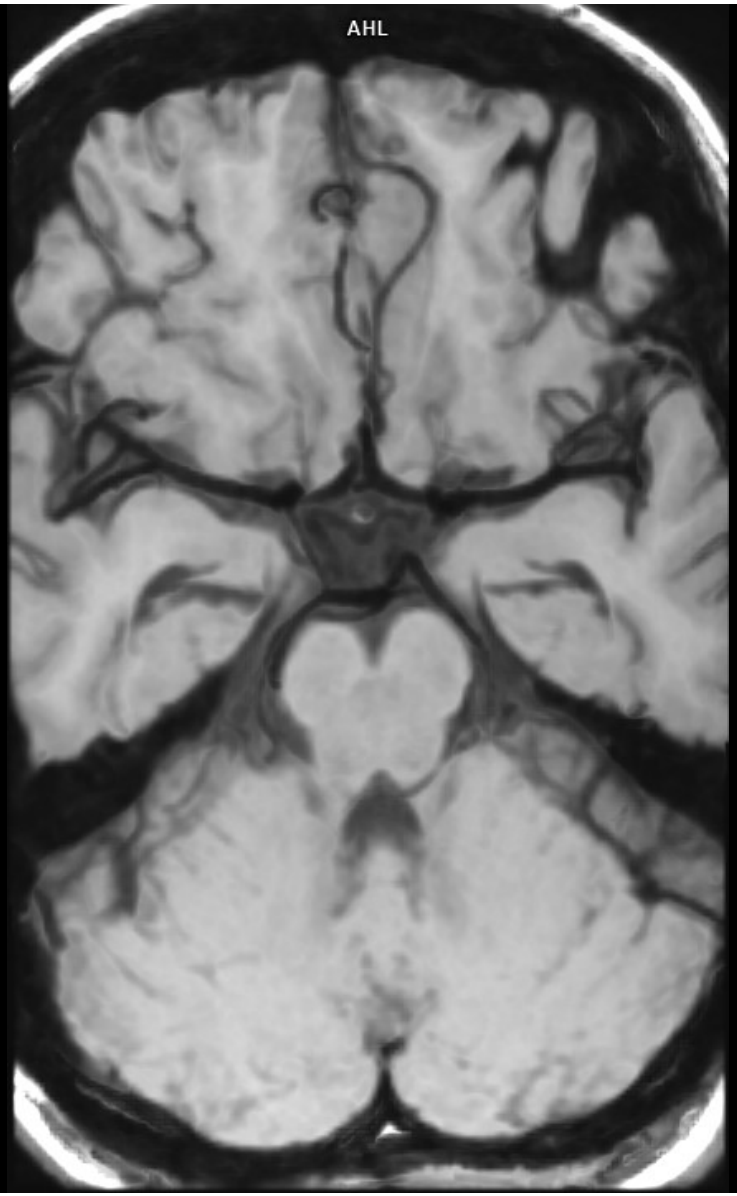


OBRAZOWANIE ŚCIANY NACZYNIOWEJ W MR

Intracranial Vessel Wall MRI

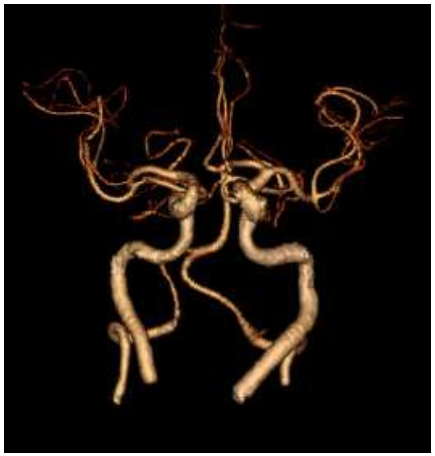
Łukasz Zwarzany
Zakład Diagnostyki Obrazowej i Radiologii Interwencyjnej
SPSK1 PUM w Szczecinie

XXVI SZKOŁA REZONANSU MAGNETYCZNEGO

13-15.10.2022, Jachranka

OCENA NACZYŃ WEWNĄTRZCZASZKOWYCH

DSA



CTA

MRA

Intracranial Vessel Wall MRI (VW-MRI):

- może wykryć zmiany w ścianie naczynia, które nie powodują istotnego zwężenia kanału przepływu;
- umożliwia dalszą charakterystykę zmian, będących przyczyną istotnych zwężeń kanału przepływu.

JAK UZYSKAĆ OBRAZY VW-MRI?

