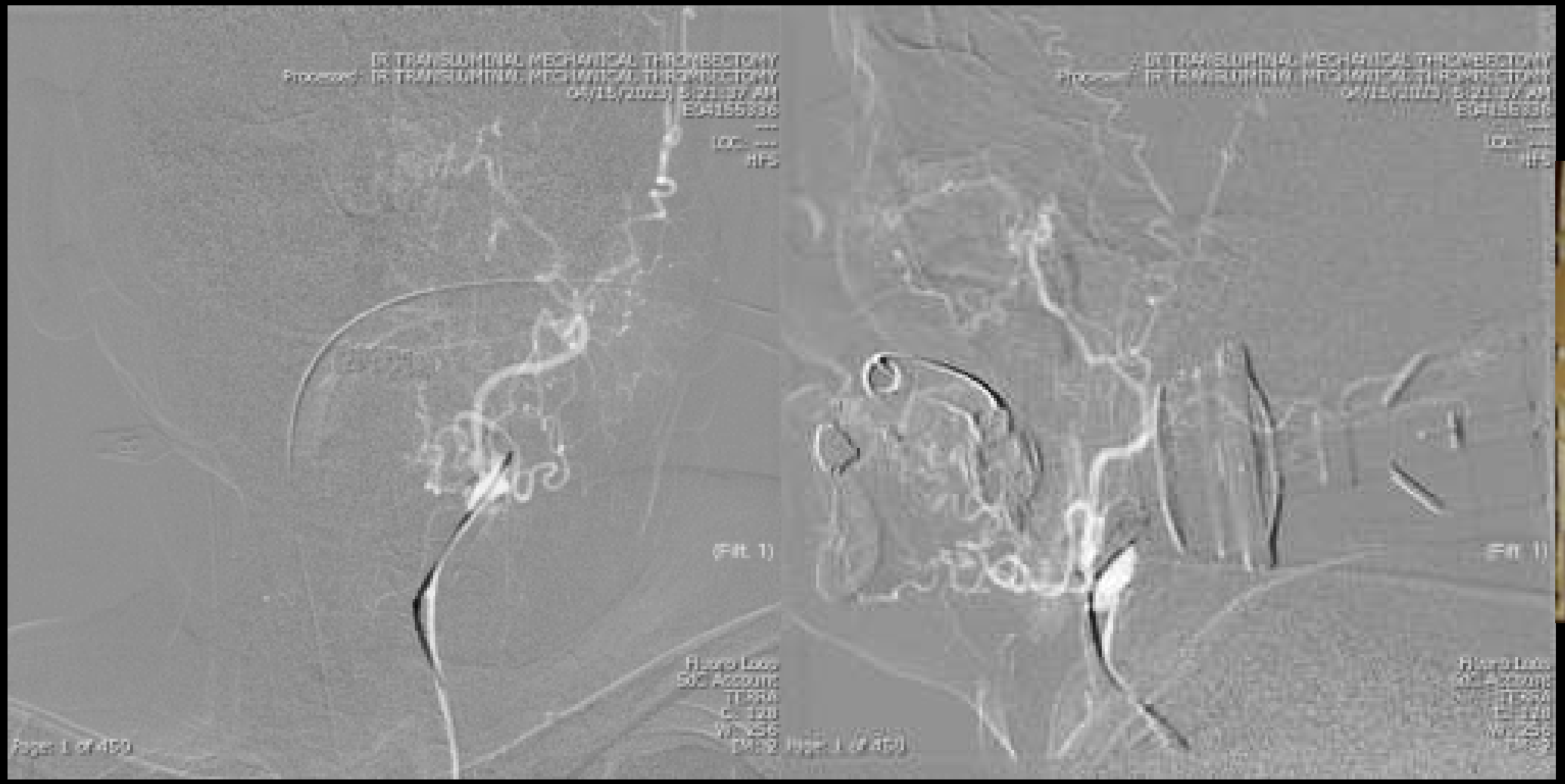
