BERTINORO ULTRASUONI

XXI CORSO NAZIONALE DI

ULTRASONOLOGIA VASCOLARE

DIAGNOSI E TERAPIA

Neurosonologia ed ischemia cerebrale

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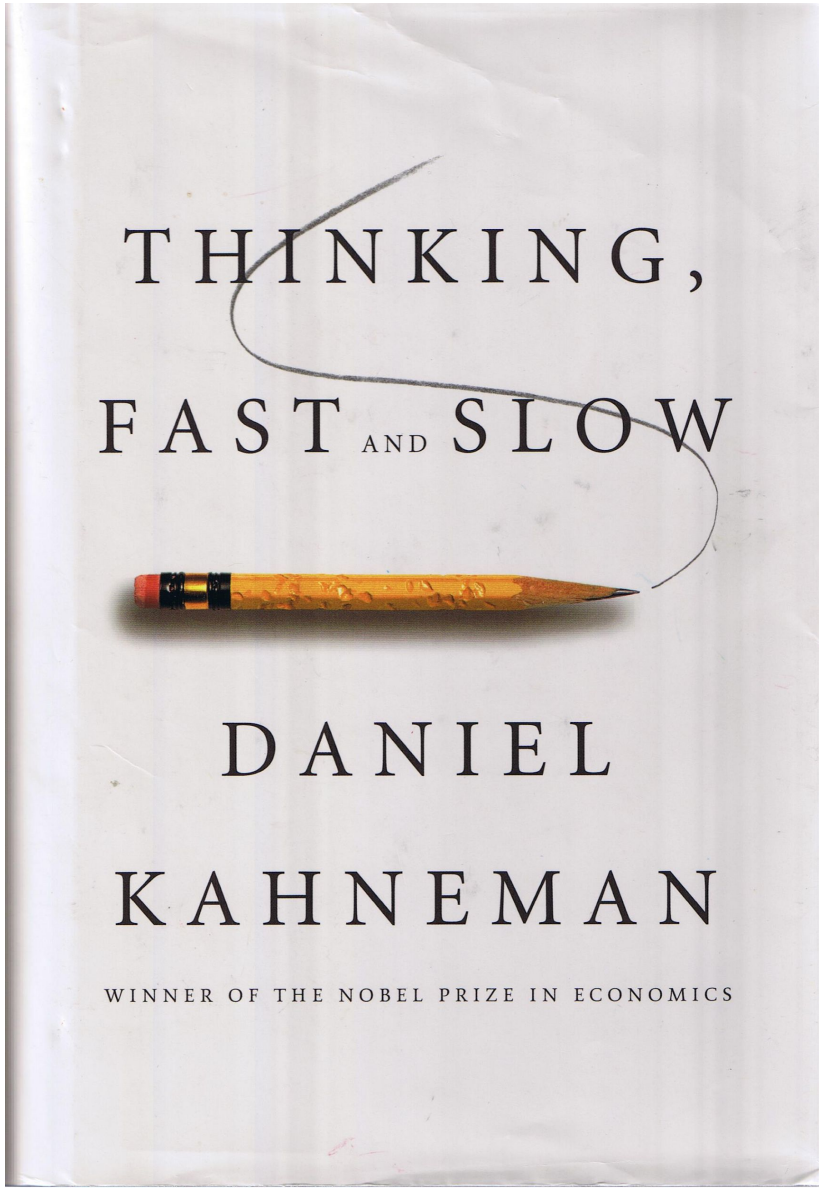
Un paziente colpito da ictus ischemico ha bisogno di essere curato con due modalità di pensiero diverse in due fasi diverse

- Fast thinking: fase acuta
- A slow thinking: subito dopo



Neurosonology: fast thinking

The aim of this study is to encourage neurologists to add quick and disease-oriented Neuro-POCUS to accompany the patient in the critical phase as **an adjunct not a substitution** for computed tomography, magnetic resonance imaging, or standard comprehensive neurosonology examination. Another goal is **to avoid unwanted complications during imaging-free periods,** ultimately resulting in advantages for the patient.

Acute diseases increasingly require **rapid and high-quality diagnostics to be able to initiate treatment**, starting in the **prehospital setting, the emergency department, intensive care medicine, and during surgical or interventional procedures**.

Valaikiene J et al. Point-of-Care Ultrasound in… Ultraschall in Med 2022; 43: 354–366 | © 2022.

Neurosonology: fast thinking

Review

Thieme

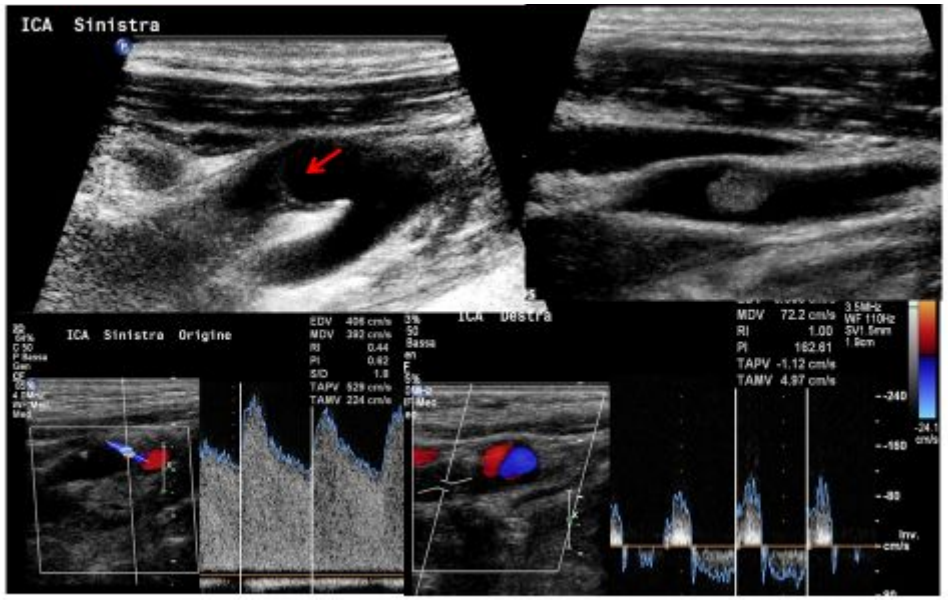
Neurosonological Diagnosis in the Acute Phase of Stroke is a Sign of Qualified Care

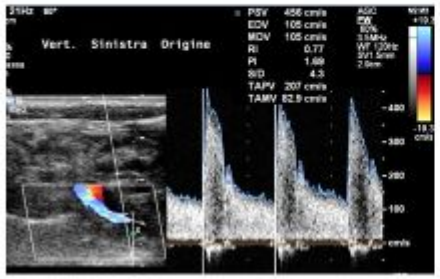
Neurosonology makes the difference in acute Stroke Care

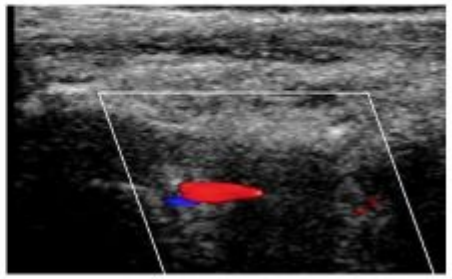
In acute ischemic stroke, occlusion or stenosis of an arterial segment induces individually variable and complex changes in cerebral haemodynamic.

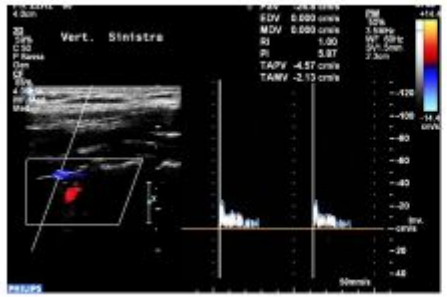
- **Acute arterial occlusion may persist,**
- **may partially or completely recanalize,**
- **re-occlude after initial recanalization or**
- **may be compensated by collateral blood flow.**

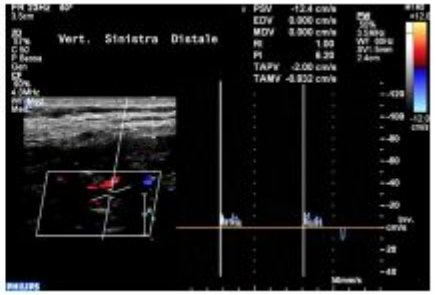
Schlachetzki F. et al. Neurology International Open 2017; 1: E182–E188 DOI https://doi.org/10.1055/s-0043-109331



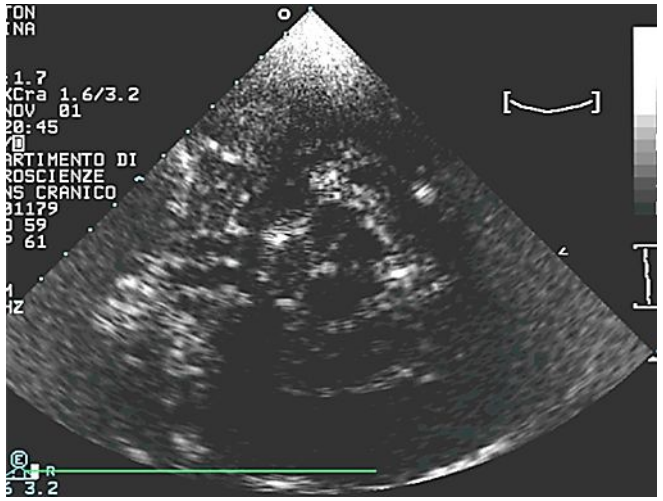


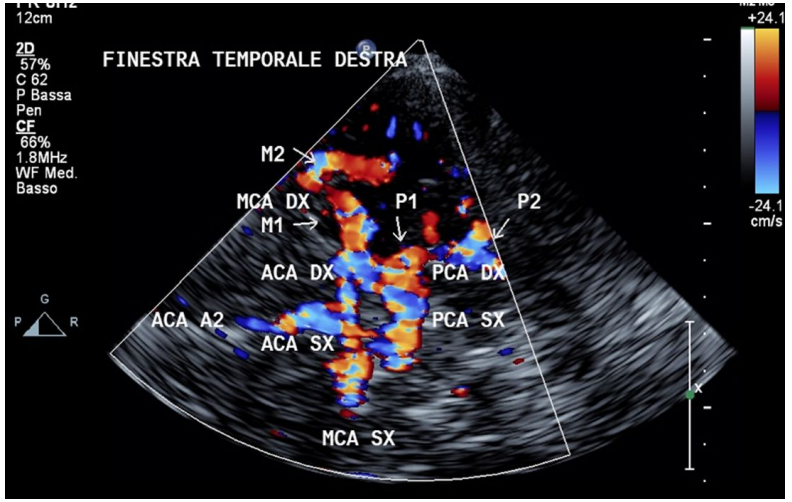


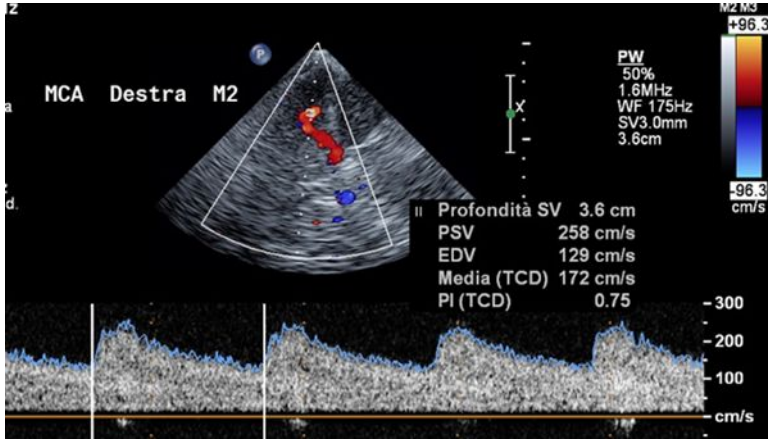




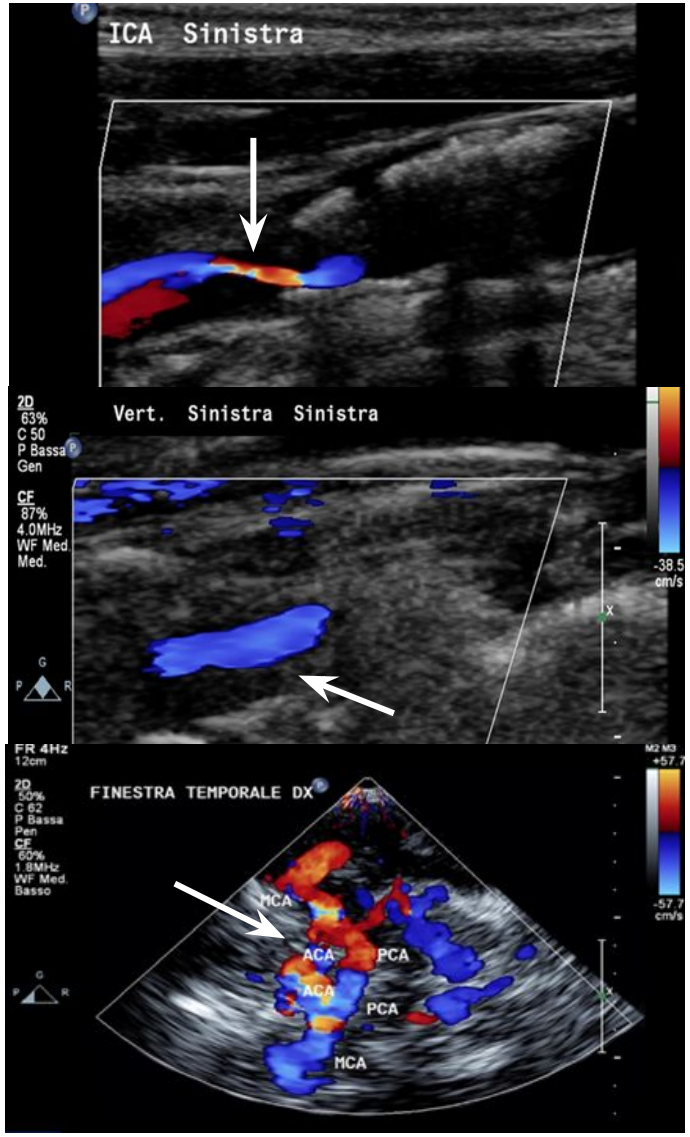
Contrast agents if needed







Acute stroke diagnosis and treatment



Neurosonology provides:

- Real-time information
- Bed-side examinations
- Monitoring
- Follow-up

Where?

- In Prehospital setting, in Emergency Room, in Stroke Unit, in angiographic Suite…

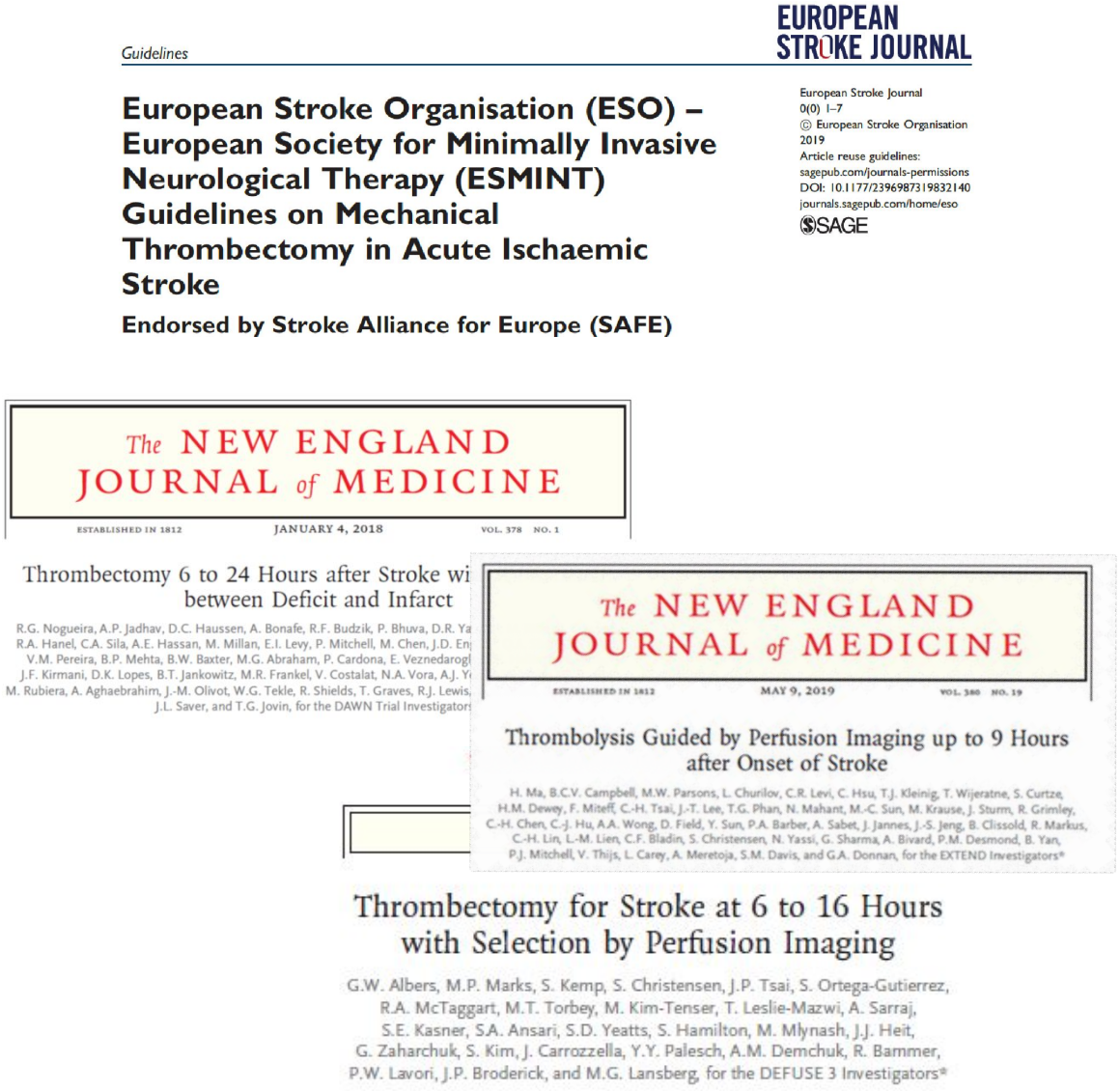
How many time?

- Whenever you need it

When?