Intracranial Vessel Wall MRI: Principles and Expert Consensus Recommendations of the American Society of Neuroradiology

D.M. Mandell, M. Mossa-Basha, Y. Qiao, C.P. Hess, F. Hui, C. Matouk, M.H. Johnson, M.J.A.P. Daemen, A. Vossough, M. Edjlali, D. Saloner, S.A. Ansari, B.A. Wasserman and D.J. Mikulis on behalf of the Vessel Wall Imaging Study Group of the American Society of Neuroradiology

American Journal of Neuroradiology February 2017, 38 (2) 218-229; DOI: https://doi.org/10.3174/ajnr.A4893

AJNR
AMERICAN JOURNAL OF NEURORADIOLOGY

Główne wymagania techniczne dla obrazowania VW-MRI:

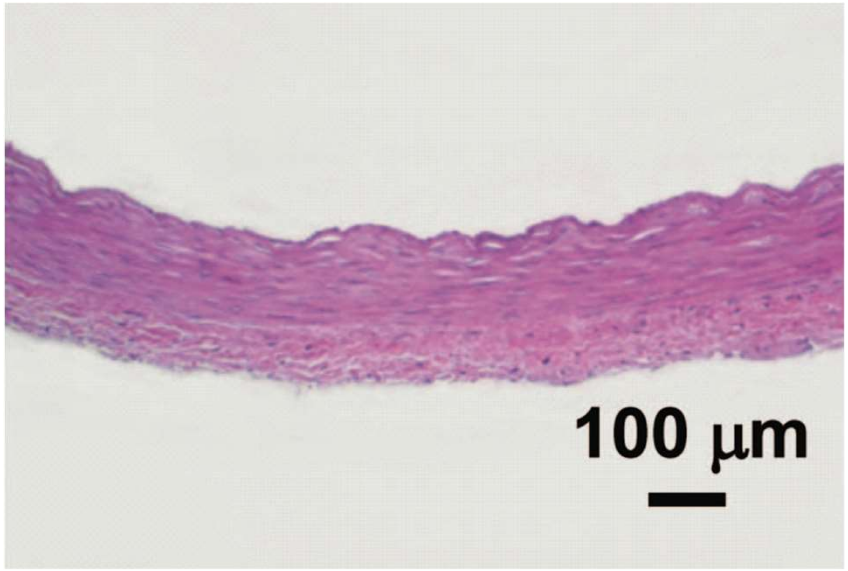
- wysoka rozdzielczości przestrzenna;
- supresja sygnału płynącej krwi oraz płynu mózgowo-rdzeniowego;
- obrazowanie 3D lub 2D w kilku płaszczyznach.

Mandell DM. Intracranial Vessel Wall MRI: Principles and Expert Consensus Recommendations of the American Society of Neuroradiology. AJNR Am J Neuroradiol. 2017 Feb;38(2):218-229.

JAK UZYSKAĆ OBRAZY VW-MRI?

Wysoka rozdzielczości przestrzenna:

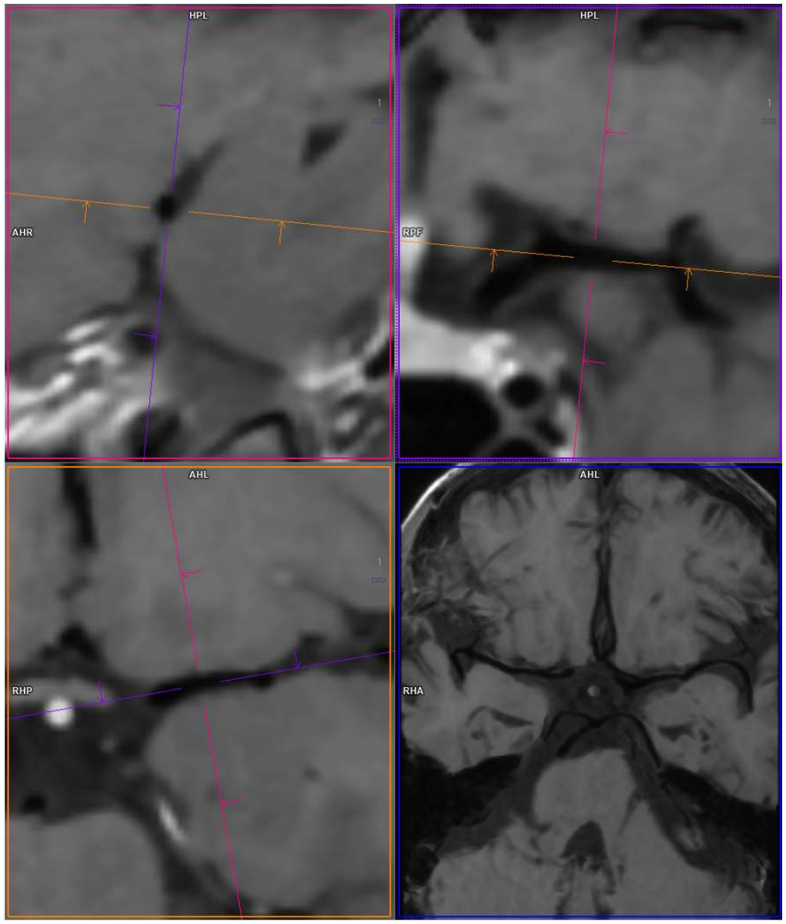
- konieczne systemy 3T z uwagi na wyższy SNR
- izotropowe sekwencje 3D, voxel o wym. 0.4 – 0.7 mm
- sekwencje 2D, voxel o wym. 2.0 x 0.4 x 0.4 mm