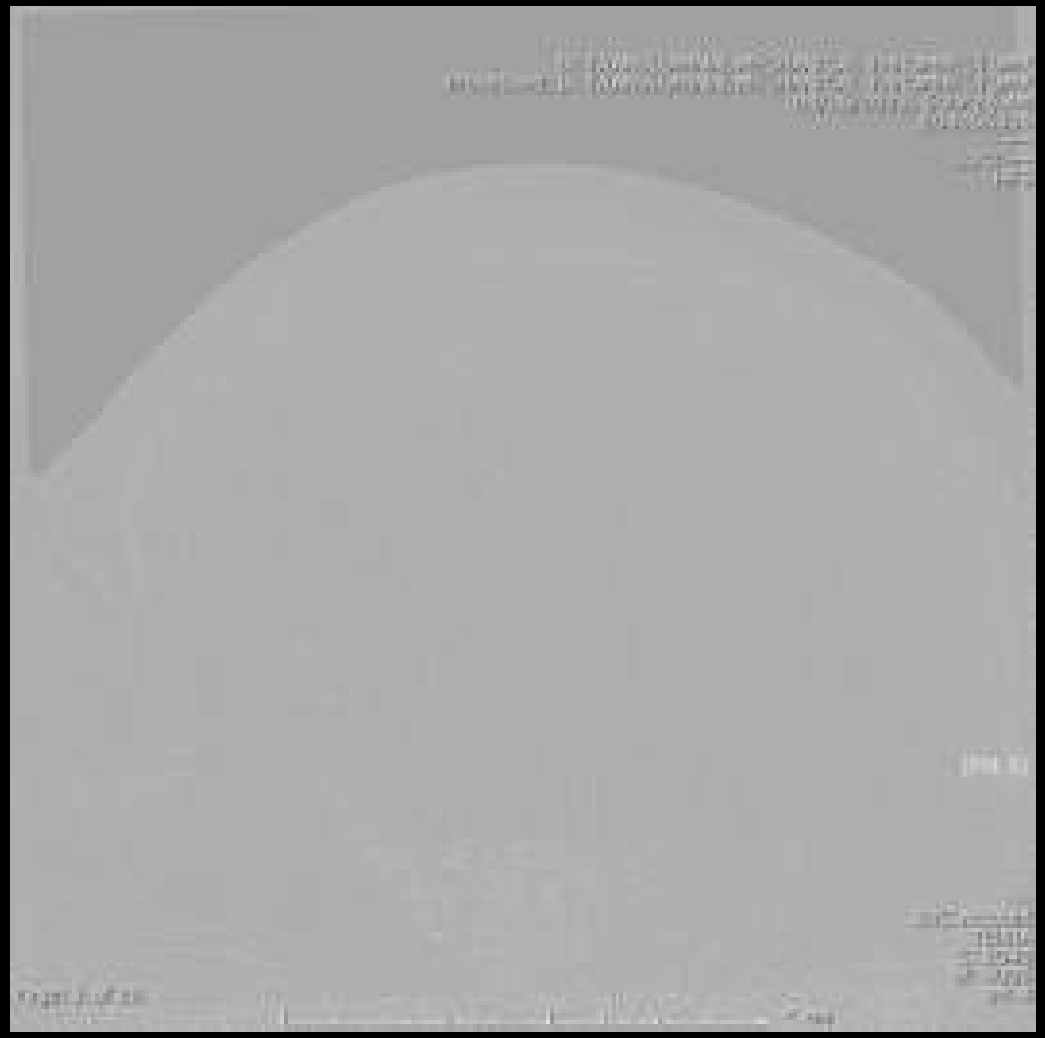