- During Emergency
- During acute reperfusion therapy
- After Therapy
- To provide differential diagnosis
- During follow-up

Acute ischemic stroke and Mechanical thrombectomy



Guidelines

EUROPEAN STROKE JOURNAL

European Stroke Organisation (ESO) – European Society for Minimally Invasive Neurological Therapy (ESMINT) Guidelines on Mechanical Thrombectomy in Acute Ischaemic Stroke

Endorsed by Stroke Alliance for Europe (SAFE)

European Stroke Journal
0(0) 1–7
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The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 4, 2018 VOL. 378 NO. 1

Thrombectomy 6 to 24 Hours after Stroke wi
between Deficit and Infarct

R.G. Nogueira, A.P. Jadhav, D.C. Haussen, A. Bonafe, R.F. Budzik, P. Bhuva, D.R. Ya
R.A. Hanel, C.A. Sila, A.E. Hassan, M. Millan, E.I. Levy, P. Mitchell, M. Chen, J.D. En
V.M. Pereira, B.P. Mehta, B.W. Baxter, M.G. Abraham, P. Cardona, E. Veznedarogl
J.F. Kirmani, D.K. Lopes, B.T. Jankowitz, M.R. Frankel, V. Costalat, N.A. Vora, A.J. Y
M. Rubiera, A. Aghaebrahim, J.-M. Olivot, W.G. Tekle, R. Shields, T. Graves, R.J. Lewis,
J.L. Saver, and T.G. Jovin, for the DAWN Trial Investigators

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 9, 2019 VOL. 380 NO. 19

Thrombolysis Guided by Perfusion Imaging up to 9 Hours after Onset of Stroke

H. Ma, B.C.V. Campbell, M.W. Parsons, L. Churilov, C.R. Levi, C. Hsu, T.J. Kleinig, T. Wijeratne, S. Curtze, H.M. Dewey, F. Miteff, C.-H. Tsai, J.-T. Lee, T.G. Phan, N. Mahant, M.-C. Sun, M. Krause, J. Sturm, R. Grimley, C.-H. Chen, C.-J. Hu, A.A. Wong, D. Field, Y. Sun, P.A. Barber, A. Sabet, J. Jannes, J.-S. Jeng, B. Clissold, R. Markus, C.-H. Lin, L.-M. Lien, C.F. Bladin, S. Christensen, N. Yassi, G. Sharma, A. Bivard, P.M. Desmond, B. Yan, P.J. Mitchell, V. Thijs, L. Carey, A. Meretoja, S.M. Davis, and G.A. Donnan, for the EXTEND Investigators*

Thrombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging

G.W. Albers, M.P. Marks, S. Kemp, S. Christensen, J.P. Tsai, S. Ortega-Gutierrez, R.A. McTaggart, M.T. Torbey, M. Kim-Tenser, T. Leslie-Mazwi, A. Sarraj, S.E. Kasner, S.A. Ansari, S.D. Yeatts, S. Hamilton, M. Mlynash, J.J. Heit, G. Zaharchuk, S. Kim, J. Carrozzella, Y.Y. Palesch, A.M. Demchuk, R. Bammer, P.W. Lavori, J.P. Broderick, and M.G. Lansberg, for the DEFUSE 3 Investigators*

- Mechanical thrombectomy (MT) is recommended by Current guidelines widely as the first-line treatment for acute ischemic stroke in patients with large vessel occlusion (LVO)
- After the publication of the positive results from recent extended time treatment trials, the indications for MT are been expanded
- There is also evidence for safety and efficacy using MT for middle-vessel occlusions or for isolated occlusion of the posterior cerebral artery
- Advanced neuroimaging is required
- If a LVO is present, bypassing Primary Stroke Unit should be a strategic choices
- Therefore we need to select the patient who should be transferred directly to an Interventional Stroke Center

Prehospital Setting

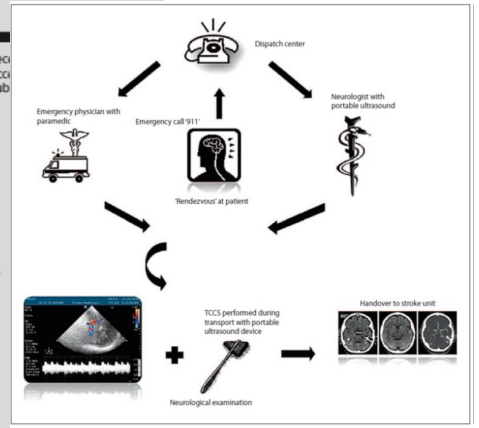
Original Paper

Cerebrovascular Diseases

Cerebrovasc Dis 2012;33:262–271
DOI: 10.1159/000334667

Transcranial Ultrasound from Diagnosis to Early Stroke Treatment – Part 2: Prehospital Neurosonography in Patients with Acute Stroke – The Regensburg Stroke Mobile Project

Felix Schlachetzki[a] Moriz Herzberg[a] Thilo Hölscher[d] Michael Ertl[a]
Markus Zimmermann[b] Karl Peter Ittner[b] Hendrik Pels[c] Ulrich Bogdahn[a]



Conclusion: **Prehospital neurological as well as transcranial vascular assessments during patient transport can be performed by a trained neurologist with high sensitivity and specificity.**

Research Article

Prehospital Identification of Middle Cerebral Artery Occlusion - A Stroke Education Program and Transcranial Ultrasound for Paramedics

Conclusion: The proposed web based **educational training course may enable paramedics to perform not just a short neurological examination but also good quality TCCS**, a combination highly suitable for patient selection for endovascular embolectomy.

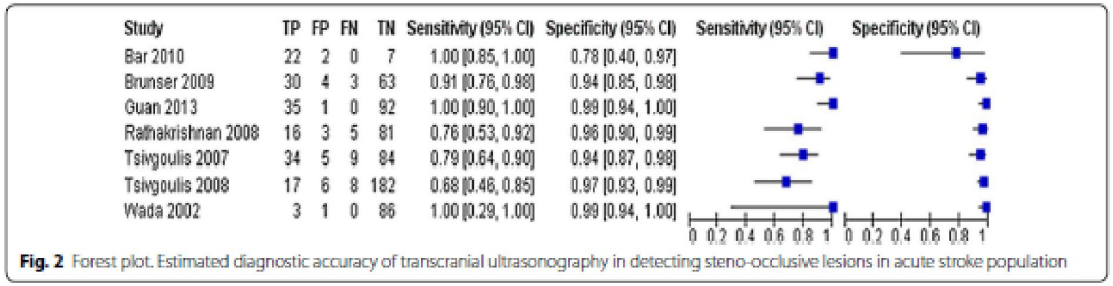
Antipova et al. Ultrasound J (2019) 11:29
https://doi.org/10.1186/s13089-019-0143-6

The Ultrasound Journal

REVIEW Open Access

Diagnostic value of transcranial ultrasonography for selecting subjects with large vessel occlusion: a systematic review

Daria Antipova[1*], Leila Eadie[1], Ashish Stephen Macaden[2] and Philip Wilson[1]

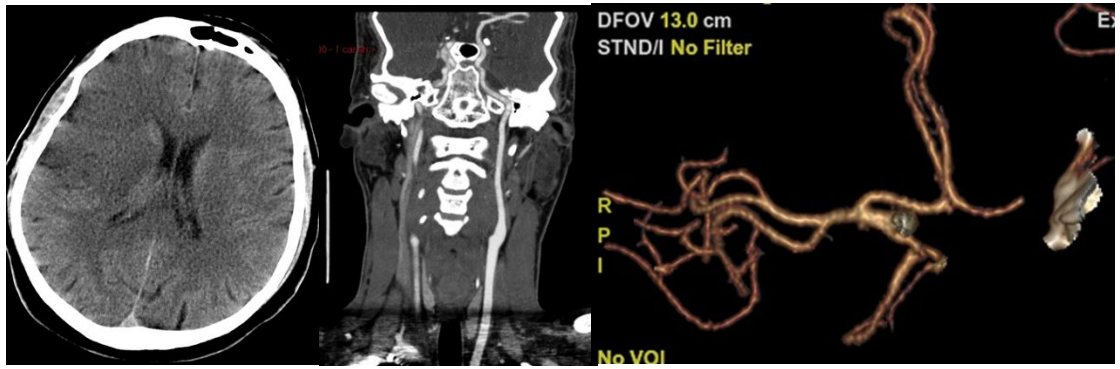


Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Bar 2010	22	2	0	7	1.00 [0.85, 1.00]	0.78 [0.40, 0.97]
Brunser 2009	30	4	3	63	0.91 [0.76, 0.98]	0.94 [0.85, 0.98]
Guan 2013	35	1	0	92	1.00 [0.90, 1.00]	0.99 [0.94, 1.00]
Rathakrishnan 2008	16	3	5	81	0.76 [0.53, 0.92]	0.96 [0.90, 0.99]
Tsivgoulis 2007	34	5	9	84	0.79 [0.64, 0.90]	0.94 [0.87, 0.98]
Tsivgoulis 2008	17	6	8	182	0.68 [0.46, 0.85]	0.97 [0.93, 0.99]
Wada 2002	3	1	0	86	1.00 [0.29, 1.00]	0.99 [0.94, 1.00]

Fig. 2 Forest plot. Estimated diagnostic accuracy of transcranial ultrasonography in detecting steno-occlusive lesions in acute stroke population

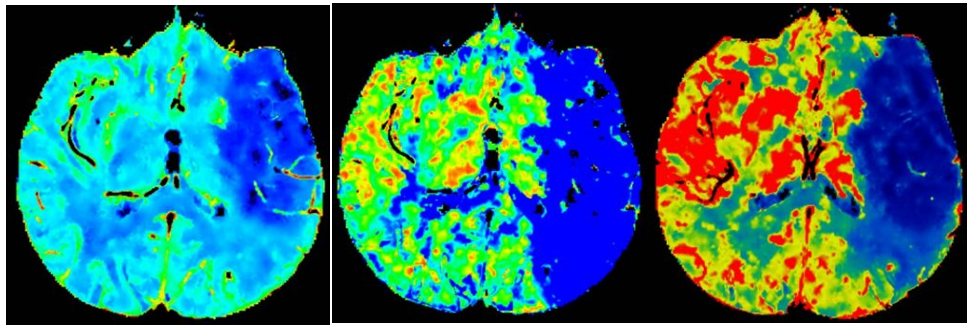
Conclusions: Transcranial ultrasonography **might potentially be used for the selection of subjects with acute LVO, to help streamline patient care and allow direct transfer to specialized endovascular Centres**.

Acute stroke diagnosis in Emergency Room
Neuroimaging: why?



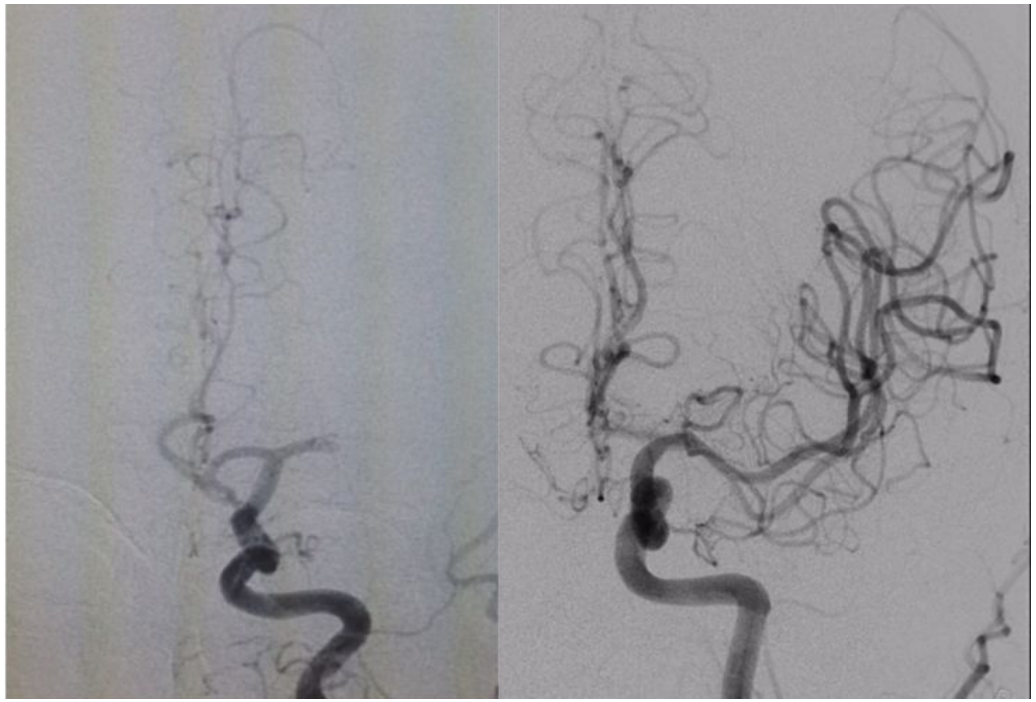
Acute Stroke Diagnosis:

- Is it an ischemic or an hemorrhagic stroke?
- Could we treat it?



Acute Stroke Diagnosis and treatment:

- Do we have the time to treat it?
- Is there salvageable penumbra?



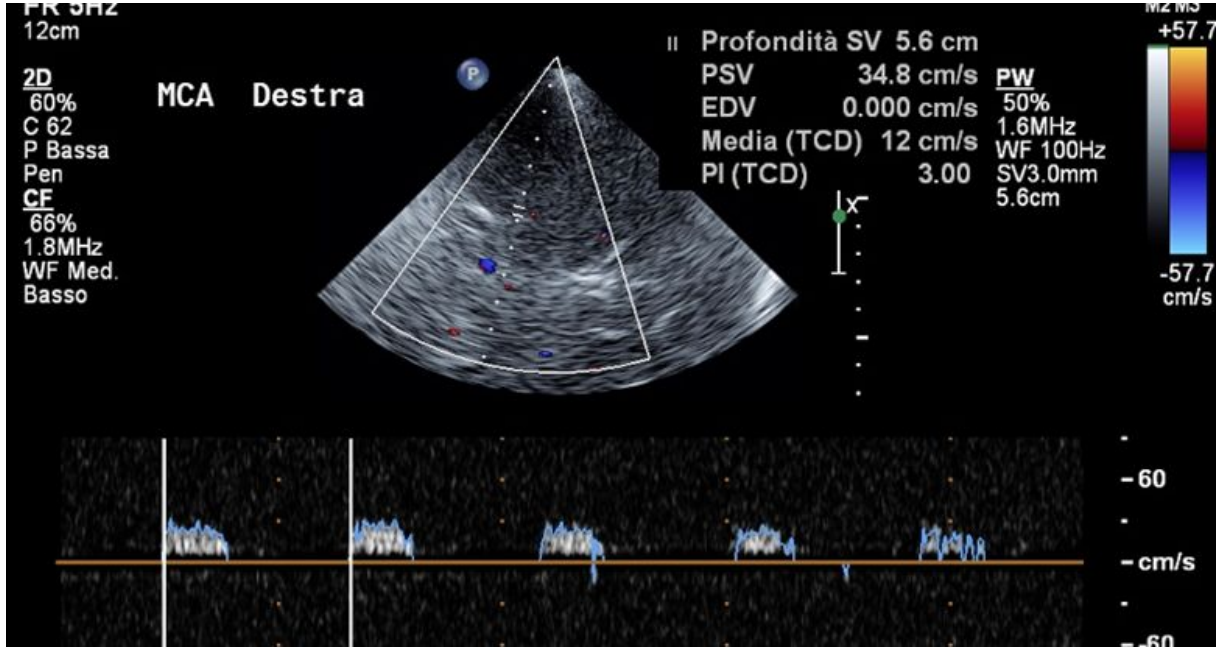
Acute Stroke Diagnosis and treatment:

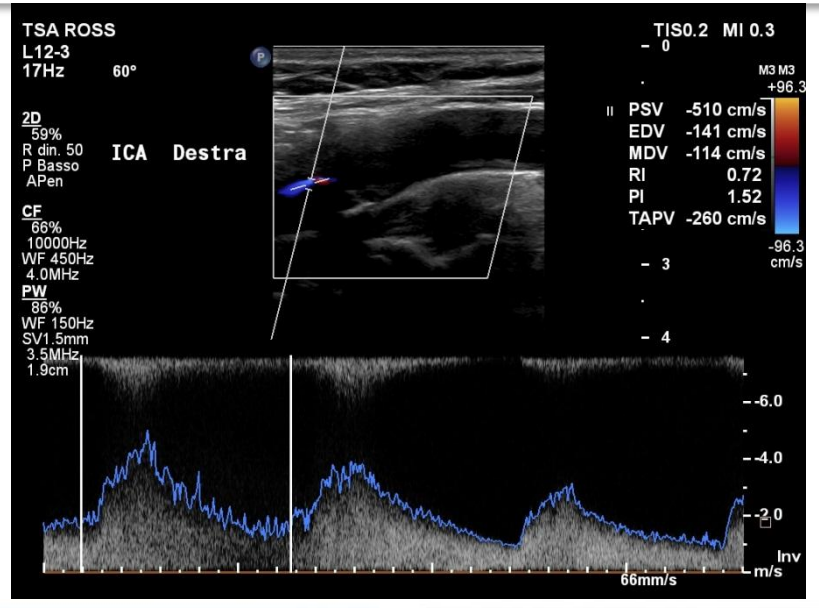
- Is there a large artery occlusion?
- Is Mechanical Thrombectomy needed?