grubość ściany prawidłowej MCA/BA wynosi 0,2-0,3 mm
(1/10 średnicy światła naczynia)

Gutierrez J et al. The contribution of HIV infection to intracranial arterial remodeling: a pilot study. Neuropathology. 2013 Jun;33(3):256-63.
Nagel MA et al. Varicella zoster virus vasculopathy. Neurology. 2011 Jul 26;77(4):364-70.

JAK UZYSKAĆ OBRAZY VW-MRI?



MPR, 3D T1WI 0.4x0.4x.0.8 mm

Sekwencje 3D vs. 2D:

- konieczność uzyskania obrazów wzdłuż osi długiej oraz krótkiej naczynia
- sekwencje 3D preferowane z uwagi na dość kręty przebieg tętnic wewnątrzczaszkowych
- sekwencje 2D przydatne, gdy lokalizacja zmian jest wcześniej znana

JAK UZYSKAĆ OBRAZY VW-MRI?

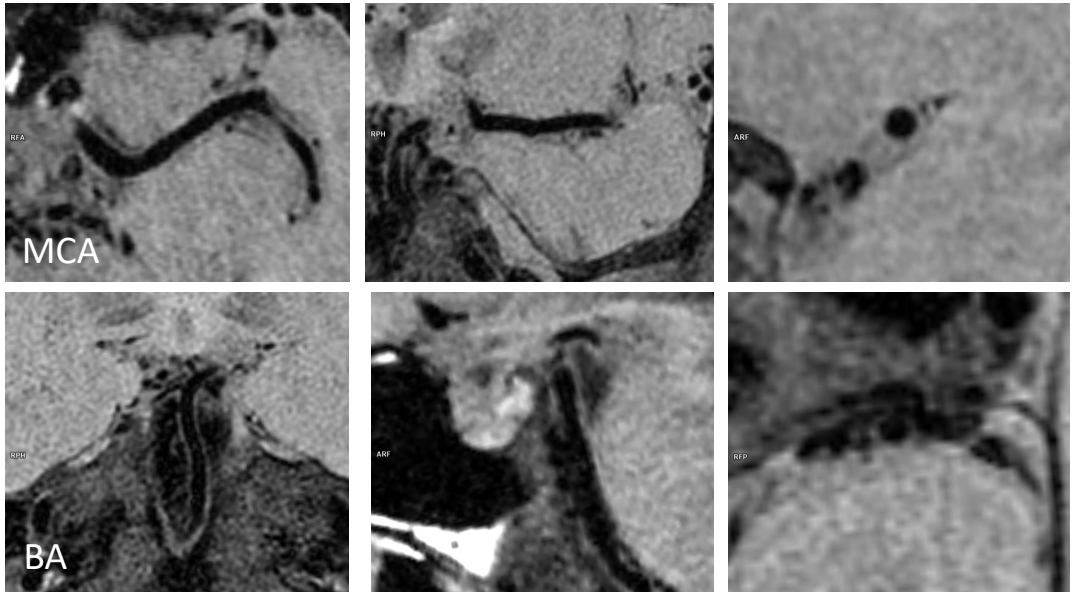
Supresja sygnału płynącej krwi oraz płynu mózgowo-rdzeniowego

- **VARIABLE FLIP ANGLE 3D FAST SPIN-ECHO SEQUENCE** („black blood imaging”)