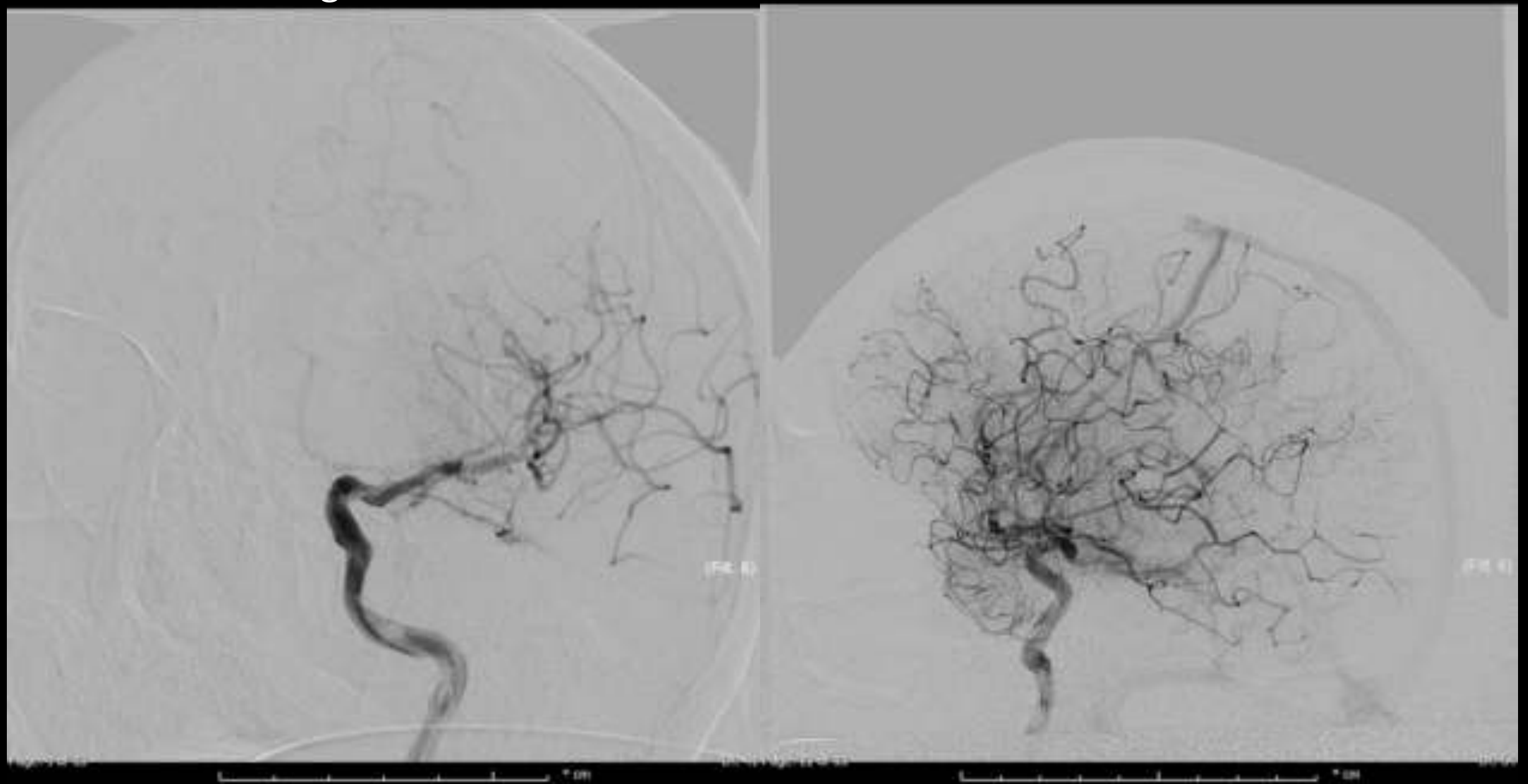
Dotter Technique