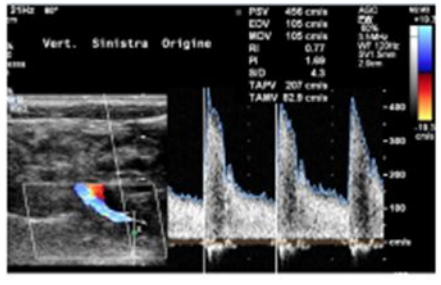
Neurosonology in Emergency Room: Acute Ischemic stroke Diagnosis

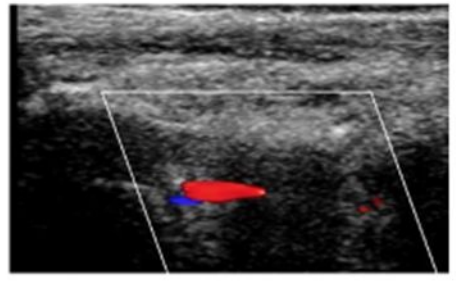
Although it should not delay CT or MR imaging and revascularization treatment, Neurosonology may rapidly provide information about:

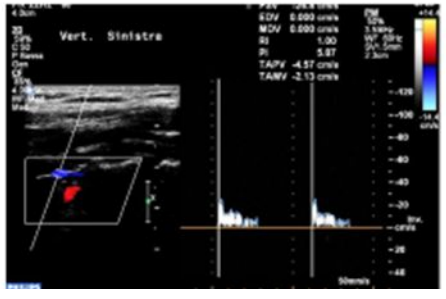
- a large vessel occlusion or significant stenosis
- or suggest a carotid or vertebral dissection

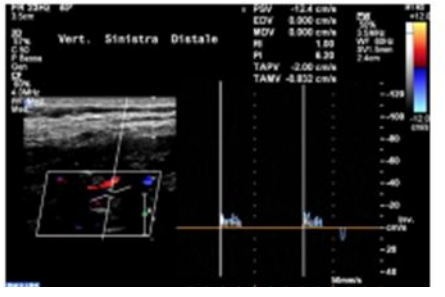




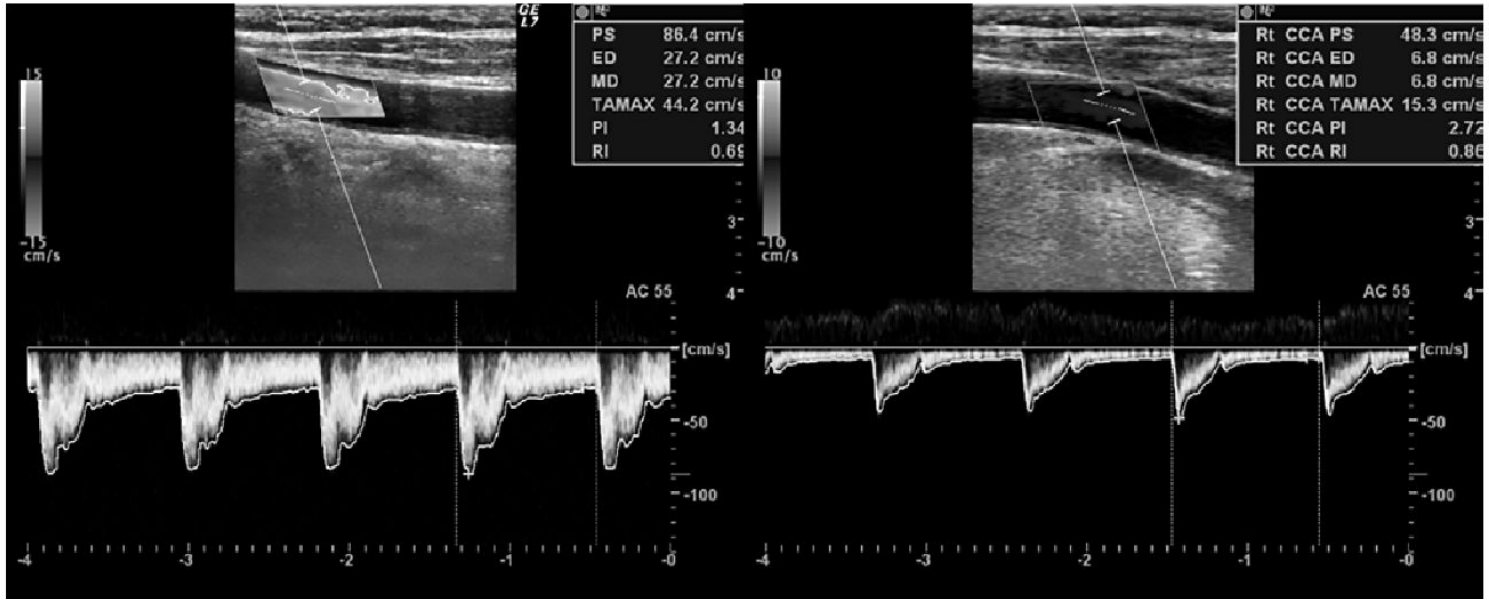








Rapid Evaluation of Large Vessel Occlusion for Mechanical Thrombectomy Using Carotid Duplex Ultrasound



If the end-diastolic velocity (EDV) ratio (ED ratio) in the common carotid arteries (CCAs) (calculated as the EDV in the contralateral, non-affected CCA divided by the EDV in the ipsilateral, affected CCA) is **>1.4**, intracranial occlusive disease in the anterior circulation can be highly suspected

Table 2. **The Sensitivity and the Specificity of Diagnosing Vessel Occlusion Based on CDU (n=40 Enrolled since June 2017).**

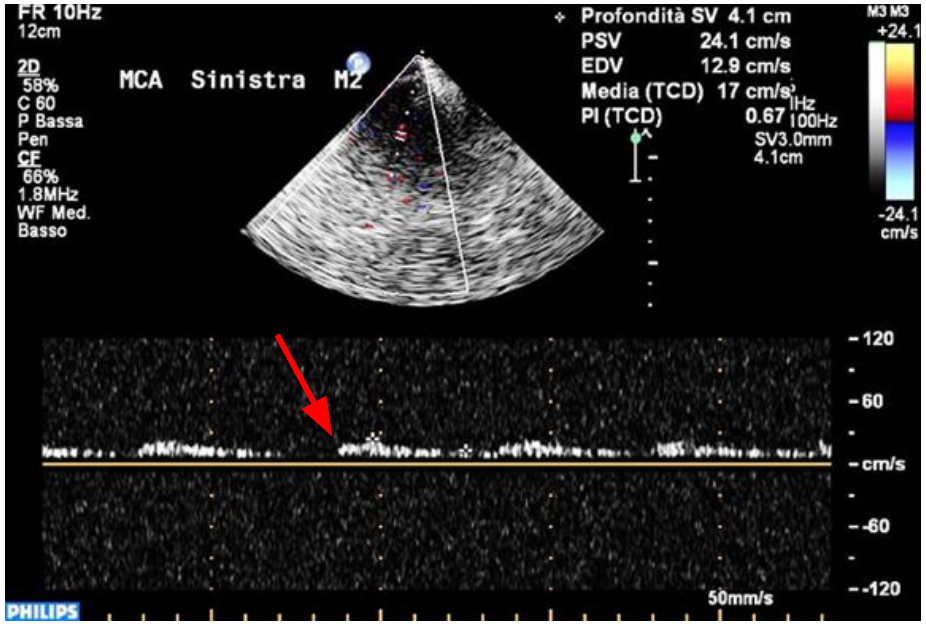
Site of LVO	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
ICA occlusion (%)	100 (76-100)	60 (52-60)	46 (35-46)	100 (87-100)
ICA/M1 occlusion (%)	83 (70-90)	82 (66-92)	86 (73-93)	78 (62-87)
ICA/M1/M2 occlusion (%)	74 (64-79)	85 (63-95)	91 (78-97)	61 (46-69)
All LVO treatable for MT (%)	83 (72-89)	88 (70-96)	91 (78-97)	78 (63-85)

CDU: carotid duplex ultrasound, CI: confidence interval, LVO: large vessel occlusion, ICA: internal carotid artery, MT: mechanical thrombectomy

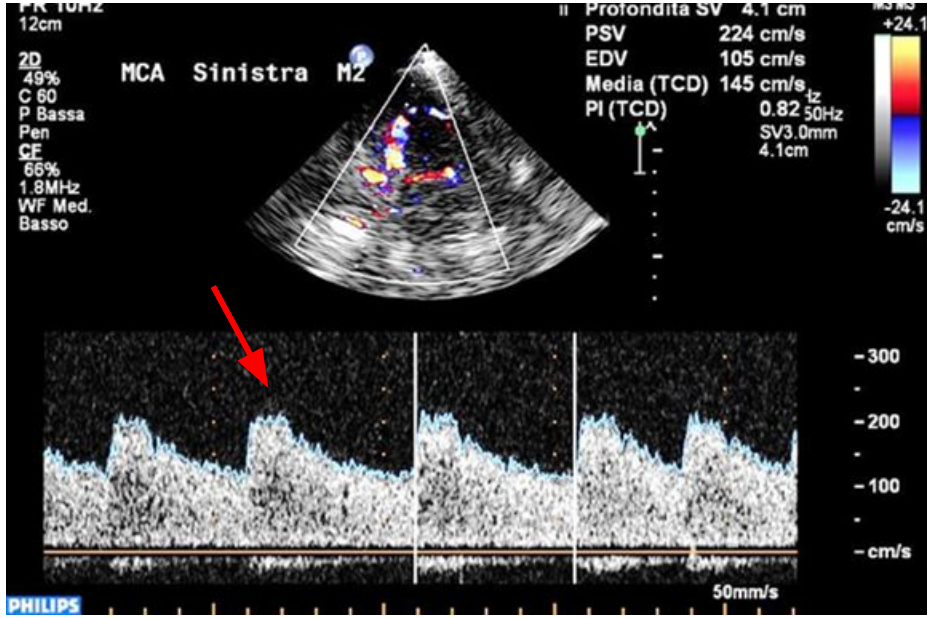
R Itabashi et al Intern Med 62: 703-710, 2023

Neurosonology during treatment

- Close monitoring of patients during AIS management is crucial and TCD/TCCS may serve as an extension to the neurological assessment, guiding treatment decisions and refining



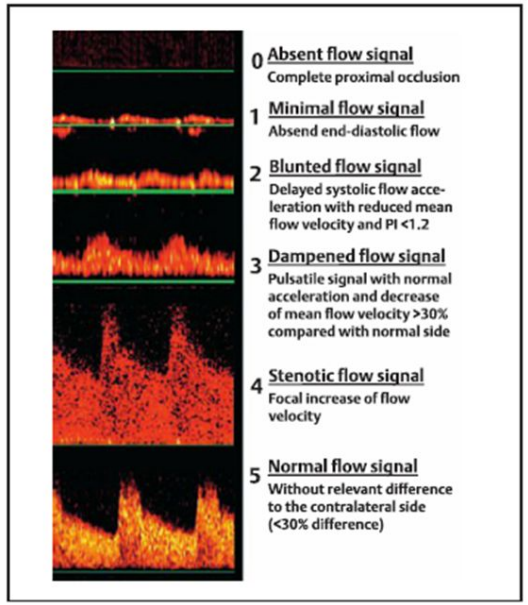
TCCS: : no color signal on M1 and systolic spikes on M1 (M1 distal occlusion)



The arterial occlusion may partially or completely recanalized

Monitoring during reperfusion therapy

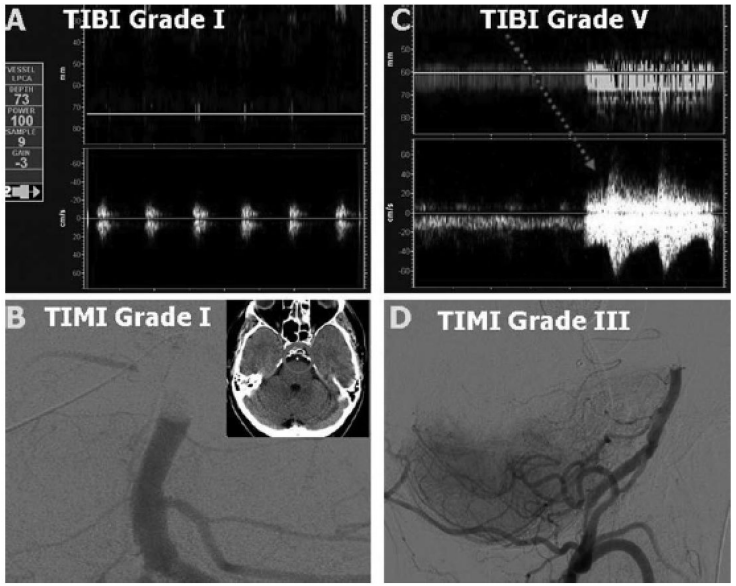
Thrombolysis in Brain Ischemia (TIBI) Transcranial Doppler Flow Grades Predict Clinical Severity, Early Recovery, and Mortality in Patients Treated With Intravenous Tissue Plasminogen Activator



AM Demchuk et al Stroke. 2001;32:89-93.

Real-time Validation of Transcranial Doppler Criteria in Assessing Recanalization During Intra-arterial Procedures for Acute Ischemic Stroke

An International, Multicenter Study



Conclusions—TIBI criteria can accurately predict brain recanalization in real time as compared with thrombolysis in myocardial infarction angiographic scores.

Tsivgoulis G et al Stroke. 2013;44:394-400.

Early neurological deterioration after a successful thrombectomy

Trans-cranial Doppler predicts early neurologic deterioration in anterior circulation ischemic stroke after successful endovascular treatment

Background: Early neurologic deterioration (END) may occur in patients with anterior circulation ischemic stroke (ACIS) after receiving endovascular treatment (EVT). ***Hemodynamic insufficiency, re-occlusion, and post-re-canalization hyper-perfusion*** are likely to play a critical role in END. We hypothesized that hemodynamic changes can predict END in patients with ACIS post-successful EVT using trans-cranial Doppler (TCD).

Methods: TCD parameters including peak systolic velocity (PSV), bilateral mean flow velocity (MFV), and pulse index (PI) were determined via the middle cerebral arteries within 72 h post-EVT. A logistic regression model was applied to detect independent predictors for END.

Table 2: Post-interventional trans-cranial Doppler findings in early neurologic deterioration and non-early neurologic deterioration patients and the cut-off values for predicting the early neurologic deterioration.

TCD parameters	Total ($n=80$)	END ($n=17$)	Non-END ($n=63$)	Statistical values*	P	Cut-off value†	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Statistical values‡	P
iPSV (cm/s)	124 (70–226)	127 (100–262)	116 (70–250)	−2.065	0.039	≥118	88.2	52.4	33.3	94.3	6.526	0.011
iEDV (cm/s)	52 (7–145)	53 (33–145)	49 (23–119)	−1.083	0.280	≥44	76.5	41.3	26.0	86.7	1.798	0.180
iMFV (cm/s)	75 (29–174)	79 (55–174)	74 (40–163)	−1.488	0.140	≥66	88.2	41.3	28.8	91.3	5.123	0.024
iPI	0.92 (0.50–2.28)	0.95 (0.50–1.33)	0.89 (0.52–1.66)	−0.818	0.410	≥0.85§	82.4	42.9	28.0	90.0	3.630	0.057
iMFV/cMFV	1.10 (0.40–3.53)	1.29 (0.81–3.41)	1.02 (0.40–3.53)	−2.094	0.036	≥1.12‖	70.6	58.7	31.6	88.1	2.958	0.085
iMFV/MBP	0.81 (0.22–2.19)	0.97 (0.61–2.19)	0.79 (0.41–1.96)	−2.659	0.008	≥0.84§	76.5	66.7	38.2	93.1	7.667	0.006

Totally, 112 EVT patients were included in this study and ***80/112 patients experienced successful*** re-canalization with <50% residual stenosis, while **17/80 (21.3%) patients suffered END: for which vasogenic cerebral edema (11/17) was considered as a leading role, symptomatic intra-cranial hemorrhage (4/17) and ischemia progression (2/17**). For the 80 patients, the PSV (median: 127 cm/s vs. 116 cm/s, P = 0.039), the ratio of ipsilateral-MFV/contra-lateral-MFV (iMFV/cMFV) (median: 1.29 vs. 1.02, P = 0.036) and iMFV/mean blood pressure (MBP) (median: 0.97 vs. 0.79, P = 0.008) in END patients were higher than those of non-END.

Yan-Bo He Chinese Medical Journal 2020;133(14)

Erly neurological deterioration after a successful thrombectomy

Trans-cranial Doppler predicts early neurologic deterioration in anterior circulation ischemic stroke after successful endovascular treatment

Table 3: Post-interventional trans-cranial Doppler findings in vasogenic cerebral edema and symptomatic intra-cranial hemorrhage and non-early neurologic deterioration patients and the cut-off values for predicting the vasogenic cerebral edema and symptomatic intra-cranial hemorrhage.

TCD parameters	$END_{VCEandsICH}$ ($n=15$)	Non-END ($n=63$)	Statistical values*	P	Cut-off value†	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Statistical values‡	P
iPSV (cm/s)	131 (100–262)	116 (70–250)	−2.283	0.022	≥118	93.3	52.4	31.8	97.1	7.468	0.006
iEDV (cm/s)	55 (33–145)	49 (23–119)	−1.351	0.177	≥44	80.0	41.3	25.0	89.7	2.347	0.126
iMFV (cm/s)	81 (55–174)	74 (40–163)	−1.719	0.086	≥66	93.3	41.3	27.5	96.3	6.410	0.011
iPI	0.93 (0.50–1.33)	0.89 (0.52–1.66)	−0.596	0.551	≥0.85	80.0	42.9	25.0	90.0	2.674	0.102
iMFV/cMFV	1.36 (0.81–3.41)	1.02 (0.40–3.53)	−2.371	0.018	≥1.12§	80.0	58.7	31.6	92.5	7.274	0.007
iMFV/MBP	0.98 (0.61–2.19)	0.79 (0.41–1.96)	−2.962	0.003	≥0.85‖	80.0	66.7	36.4	93.3	10.810	0.001

Cut-off values for PSV, PI, iMFV/cMFV, and iMFV/MBP for END, we found that **PI ≥0.85** (odds ratio: 11.03, 95% confidence interval: 1.92–63.46, P = 0.007) **and iMFV/MBP ≥0.84** (odds ratio: 9.20, 95% confidence interval: 2.07–40.84, P = 0.004) were independent predictors of END in a multivariate logistic regression model, with a sensitivity of 82.4% and 76.5% and a specificity of 42.9% and 66.7%, respectively, and had the positive predictive values of 29.0% and 38.2%, and negative predictive values of 90.0% and 91.3%, with an area under the receiver operating characteristic curve of 0.57 and 0.71, respectively.

Conclusion: TCD examination of EVT patients may be used as **a real-time tool to detect END predictors, such as the higher PI and iMFV/MBP, allowing for better post-thrombectomy management in ACIS patients**.

Yan-Bo He Chinese Medical Journal 2020;133(14)

Early neurological deterioration after a successful thrombectomy

Association Between Post-procedure Cerebral Blood Flow Velocity and Severity of Brain Edema in Acute Ischemic Stroke With Early Endovascular Therapy

Objectives: We aimed to investigate the association between post-procedure cerebral blood flow velocity (CBFV) and severity of brain edema in patients with acute ischemic stroke (AIS) who received early endovascular therapy (EVT).

Methods: We retrospectively included patients with AIS who received EVT within 24 h of onset. **Post-procedure CBFV of the middle cerebral artery was measured in the affected and the contralateral hemispheres using TCD**. The severity of brain edema was measured using the **three-level cerebral edema grading from the Safe Implementation of Thrombolysis in Stroke-Monitoring Study, with grades 2–3** indicating severe brain edema. The Association between CBFV parameters and severity of brain edema was analyzed.