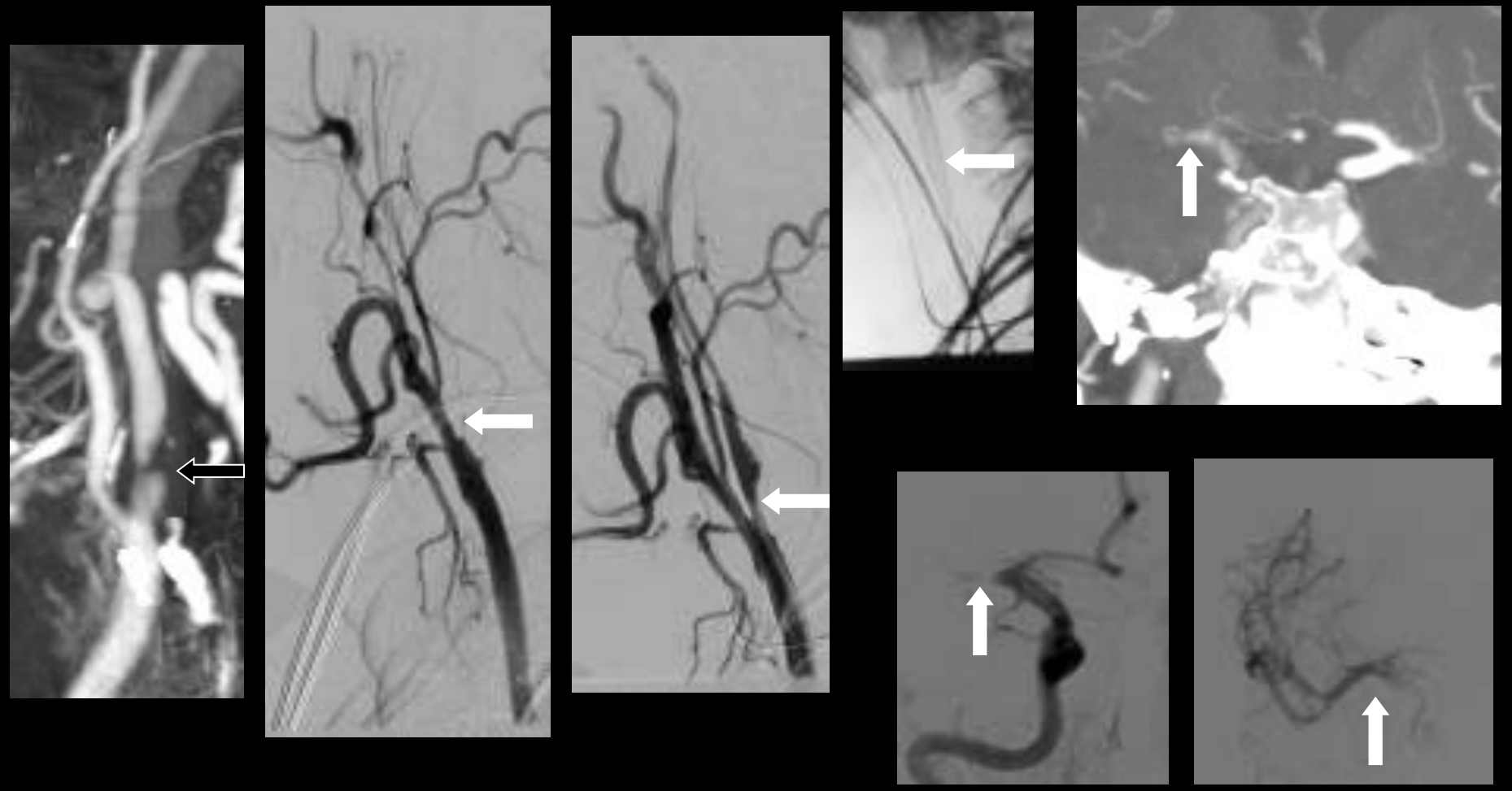
Dotter Technique



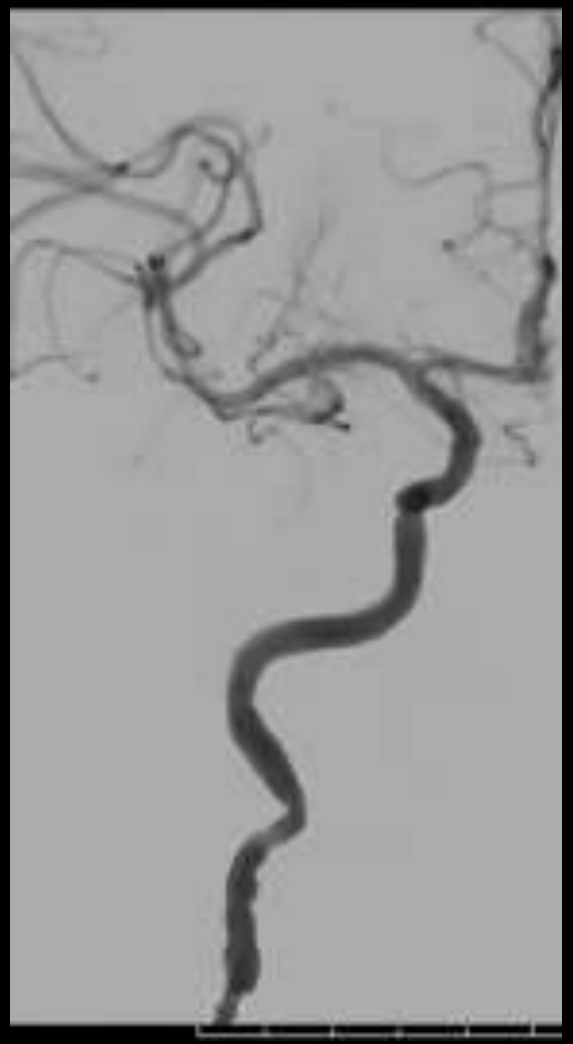
Post Dotter Retrograde



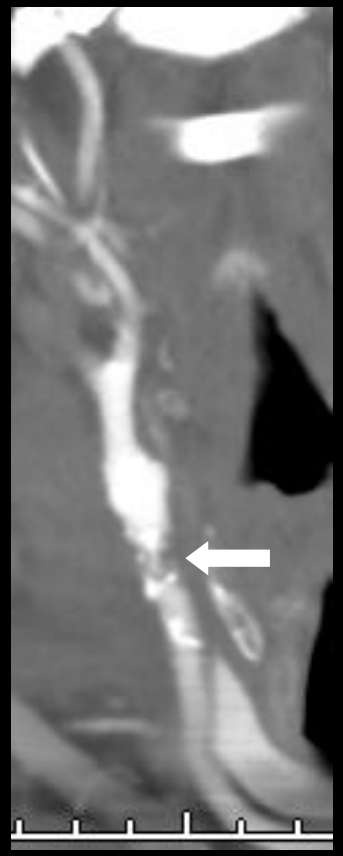
AIS Carotid Stenting and Mechanical Thrombectomy