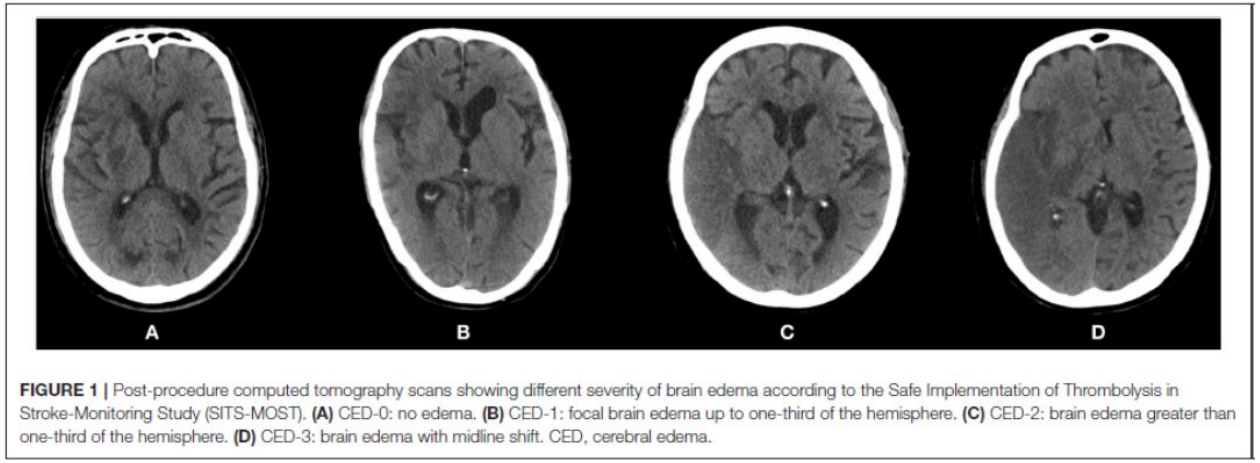


FIGURE 1 | Post-procedure computed tomography scans showing different severity of brain edema according to the Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST). **(A)** CED-0: no edema. **(B)** CED-1: focal brain edema up to one-third of the hemisphere. **(C)** CED-2: brain edema greater than one-third of the hemisphere. **(D)** CED-3: brain edema with midline shift. CED, cerebral edema.

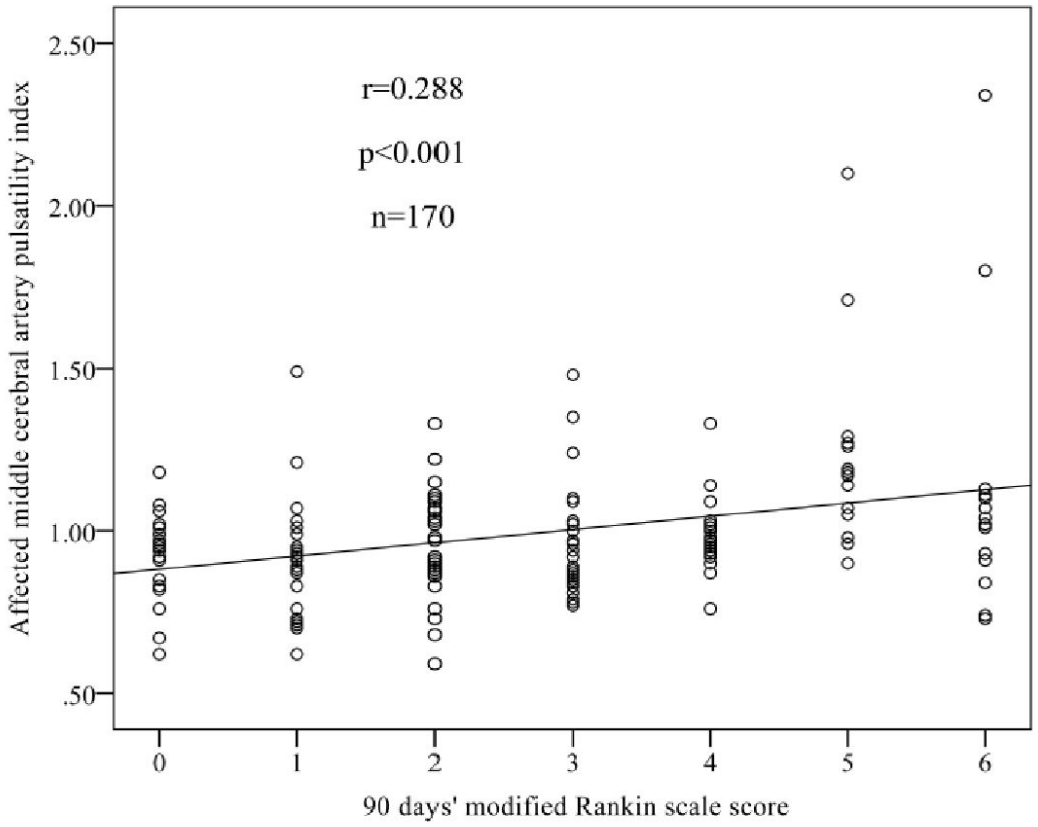
Compared to patients with non-severe brain edema, **patients with severe brain edema had lower affected/contralateral ratios of systolic CBFV (median 1 vs. 1.2, P = 0.020) and mean CBFV (median 0.9 vs. 1.3, P = 0.029).**

Jie Pan et al Front. Neurol., 18 July 2022

ORIGINAL ARTICLE

CNS Neuroscience & Therapeutics WILEY

Elevated pulsatility index is associated with poor functional outcome in stroke patients treated with thrombectomy: A retrospective cohort study



CNS Neurosci Ther. 2022;28:1568–1575

Aims: To evaluate **pulsatility index (PI)** in patients with acute ischemic stroke (AIS) who underwent endovascular thrombectomy (EVT). **Methods:** Patients were retrospectively recruited if their stroke were secondary to middle cerebral artery **(MCA) occlusion and achieved full recanalization** after EVT. **Transcranial Doppler** was performed within **24-hour post-EVT**.

The primary outcome was correlation between the **MCA-PI on the affected side and 3-month functional outcome**, with modified Rankin scale (mRS) ≥5 indicated extremely poor functional outcomes.

Results: Totally, 170 patients were included. High MCA-PI was positively related to the 3-month mRS score ($r = 0.288$, $p < 0.001$). **The highest quartile of the MCA-PI was associated with a high incidence of extremely poor functional outcomes**. The predictive capacity of the MCA-PI for extremely poor functional outcomes was good, and its **cutoff** value for predicting extremely poor outcomes was **1.04**, with a sensitivity of 65.6% and specificity of 78.3%.

Conclusion: The MCA-PI on the affected side is a prognostic biomarker in patients who have undergone stroke thrombectomy. **An elevated MCA-PI may be prognostically valuable for predicting extremely poor functional outcomes**

No-Reflow phenomenon after a thrombectomy

Persistently Elevated Microvascular Resistance Postrecanalization

A Clinical Marker of No-Reflow Phenomenon

No-reflow with persistent oligemia is a well-recognized but poorly understood phenomenon in the coronary circulation and among preclinical stroke studies. Capillary dysfunction with microvascular occlusion has been suggested as the common mechanism among proposed theories including microthrombi clogging, astrocyte swelling, and pericyte constriction.

Impaired microvascular reperfusion despite complete recanalization (no-reflow) represents a potential therapeutic target to improve outcomes after recanalization therapies.

- Whether TCD can detect acute microvascular changes postrecanalization as a biomarker of the no-reflow phenomenon in stroke patients.
- Consecutive patients with recanalized (TICI IIb/III) acute middle cerebral artery occlusion by thrombectomy were retrospectively identified.
- Sonographic measures of **MCA territory microvascular resistance (PI and RI)** on days 1 to 3 follow-up TCD were compared between patients and age/gender-matched controls.

Stroke. 2018;49:2512-2515. DOI: 10.1161/STROKEAHA.118.021631

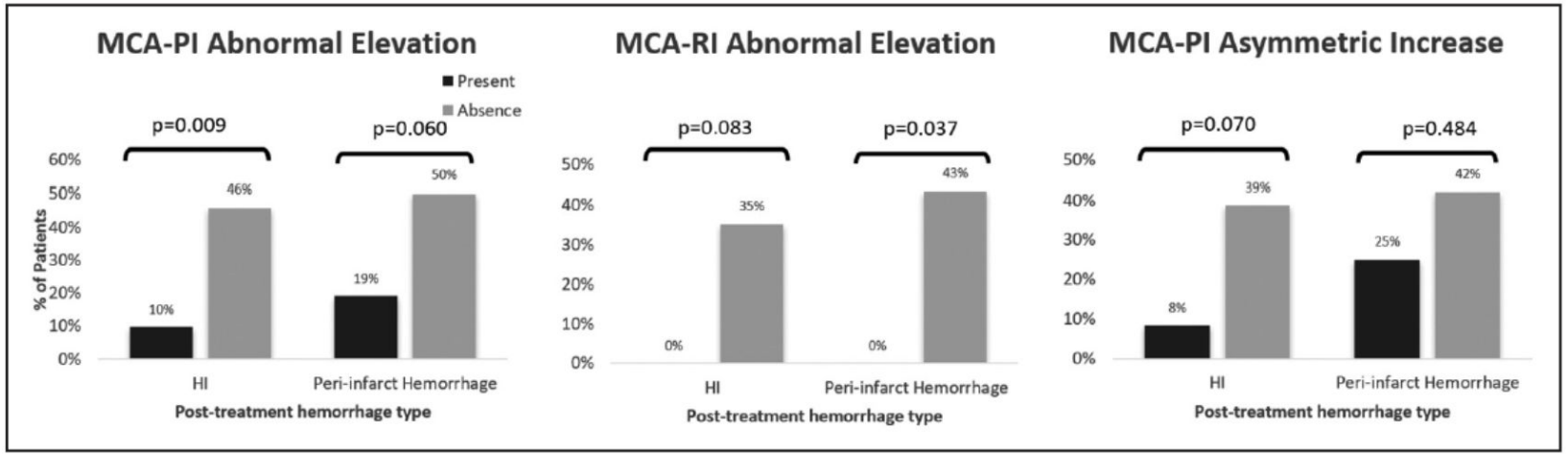
No-Reflow phenomenon after a thrombectomy

Persistently Elevated Microvascular Resistance Postrecanalization

A Clinical Marker of No-Reflow Phenomenon

Stroke. 2018;49:2512-2515. DOI: 10.1161/STROKEAHA.118.021631

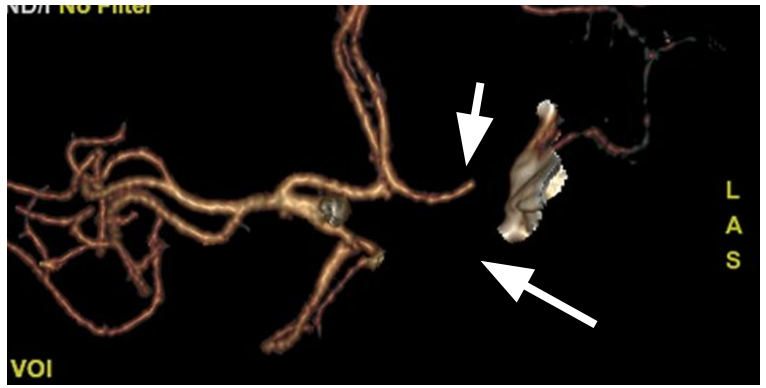
In **53 patients**, MCA **PI** was significantly more likely **to be asymmetrically increased on interside comparison** (27.9% versus 4.9%; *P*=0.007) and **abnormally elevated beyond normal reference ranges** (46.7% versus 22.0%; *P*=0.016) in the **symptomatic hemisphere. 47% of patients had an excellent functional outcome at 90 days (mRS ≤1)**. The rate of Hemorrhage were 24.5%, 9,4% PH and 5.7% symptomatic PH.



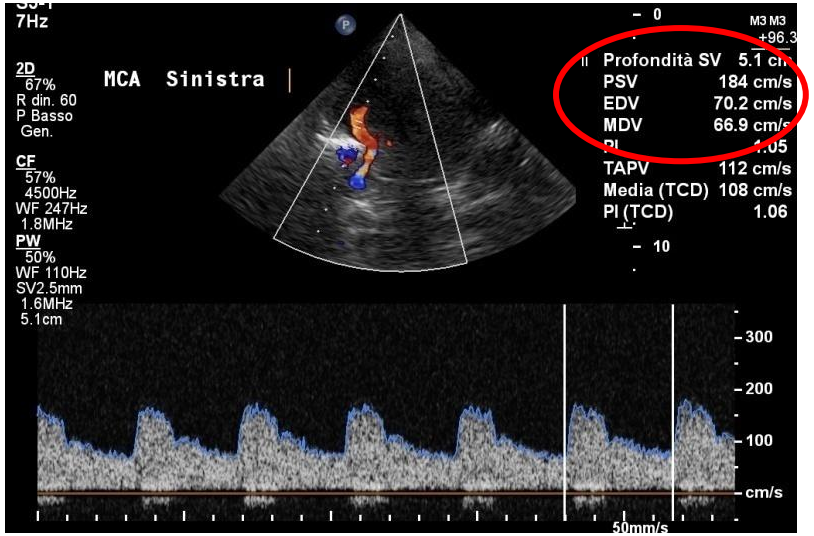
MCA PI elevation was associated with less hemorrhagic infarction (9.5% versus 45.8%; *P*=0.009) **but worse functional outcome irrespective of infarct volume as assessed on 90-day modified Rankin Scale** (score of ≤1, 18.2% versus 58.1%; *P*=0.035).

This study suggests that TCD may also be used for microvascular resistance assessment in acute stroke clinical studies to examine postrecanalization pathophysiology. As a hypothesis-generating study, our data further raise **the possibility that elevated microvascular resistance after cerebral ischemia may be a maladaptive pathophysiological reaction protective of reperfusion hemorrhage but adversely associated with injury beyond radiologically defined infarct.** Elevated microvascular resistance within the ischemic territory is commonly present after successful recanalization as measured by pulsatility index on transcranial Doppler and may be a readily available and clinically relevant biomarker of the no-reflow phenomenon.

Risk of intracranial haemorrhage after a successful thrombectomy

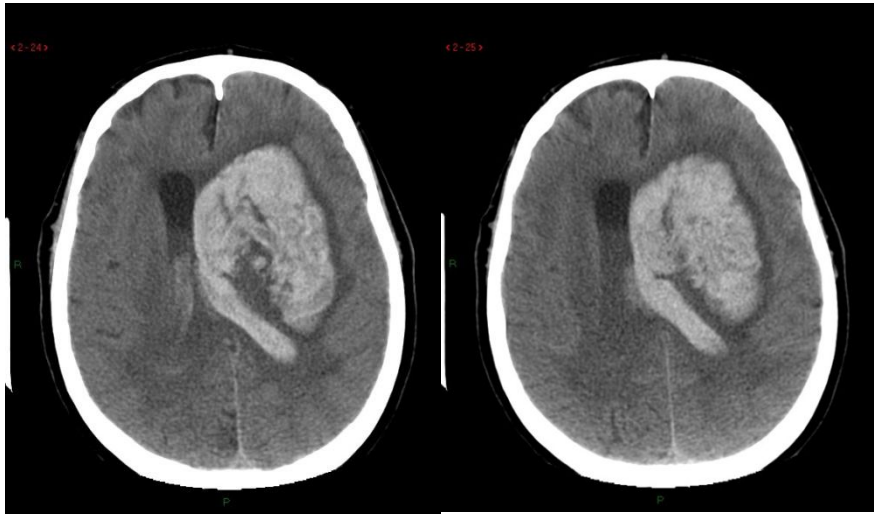


CT Angiography: left ICA and M1 distal occlusion

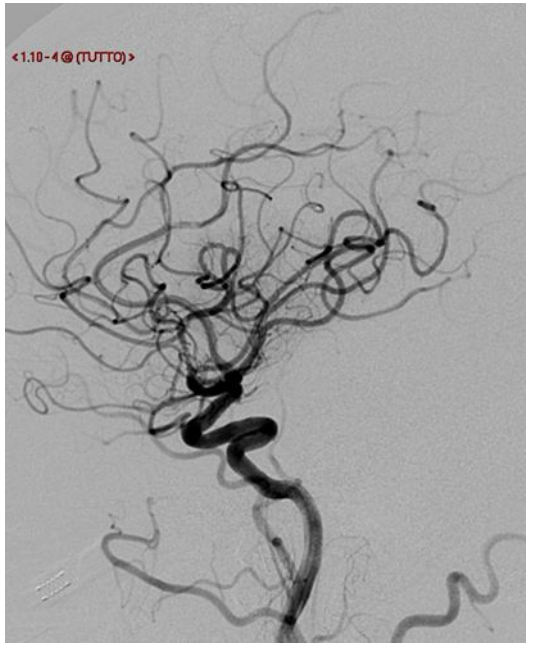


TCCS after 12 hours: systolic velocity increase on the left MCA

A 65 years old patient, current smoker and affected by hypertension comes to Emergency Department because of a sudden aphasia and right hemiplegia due to an acute occlusion of left Internal carotid and M1 (NIH 20).
CT: ASPECT 9
An intravenous thrombolysis and a successful thrombectomy were performed with a dramatic clinical improvement (NIH 5)



CT: 48 H after



CT Angiography after left ICA and M1 recanalization

Risk of intracranial haemorrhage after thrombectomy

Ultrasound Identification of Patients at Increased Risk of Intracranial Hemorrhage After Successful Endovascular Recanalization for Acute Ischemic Stroke

Claudio Baracchini[1], Filippo Farina[1], Alessio Pieroni[1], Anna Palmieri[1], Caterina Kulyk[1], Federica Viaro[1], Joseph-Domenico Gabrieli[2], Giacomo Cester[2], Francesco Causin[2], Renzo Manara[2]

World Neurosurg. 2019;125:e849-e855

Increased middle cerebral artery mean blood flow velocity index after stroke thrombectomy indicates increased risk for intracranial hemorrhage

Kneihs M et al. J Neurointerv Surg. 2018 Sep;10(9):882-887

Original Contribution

Blood Pressure After Endovascular Thrombectomy
Modeling for Outcomes Based on Recanalization Status

Marius Matusevicius, MSc; Charith Cooray, MD, PhD; Matteo Bottai, PhD; Michael Mazya, MD, PhD; Georgios Tsivgoulis, MD, PhD; Ana Paiva Nunes, MD; Tiago Moreira, MD, PhD; Jyrki Ollikainen, MD; Rosanna Tassi, MD; Daniel Strbian, MD; Danilo Toni, MD, PhD; Staffan Holmin, MD, PhD; Niaz Ahmed, MD, PhD

Stroke. 2020;51:519-525

Early Cerebrovascular Ultrasonography as a Predictor of Hemorrhagic Transformation After Thrombectomy

Crz L. Journal of Stroke and Cerebrovascular Diseases, Vol. 30, No. 8 (August), 2021

Cerebrovascular Diseases

Cerebrovasc Dis
DOI: 10.1159/000506855

Received: November 13, 2019
Accepted: February 28, 2020
Published online: April 21, 2020

Early hemodynamic predictors of good outcome and reperfusion injury after endovascular treatment

Baracchini C. et al Neurology ® 2019;92:e1-e10. doi:10.1212/WNL.0000000000007646

Controlling Blood Pressure Under Transcranial Doppler Guidance after Endovascular Treatment in Patients with Acute Ischemic Stroke

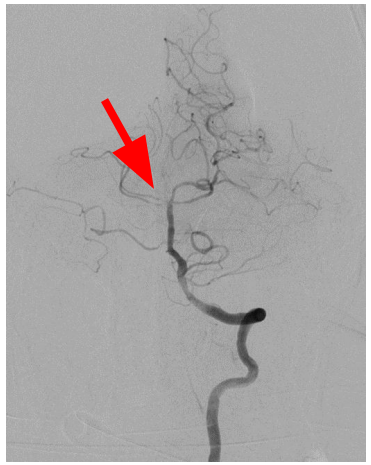
Hongbo Chen et al Cerebrovasc Dis 2020;49(2):160-169

The arterial may re-occlude after initial recanalization

A 73 years old patients affected by hypertension and diabetes, came to Emergency Department one hour after the beginning of dysarthria, left hemianopsia and hyposthenia.

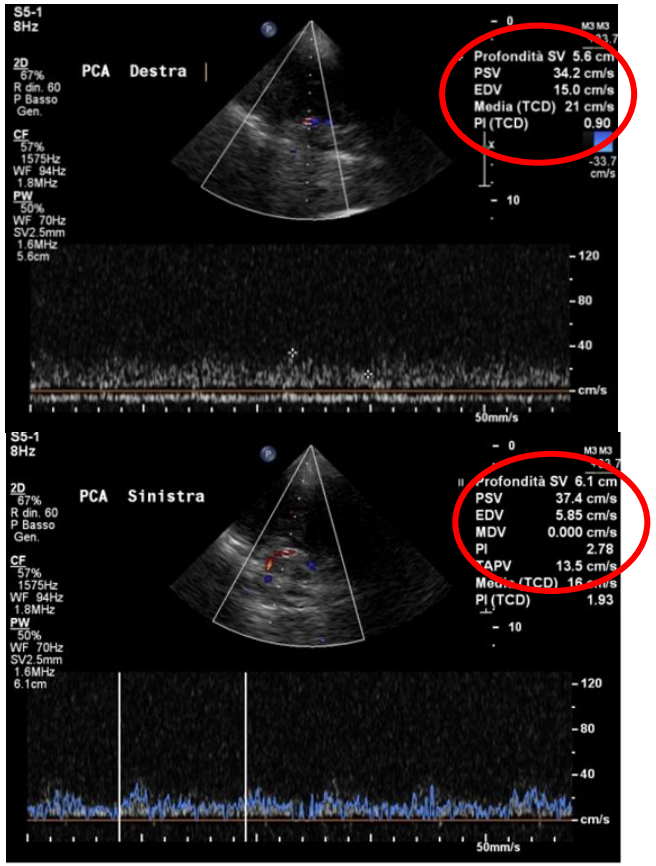
A CT: was negative for haemorrhage (ASPECT 10)

AngioCT: occlusion of P1 in right PCA.

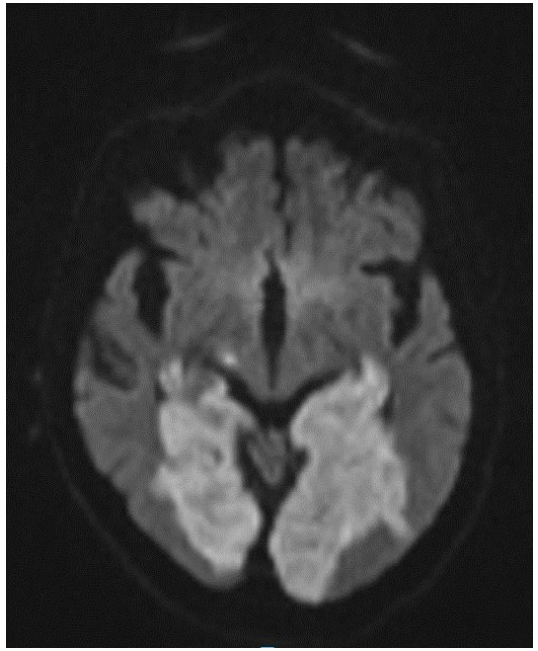


Intravenous Thrombolysis with rtPA was started and a Mechanical Thrombectomy was successfully performed

In the following 2 days the patient presented a progressively worsening bilateral hemianopsia



TCCS: severely reduced flow in both right and left P1 segment of PCA

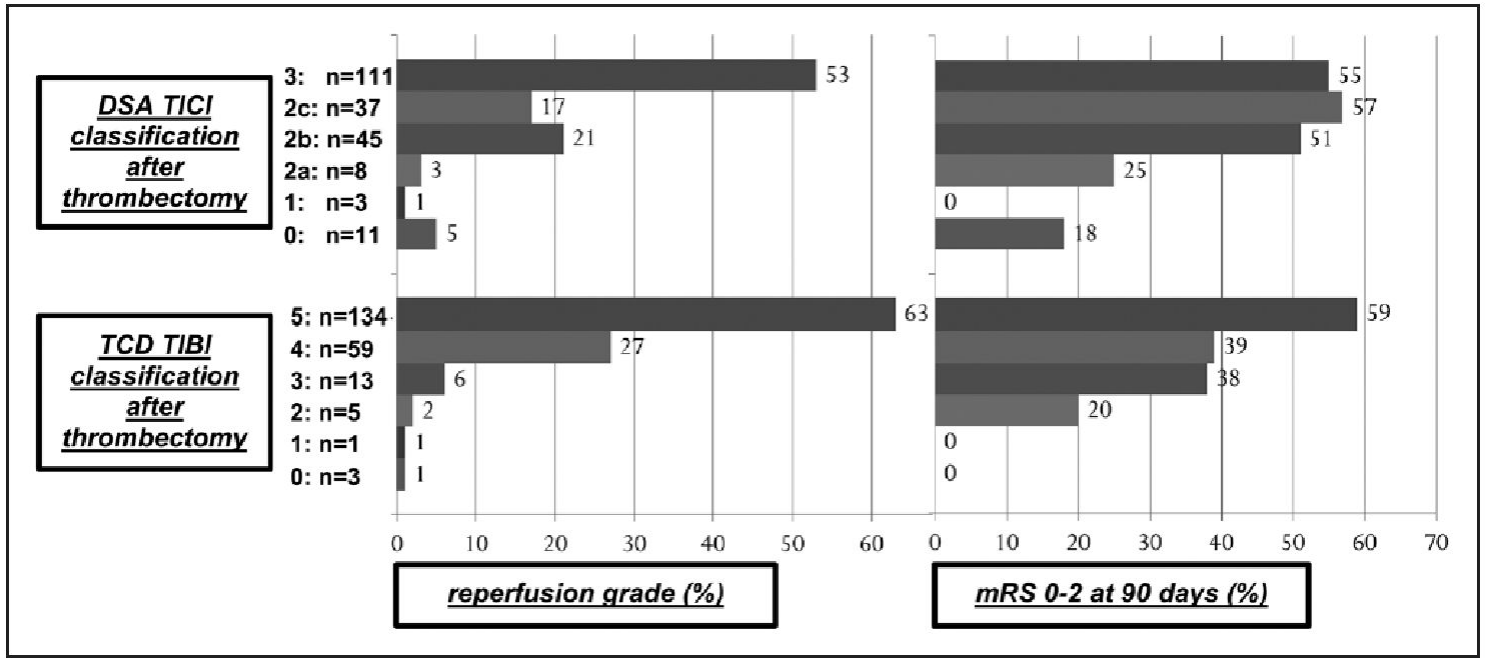


MR: bilateral occipital infarctions

Monitoring after reperfusion therapy

Abnormal Blood Flow on Transcranial Duplex Sonography Predicts Poor Outcome After Stroke Thrombectomy

- The Authors investigated postinterventional middle cerebral artery blood flow on TCD and its prognostic value for anterior large vessel occlusion stroke patients
- Of 215 large vessel occlusion stroke patients, 193 patients (90%) showed successful angiographic recanalization (TICI 2b-3).
- Of those, **69 (36%)** patients had abnormal sonographic middle cerebral artery blood flow **(TIBI grade 0–4) within 72 hours after** MT, **which was an independent predictor for poor 90-day outcome**.



Kneihsl M et al Stroke. 2018;49:2780-2782. DOI: 10.1161/STROKEAHA.118.023213.

The arterial may re-occlude after initial recanalization

Predictors of Unexpected Early Reocclusion After Successful Mechanical Thrombectomy in Acute Ischemic Stroke Patients

Mosimann PJ et al. Stroke. 2018;49:2643-2651.

Twenty-Four–Hour Reocclusion After Successful Mechanical Thrombectomy
Associated Factors and Long-Term Prognosis

Marto JP et al .Stroke. 2019;50:2960-2963.

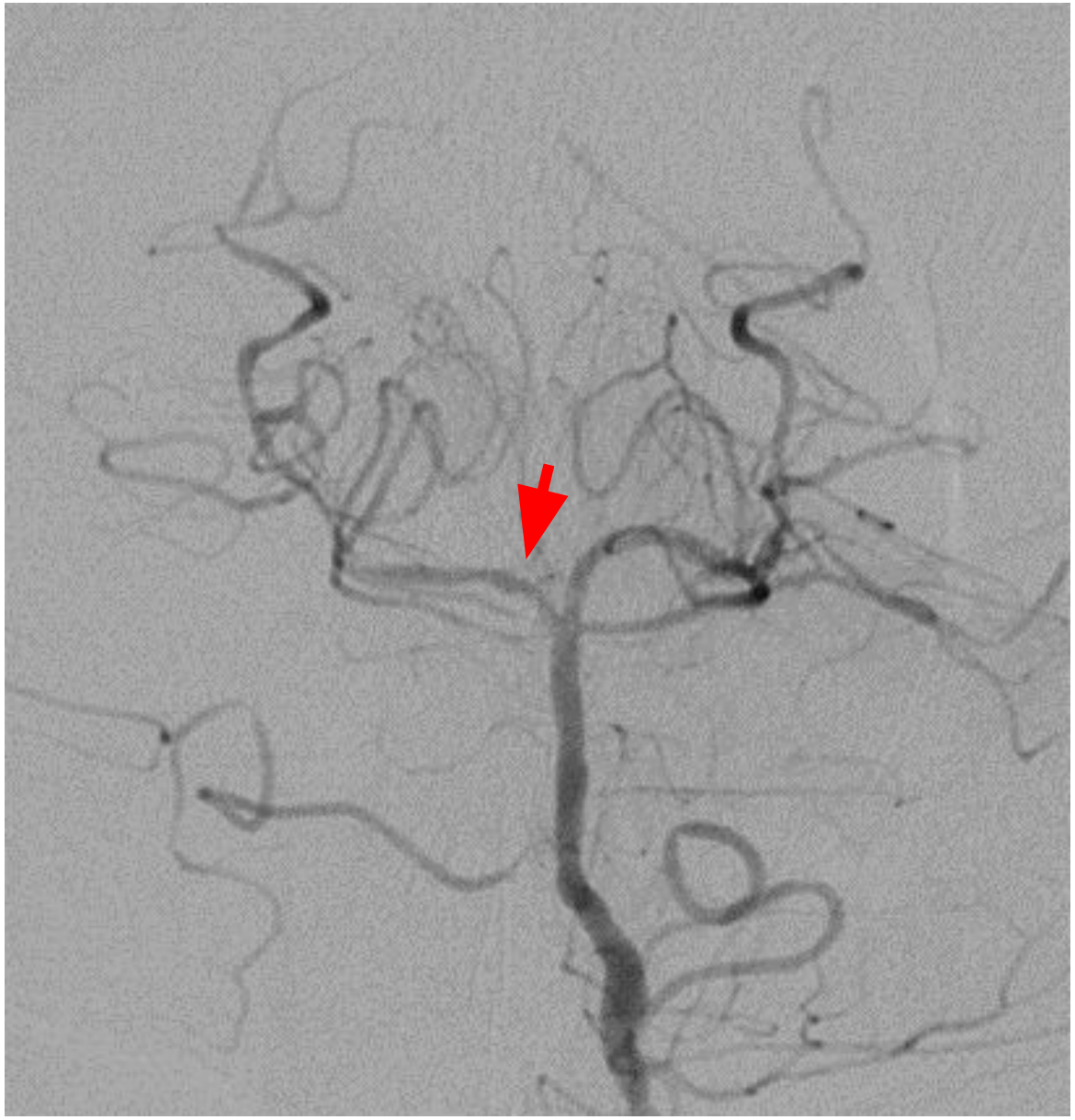
Original Article

Page 1

The predictors and prognosis for unexpected reocclusion after mechanical thrombectomy: a meta-analysis

Ann Transl Med 2020;8(23):1566 | http://dx.doi.org/10.21037/atm

The arterial may re-occlude after initial recanalization



Early re-occlusion within 24-48 hours after successful mechanical thrombectomy is rare but associated with poor outcome.

Risk factors associated with re-occlusion are:

- high platelets on admission
- statin pretreatment
- occlusion site
- more complex procedures
- atherosclerotic cause
- **residual embolic fragments or stenosis at the thrombectomy site**

Because the Re-occlusion affects long-term outcome we have to monitor and prevent this early complication for example carefully re-evaluating the last angiographic run before considering the intervention is over

Microemboli after reperfusion therapy

Prognostic Role of Microembolic Signals After Endovascular Treatment in Anterior Circulation Ischemic Stroke Patients

RESULTS: MES were detected in 65% (26/40) of patients after EVT. Ipsilateral carotid occlusion ($P = 0.05$), ≥50% ipsilateral carotid stenosis ($P = 0.05$), incomplete recanalization ($P = 0.03$), and inadequate collaterals ($P = 0.04$) were associated with a significantly higher MES count, which was correlated with a worse functional prognosis ($P = 0.03$), higher mortality ($P = 0.02$), higher distal embolization burden even outside the original ischemic territory ($P = 0.02$), and higher risk of cardiovascular events ($P = 0.04$).

F. Farina et al World Neurosurg. (2017). https://doi.org/10.1016/j.wneu.2017.11.120

Monitoring after reperfusion therapy

Microemboli After Successful Thrombectomy Do Not Affect Outcome but Predict New Embolic Events

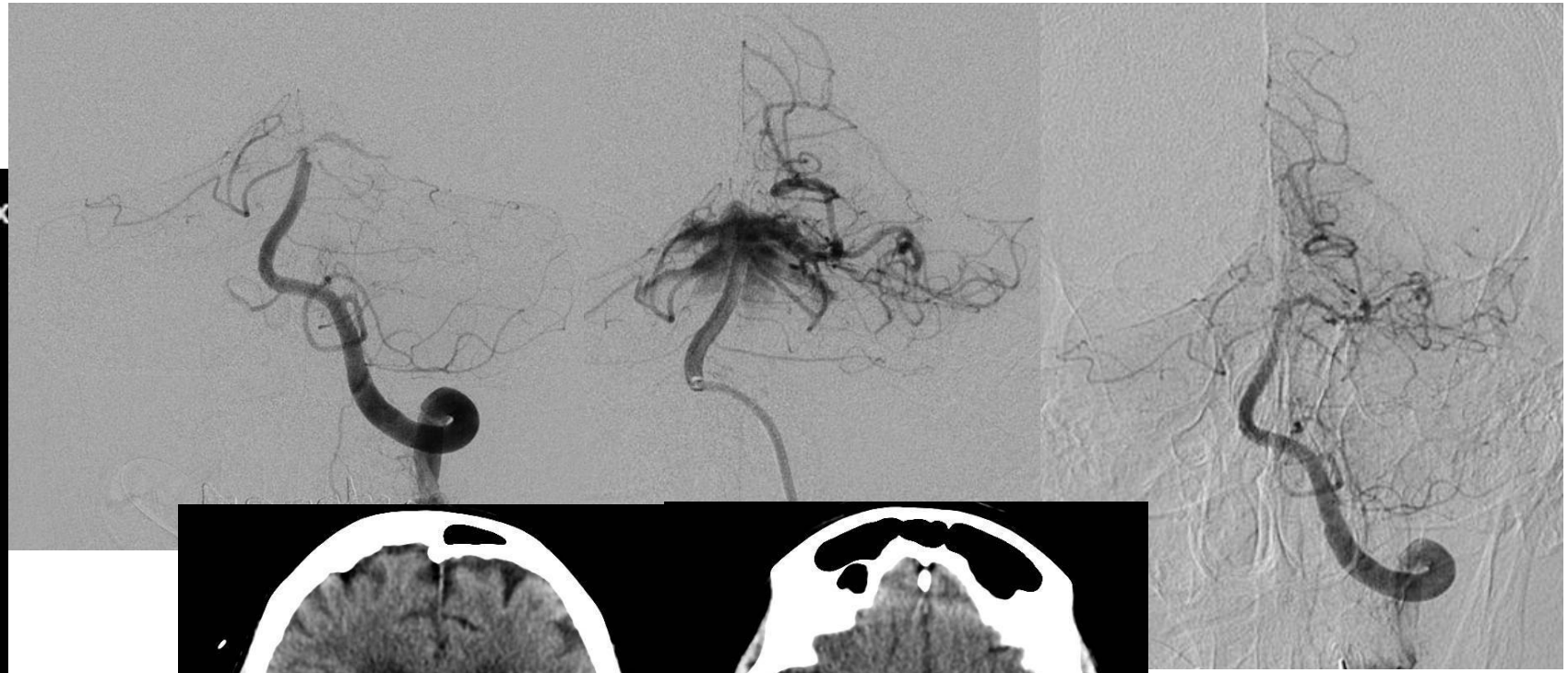
Table 3. Comparison of the Risk of Composite Outcome Vascular Event, Ischemic Stroke/TIA and All-Cause Mortality in Patients With MES-Positive Compared With MES-Negative Using Cox Proportional Hazard Regression