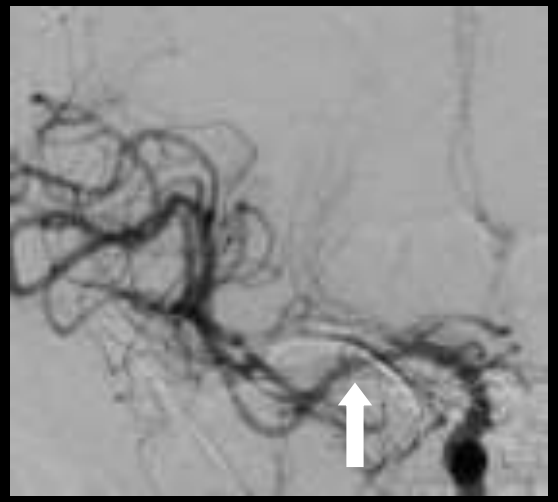


AIS Dotter Technique and Mechanical Thrombectomy

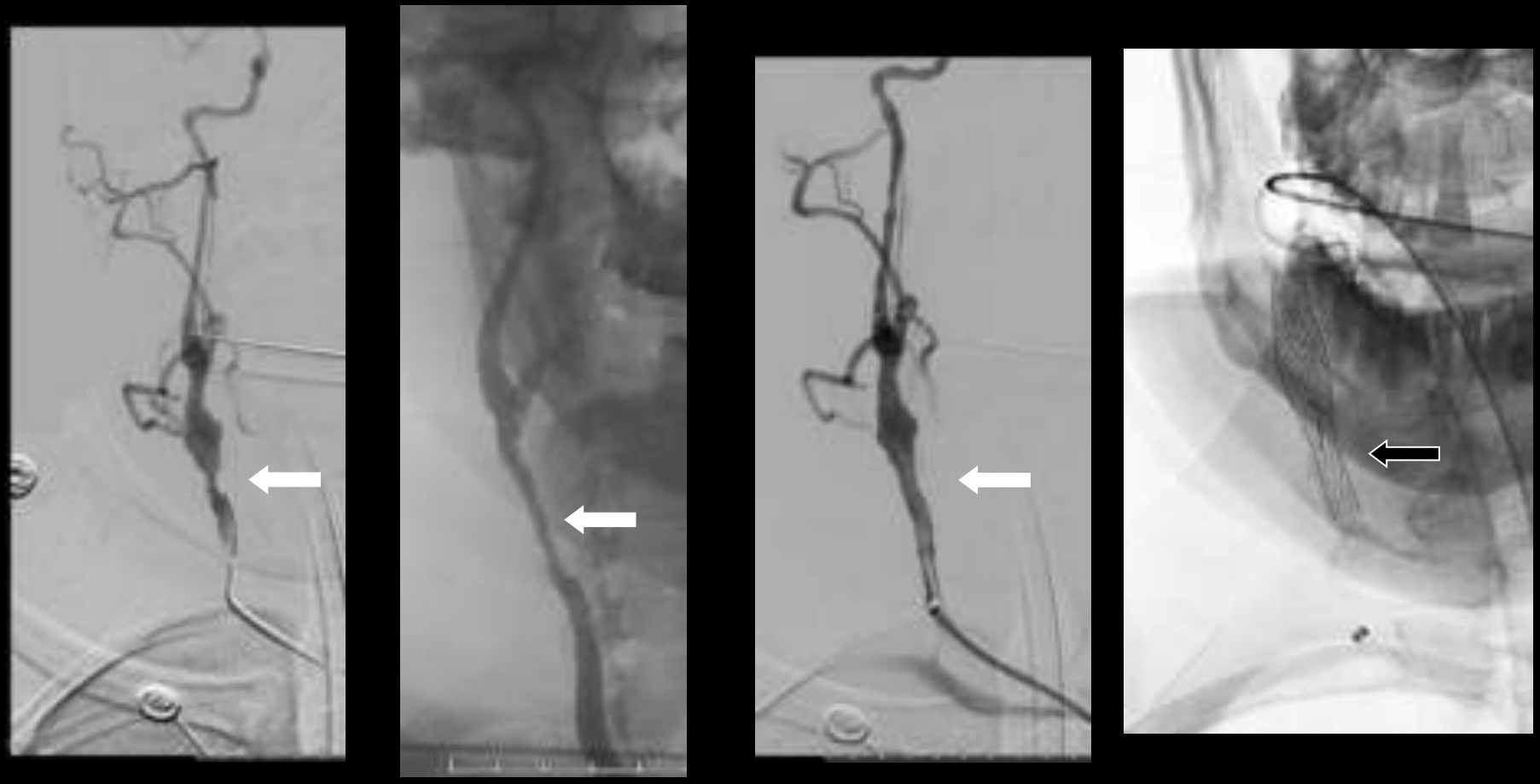


AIS Dotter Technique and Mechanical Thrombectomy





AIS Dotter Technique and Delayed Carotid Stenting



Cervical Carotid Stenosis/Occlusion in AIS: Acute Carotid Stenting vs Dotter Technique

- Carotid Stent Pros:
  - Can be done safely
    - Behme Et Al *Stroke* March 2017 – Nice Point Counterpoint by Daniel Eehme and Marc Ribo
    - Misha et al *INR* 2015 showed safety in 7 pts
  - Immediate recanalization of ICA
  - Limited evidence Level IIb (Weak recommendation)
  - MCA thrombosis was caused by carotid stenosis
  - No definite increased hemorrhage with dual antiplatelets without iv tPA
  - Easier to pass guided catheter into carotid stent
  - Increased perfusion of MCA

Cervical Carotid Stenosis/Occlusion in AIS: Acute Carotid Stenting vs Dotter Technique

- Dotter Technique Pros:
  - Carotid Stenting requires dual antiplatelets – theoretical increased bleeding risk
  - Dotter can be performed safely
    - Woodward et al *J Neuroint Surg* 2016 – 7 pts
    - Li et al *Intervt Neurol* 2016
  - Faster than carotid stenting
  - May not need to open carotid stenosis if collaterals

Surgical Options

- **Carotid Endarterectomy (CEA):**
  - Surgical removal of atherosclerotic plaque.
  - Best suited for extracranial lesions.
- **Bypass Surgery:**
  - In certain cases, bypassing occluded segment might be considered.

Timing and Decision Making

- Importance of timely intervention
- Balancing risks and benefits
- Considering patient factors:
  - Age, health status, other comorbidities
- Concurrent medical therapy
  - Antiplatelets, anticoagulants, statins

Prognosis and Follow-Up

- Importance of follow-up imaging
- Risk of re-stenosis or re-occlusion
- Ongoing medical management and lifestyle interventions

Summary

- Significance of carotid tandem lesions
- Importance of prompt and effective intervention
- Antegrade vs Retrograde
  - Trend towards retrograde, though large scale prospective data needed
- Extracranial or Intracranial Lesion Management
  - Stent Placement
  - Wire traversal and mechanical thrombectomy
  - Varying degrees of Dotter
- Combined role of endovascular and surgical approaches

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