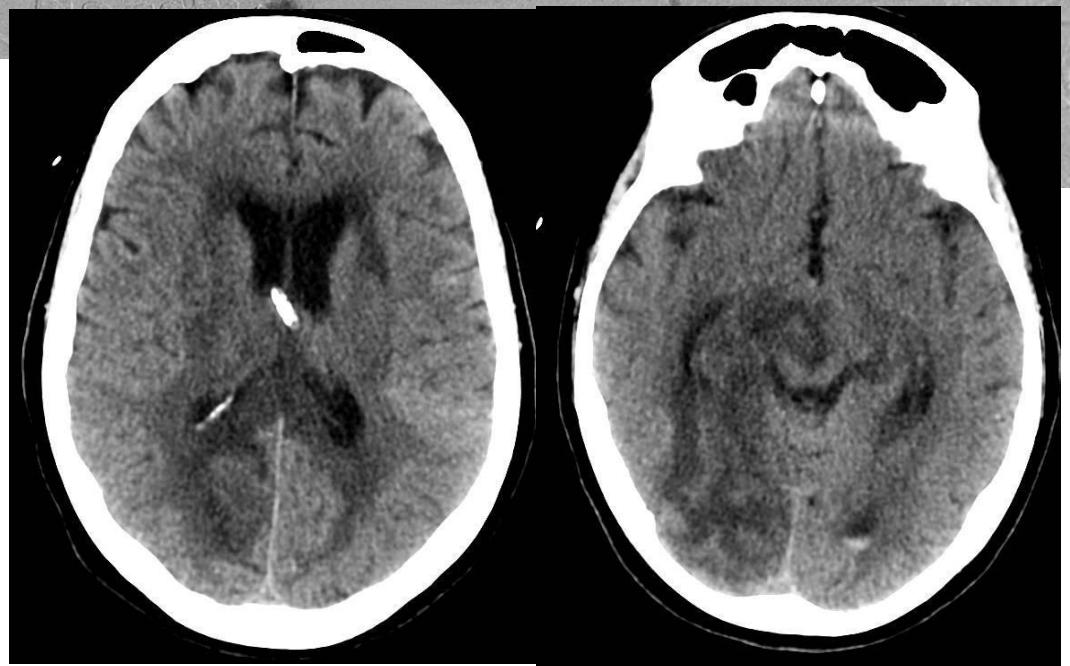
	Recurrent Ischemic Stroke or TIA			*Composite Outcome			All-cause Mortality		
	n	HR (95% CI)	*P* Value	n	HR (95% CI)	*P* Value	N	HR (95% CI)	*P* Value
Unadjusted analysis									
MES-positive	7	5.78 (1.20–27.9)	0.03	8	4.50 (1.19–16.9)	0.03	2	0.38 (0.08–1.82)	0.29
MES-negative	2	Reference		3	Reference		8	Reference	
†Adjusted analysis									
MES-positive	7	8.22 (1.55–43.6)	0.01	8	6.73 (1.63–27.8)	0.01	2	0.40 (0.07–2.27)	0.30
MES-negative	2	Reference		3	Reference		8	Reference	

Conclusions—MES detected by transcranial Doppler following endovascular treatment of anterior circulation occlusions do not predict clinical or radiological outcome. **However, such emboli are an independent marker of recurrent embolic events within 90 days.** (F. Sheriff et al Stroke. 2020;51:154-161. DOI: 10.1161/STROKEAHA.119.025856.)

Unsuccessful thrombectomy

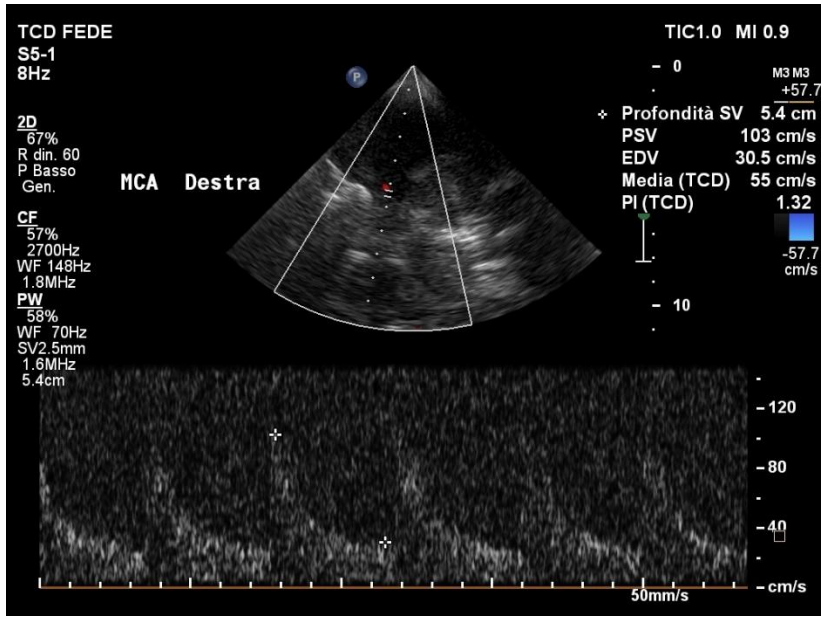
4.10.22 Donna 65 arriva in DEA per perdita di coscienza acuta GCS:5 intubata

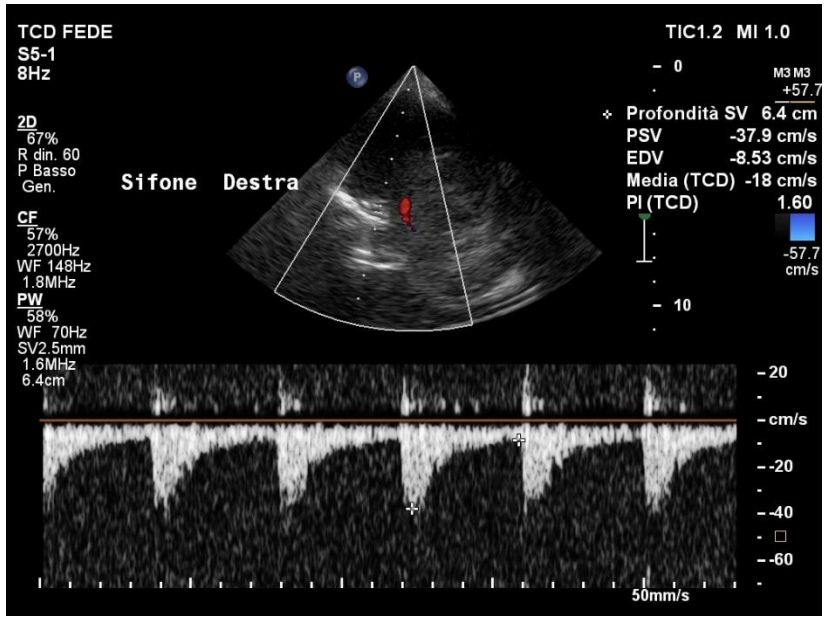


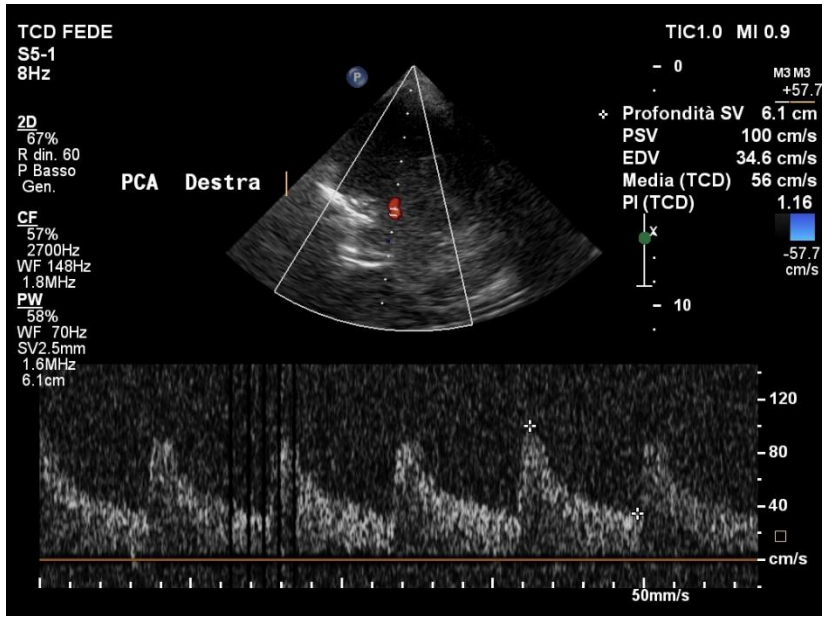


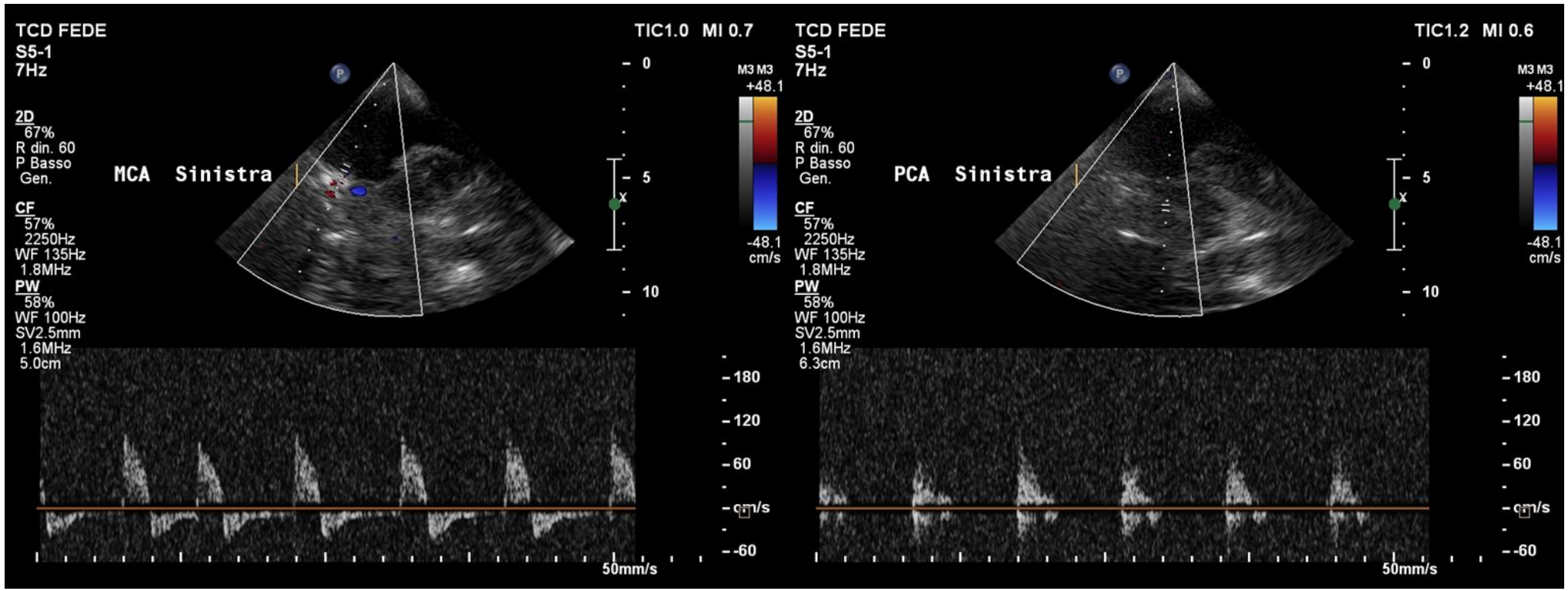
17.10.22

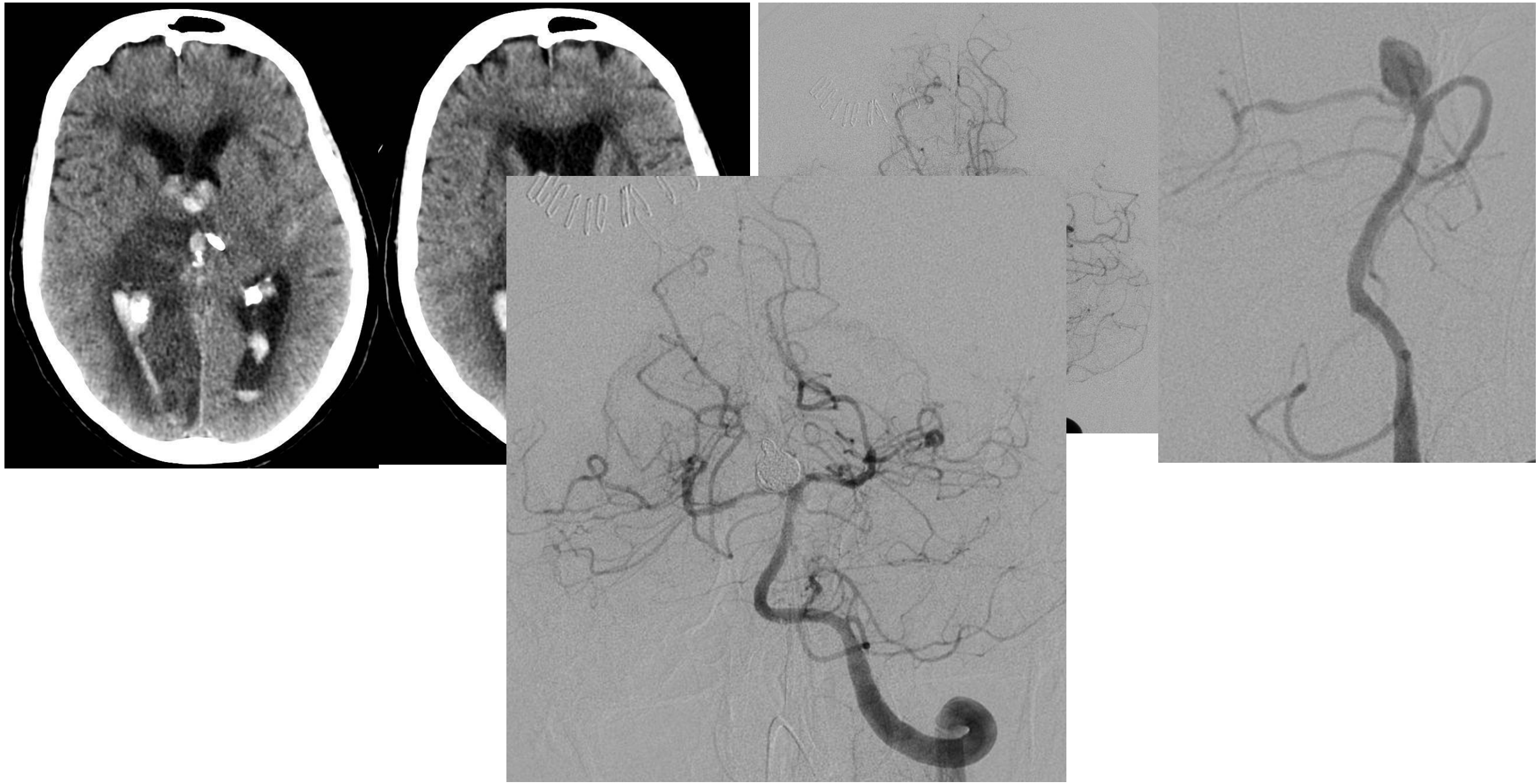
19.10.22


TCD FEDE
S5-1
8Hz
TIC1.0 MI 0.9
MCA Destra
Profondità SV 5.4 cm
PSV 103 cm/s
EDV 30.5 cm/s
Media (TCD) 55 cm/s
PI (TCD) 1.32
2D
67%
R din. 60
P Basso
Gen.
CF
57%
2700Hz
WF 148Hz
1.8MHz
PW
58%
WF 70Hz
SV2.5mm
1.6MHz
5.4cm
120
80
40
cm/s
50mm/s


TCD FEDE
S5-1
8Hz
TIC1.2 MI 1.0
Sifone Destra
Profondità SV 6.4 cm
PSV -37.9 cm/s
EDV -8.53 cm/s
Media (TCD) -18 cm/s
PI (TCD) 1.60
2D
67%
R din. 60
P Basso
Gen.
CF
57%
2700Hz
WF 148Hz
1.8MHz
PW
58%
WF 70Hz
SV2.5mm
1.6MHz
6.4cm
20
cm/s
-20
-40
-60
50mm/s

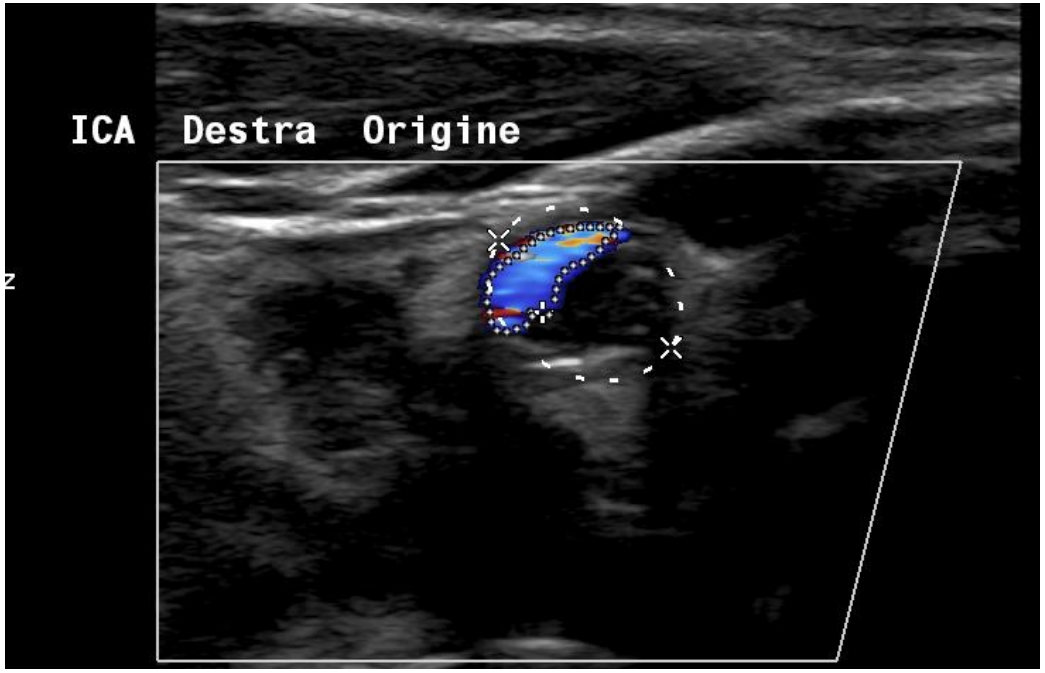

TCD FEDE
S5-1
8Hz
TIC1.0 MI 0.9
PCA Destra
Profondità SV 6.1 cm
PSV 100 cm/s
EDV 34.6 cm/s
Media (TCD) 56 cm/s
PI (TCD) 1.16
2D
67%
R din. 60
P Basso
Gen.
CF
57%
2700Hz
WF 148Hz
1.8MHz
PW
58%
WF 70Hz
SV2.5mm
1.6MHz
6.1cm
120
80
40
cm/s
50mm/s

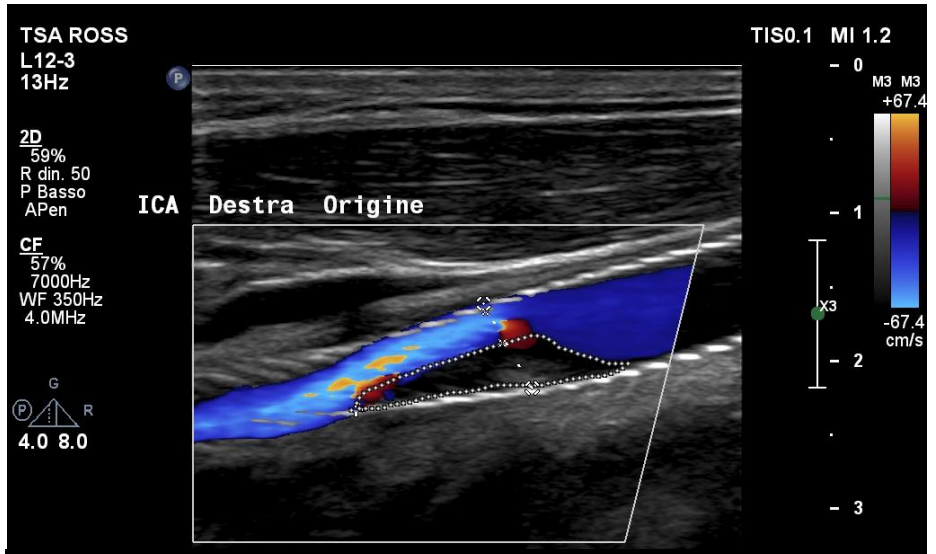

TCD FEDE
S5-1
7Hz
2D
67%
R din. 60
P Basso
Gen.
CF
57%
2250Hz
WF 135Hz
1.8MHz
PW
58%
WF 100Hz
SV2.5mm
1.6MHz
5.0cm
TIC1.0 MI 0.7
MCA Sinistra
M3 M3
+48.1
-48.1
cm/s
0
5
10
180
120
60
cm/s
-60
50mm/s
TCD FEDE
S5-1
7Hz
2D
67%
R din. 60
P Basso
Gen.
CF
57%
2250Hz
WF 135Hz
1.8MHz
PW
58%
WF 100Hz
SV2.5mm
1.6MHz
6.3cm
TIC1.2 MI 0.6
PCA Sinistra
M3 M3
+48.1
-48.1
cm/s
0
5
10
180
120
60
cm/s
-60
50mm/s

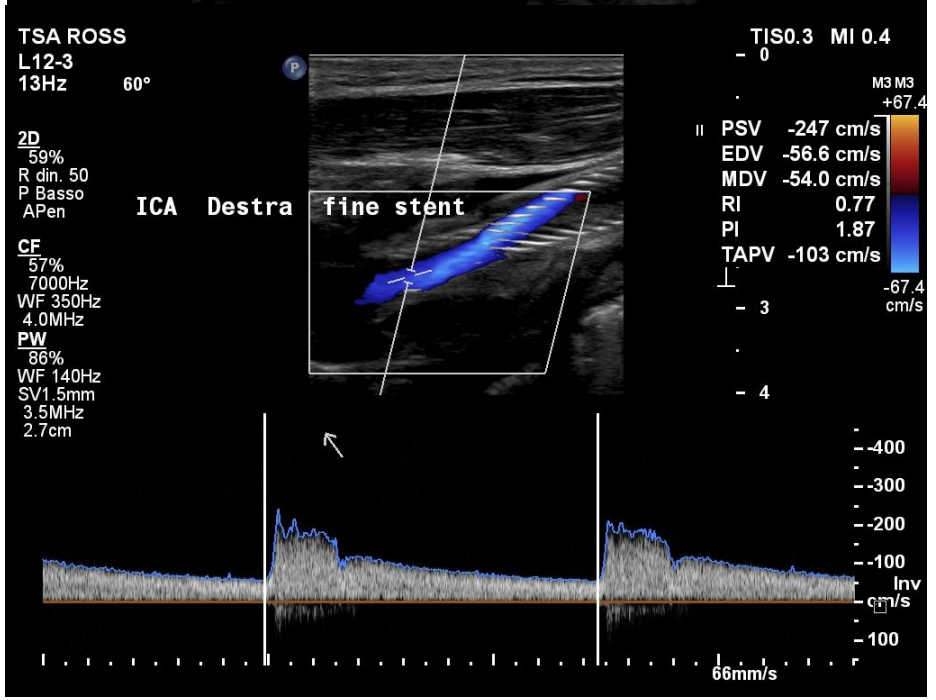


Morever…….

Uomo di 31 anni
Al risveglio anartria ed emiplegia sinistra
ANGIOTC: occlusione in tandem a dx
Disostruzione meccanica + stent di ICA dx
Somministrazione di tirofiban per 12 ore con embricazione di aspirina e clopidogrel
A circa 12 ore controllo dell'eco-color-doppler







Neurosonology in Stroke Unit: slow thinking

What was the cause? Identification of major etiological subtypes:

- Large artery Atherosclerotic stenosis
- Small Vessel Disease
- Cryptogenic /ESUS
- Cardioembolic
- Unusual (dissection, inflammation…)

Large artery atherosclerotic occlusive disease

Large Artery Atherosclerotic Occlusive Disease

John W. Cole, MD, MS

Continuum 2017;23:133-157

Review

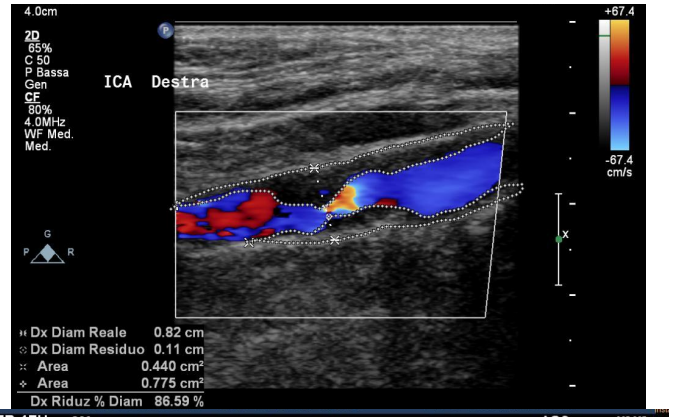
Ultrasound Assessment of Extracranial Carotids and Vertebral Arteries in Acute Cerebral Ischemia

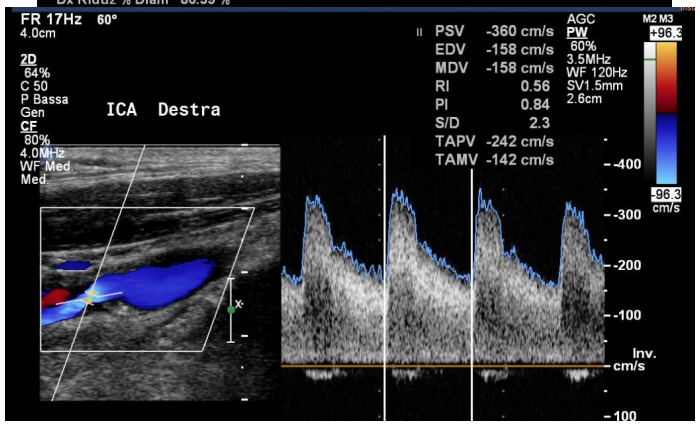
Klearchos Psychogios [1,2,3], Georgios Magoufis [4], Odysseas Kargiotis [1], Apostolos Safouris [1], Eleni Bakola [1], Maria Chondrogianni [1], Panagiotis Zis [5], Elefterios Stamboulis [1] and Georgios Tsivgoulis [2,*]

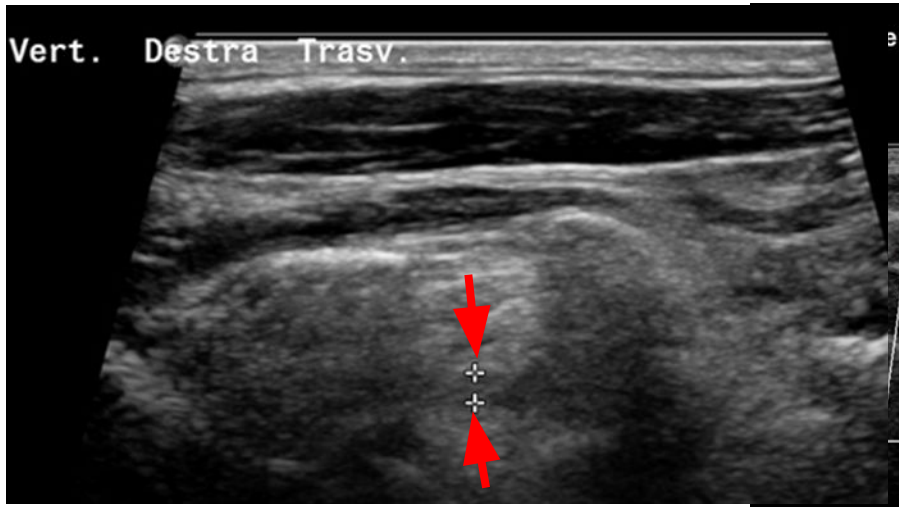
Symptomatic carotid and vertebral stenosis

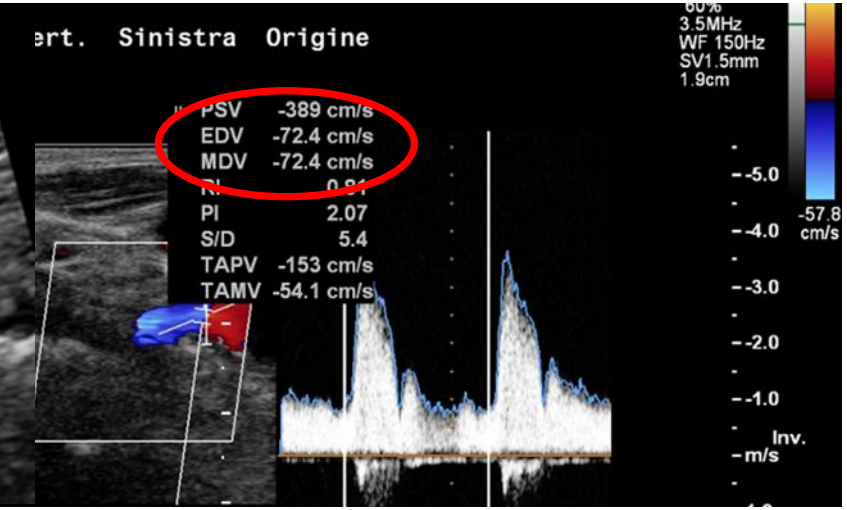
CDU is an excellent tool to evaluate carotid, vertebral and subclavian atherosclerotic plaques providing details about:

- composition and surface of the lesion, degree of the stenosis by means of spectral Doppler ultrasound









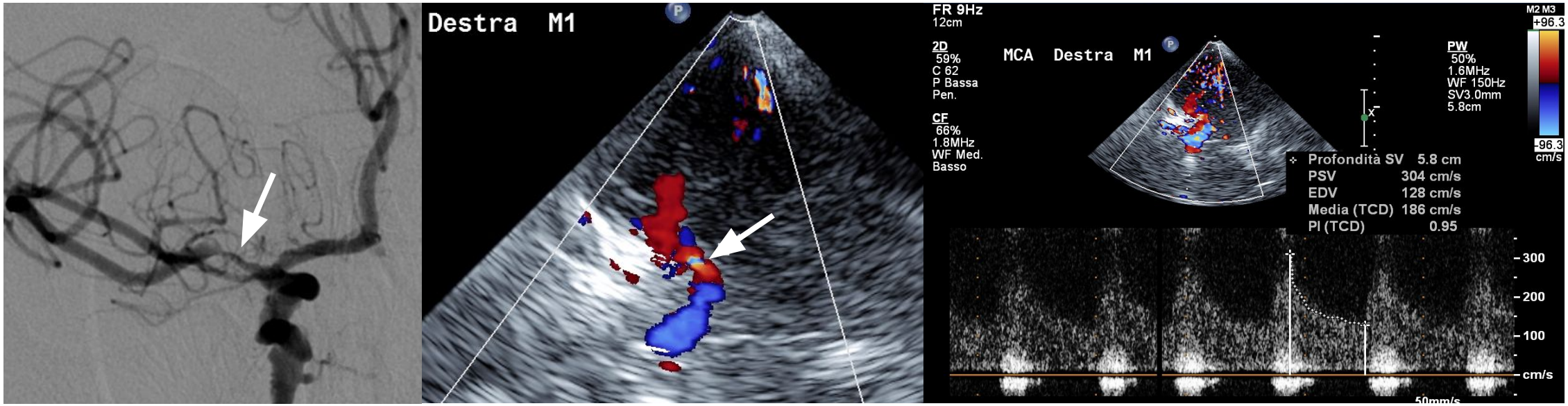
Large artery atherosclerotic occlusive disease

Transcranial Doppler sonography for detecting stenosis or occlusion of intracranial arteries in people with acute ischaemic stroke (Review)

Mattioni A, Cenciarelli S, Eusebi P, Brazzelli M, Mazzoli T, Del Sette M, Gandolfo C, Marinoni M, Finocchi C, Saia V, Ricci S

Cochrane Database of Systematic reviews 2020

Symptomatic intracranial stenosis



A 79 years old patient, previous smoker, previous myocardial infarction, affected by hypertension, came to Emergency Department due to dysarthria and left hemiparesis

CT showed an ischemic lesion in left internal capsule

Angiography identified a right M1 stenosis confirmed by **TCCS** (PSV 304 cm/s e EDV 124 cm/s). A best medical therapy was chosen followed by TCCS evolution monitoring

JNN
REVIEW ARTICLE
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Neurosonology and Imaging in Uncommon Causes of Stroke

Seung Min Kim*, Sang Hee Ha†, Sang Mi Noh‡, Sung Hyuk Heo†, Bum Joon Kim†

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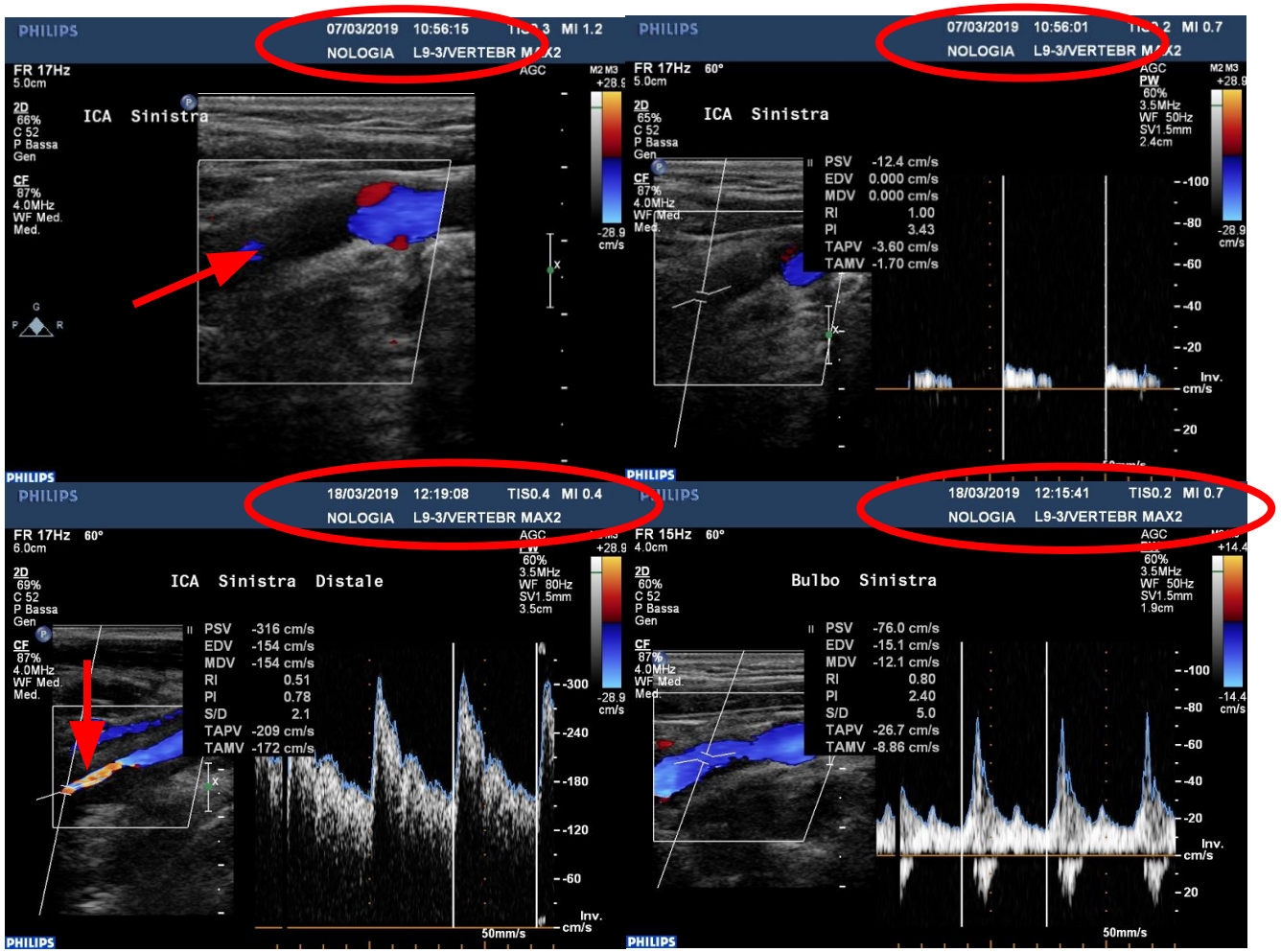
Unusual causes

Cerebral artery dissections

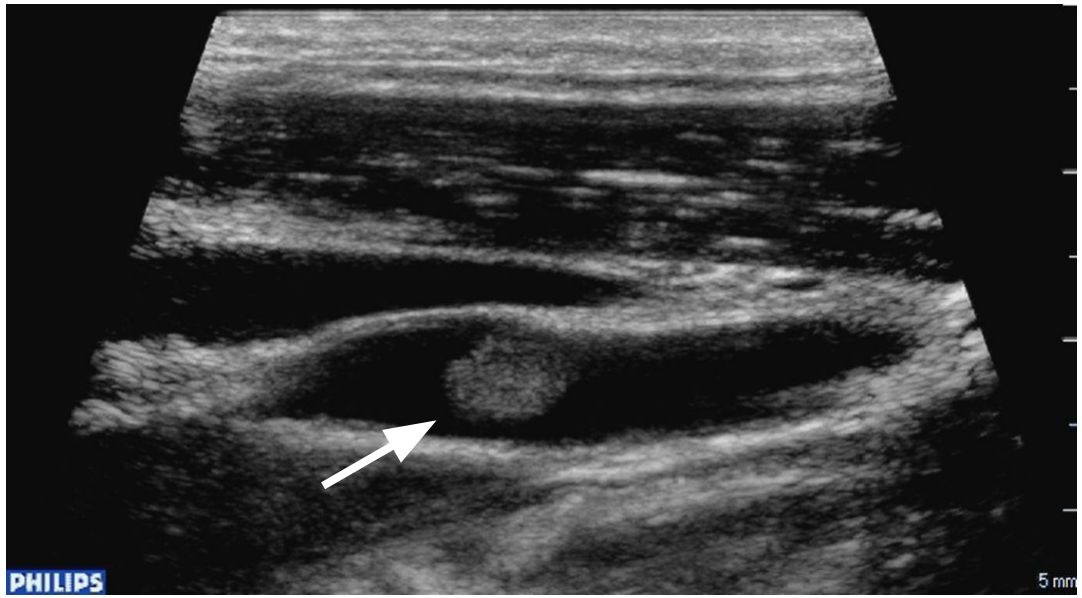
Cerebral artery dissections can be determined sonographically by:

- **Wall vessel abnormalities** such as hypoechogenic increase of wall thickness (intramural hematoma) causing stenosis or occlusion.
- **Increased peripheral flow resistance** and post-stenotic changes.
- Further **sonographic follow-up** are necessary during the acute phase because of the disease dynamic, to detect occlusion progression or recanalization



Unusual causes

Mobile Thrombus



A 50 years old patient current smoker, affected by hypertension, came to the Emergency Department a day after the beginning of slight aphasia

CDU showed a mobile thrombus on the left internal carotid artery

Unfractionated heparin was started with resolution of the thrombus some days later

Unusual causes

Carotid artery webs in embolic stroke of undetermined source with large intracranial vessel occlusion

Marc-Antoine Labeyrie[1], Fabiola Serrano[1], Vittorio Civelli[1], Clément Jourdaine[1], Peggy Reiner[2], Jean-Pierre Saint-Maurice[1], Hugues Chabriat[2] and Emmanuel Houdart[1]

International Journal of Stroke
2021, Vol. 16(4) 392–395

DOI: 10.1177/1747493020929945
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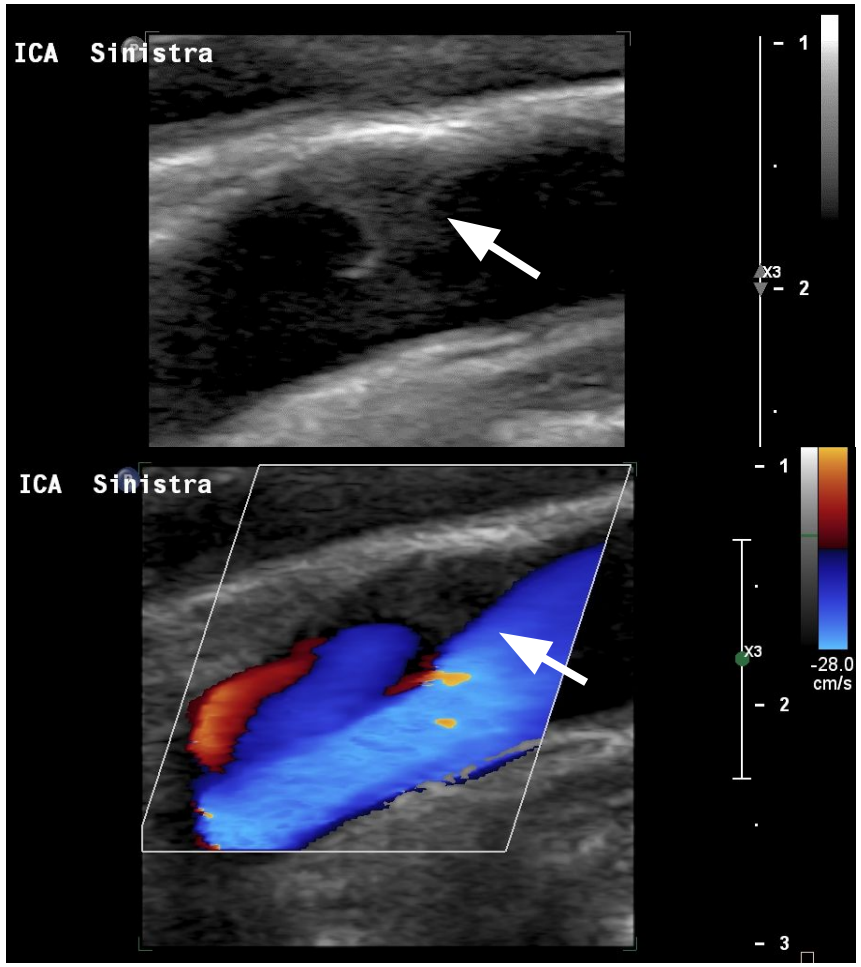
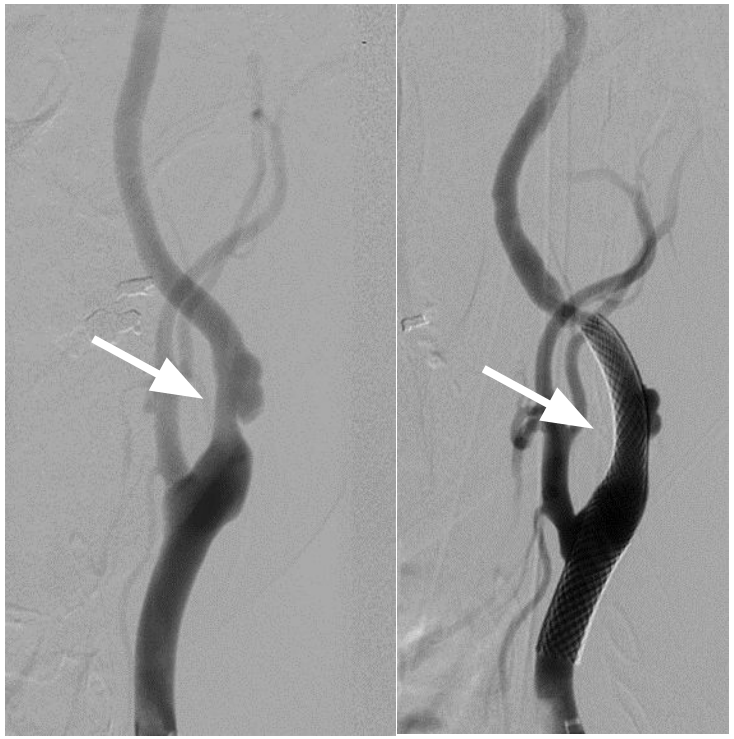
Carotid web

- Carotid web is a non-atheromatous and non-dissecting membrane-like strand that protrudes into the lumen of the carotid artery.
- This is an underrecognized cause of stroke.
- Carotid web may cause a high rate of stroke recurrence explained by the flow stagnation along the superior surface of the septum that leads to the formation of a superimposed thrombus





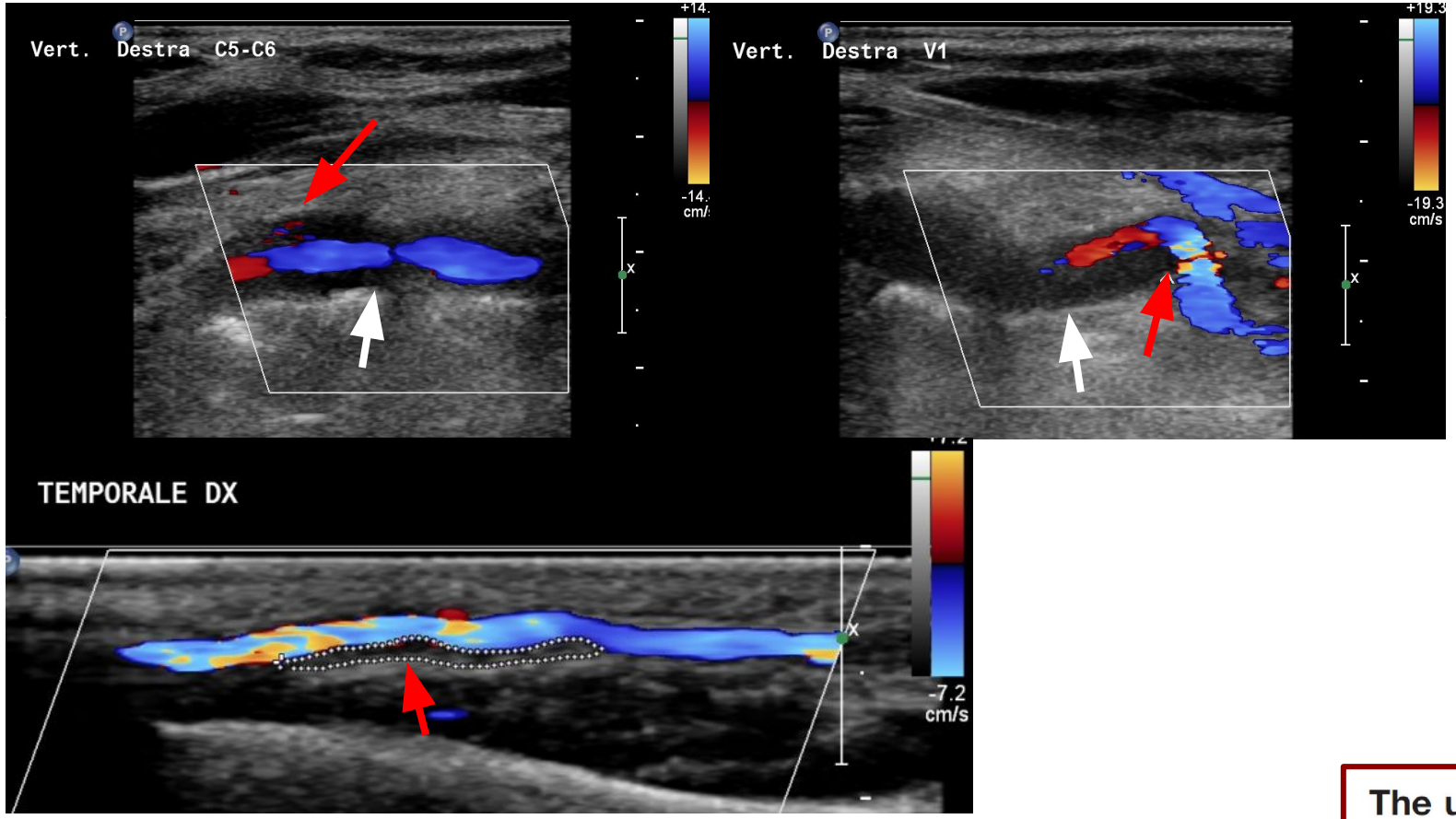
A 65 years old patient affected by hypertension, comes to our Stroke Unit 2 days after an IVT performed in Spoke Hospital for aphasia.

The CDU: showed a strand protruding in the lumen of left ICA as a carotid web. Same days after a carotid stent was inserted

Unusual causes

Inflammatory Cerebrovascular Diseases

Giant cell arteritis



A 70 years old woman without risk factors, came to Emergency Department for a sudden Wallenberg Syndrome preceded by many days of bitemporal headache.

CUD: bilateral vertebral arteries vessel wall edema, with multiple stenosis and bilateral temporal arteries Halo Sign

CUD: Hypoechogenic vessel wall edema **(halo sign)** is pathognomonic with high specificity (97 %).

Local stenosis (flow accelerations) can be observed

The use of ultrasound to assess giant cell arteritis: review of the current evidence and practical guide for the rheumatologist

Sara Monti[1,2], Alberto Floris[3], Cristina Ponte[4,5], Wolfgang A. Schmidt[6], Andreas P. Diamantopoulos[7], Claudio Pereira[1], Jennifer Piper[1] and Raashid Luqmani[1]

Rheumatology 2018;57:227-235

MES ed Ictus acuto

Eur J Vasc Endovasc Surg (2016) 52, 565–580

REVIEW

Transcranial Doppler Ultrasound Detection of Microemboli as a Predictor of Cerebral Events in Patients with Symptomatic and Asymptomatic Carotid Disease: A Systematic Review and Meta-Analysis

L.M.J. Best [a,*], A.C. Webb [b], K.S. Gurusamy [a], S.F. Cheng [a], T. Richards [a]

Microembolic signal monitoring of TOAST-classified cerebral infarction patients

JIANDONG JIANG[1], YULONG JIANG[1], SHOUQIN FENG[2], DEJIN SUN[1], AIXIA ZHUANG[1], QINGHONG ZENG[1], YI ZHANG[3], HONGMEI HUANG[4], HONGXIA NIE[1] and FANG ZHOU[1]

Departments of [1]Neurology, [2]Neurological Examination, [3]Radiology and [4]Ultrasound, Lianyungang Second Hospital, Lianyungang, Jiangsu 222006, P.R. China

Received October 19, 2012; Accepted June 19, 2013

DOI: 10.3892/mmr.2013.1609

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https://doi.org/10.1186/s13089-020-0156-1

The Ultrasound Journal

ORIGINAL ARTICLE Open Access

Relationship of spontaneous microembolic signals to risk stratification, recurrence, severity, and mortality of ischemic stroke: a prospective study

Rodrigo Bazan[1], Gustavo José Luvizutto[2], Gabriel Pereira Braga[1], Silméia Garcia Zanati Bazan[3], João Carlos Hueb[3], Carlos Clayton Macedo de Freitas[1], Pedro Tadao Hamamoto Filho[1*], Gabriel Pinheiro Módolo[1], André Petean Trindade[4], Marcone Lima Sobreira[5], Hélio Rubens de Carvalho Nunes[1]

Original Research Article

EUROPEAN STROKE JOURNAL

Micro-embolic signal monitoring in stroke subtypes: A systematic review and meta-analysis of 58 studies

European Stroke Journal
2021, Vol. 6(4) 403–411

DOI: 10.1177/2396987321060819
journals.sagepub.com/home/eso
SAGE

Pachipala Sudheer, Shubham Misra, Manabesh Nath, Pradeep Kumar, Deepti Vibha, M.V.Padma Srivastava, Manjari Tripathi, Rohit Bhatia, Awadh Kishor Pandit and Rajesh K Singh

Diagnosi eziologica

- Carotidea: ipsilaterali
- Cardioembolica: bilaterali
- SVD: generalmente assenti

Diagnosi patogenetica

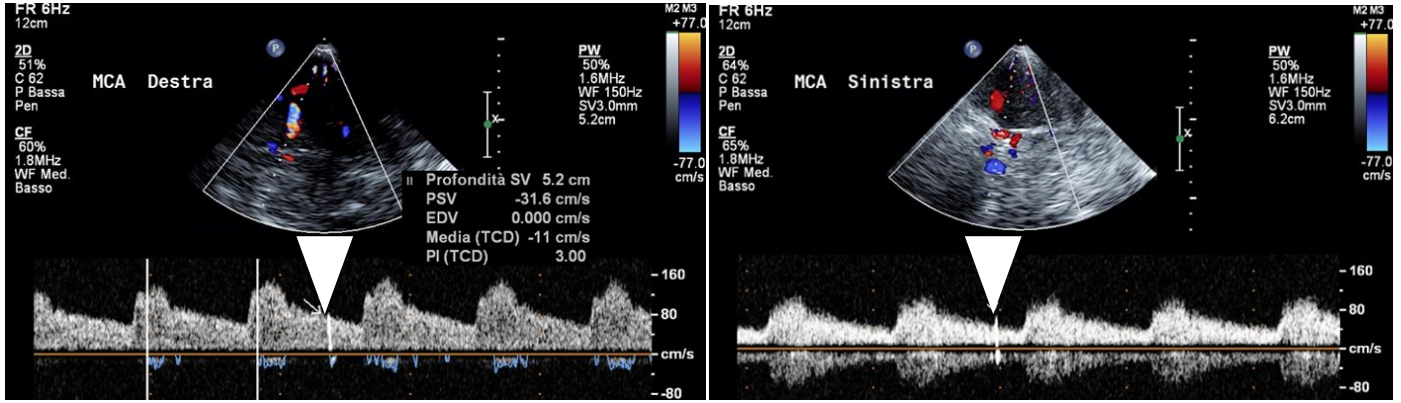
- embolica
- emodinamica

Valore prognostico

- correlazione tra MES e recidiva

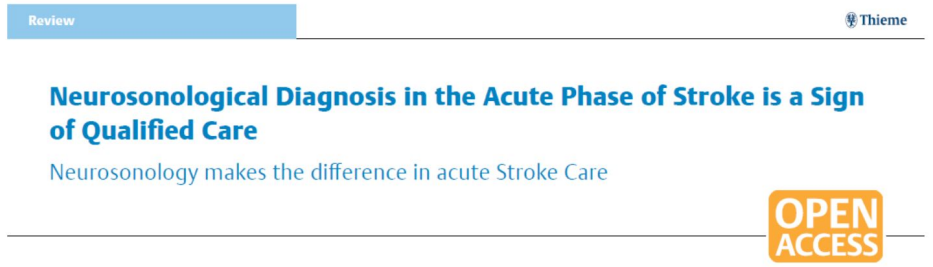
Valutazione terapeutica

- Riduzione MES in base alla terapia



Take home messages

- Neurosonology offers us a wide-range of opportunities regarding acute phase monitoring options, causal and preventive investigation alternatives, and the possibility to understand complex hemodynamic contexts impacting further decision choices.
- But mostly it gives to neurologists the possibility to get an independent assessment every time during the stroke care.
- At last, my opinion is the same as that expressed in this interesting paper, that is worth reading: **“Neurosonology makes the difference in acute Stroke Care”**



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