SPACE SIEMENS Healthineers

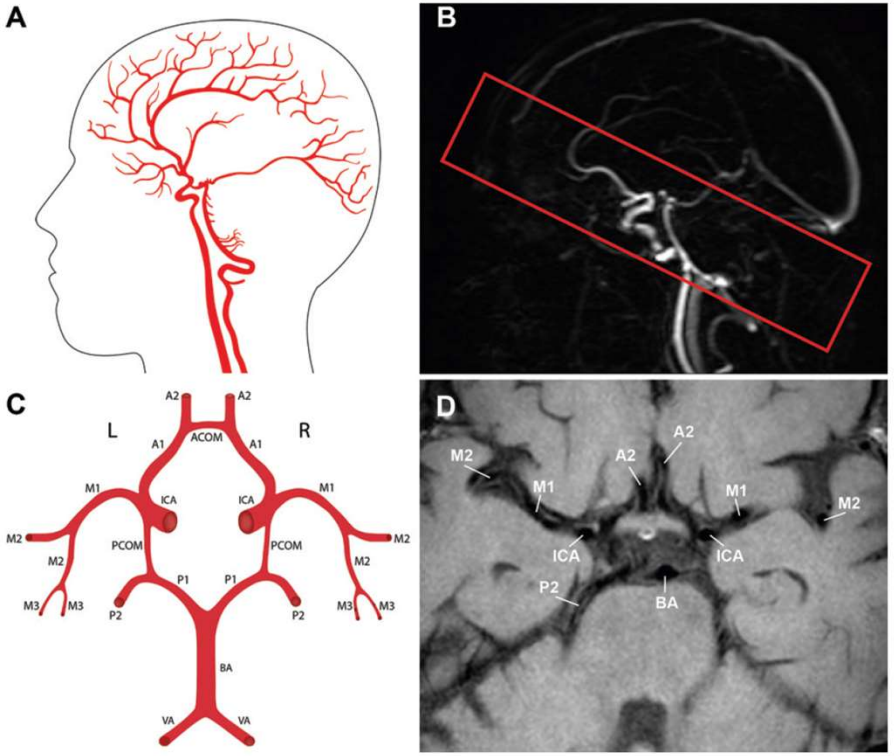
CUBE GE Healthcare

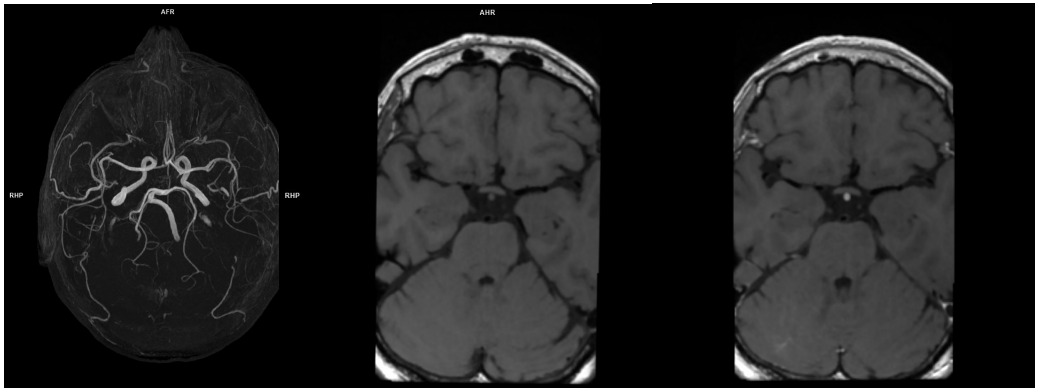
VISTA PHILIPS Healthcare



CUBE MSDE 0.6 x 0.6 x 0.6 mm

JAK UZYSKAĆ OBRAZY VW-MRI?





TOF MRA 3D CUBE T1 3D CUBE T1 + GAD

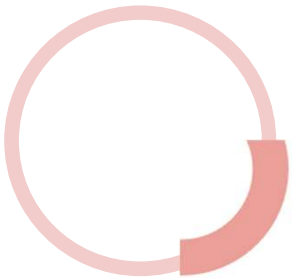
- FOV zaplanowany w płaszczyźnie poprzecznej skośnej na podstawie TOF MRA
- czas trwania badania ok. 30 minut
- długie sekwencje → podatność na artefakty ruchowe

Lindenhold A et al. The Use and Pitfalls of Intracranial Vessel Wall Imaging: How We Do It. Raddiology. 2018 Jan;286(1):12-28.

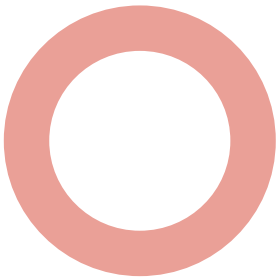
JAK INTERPRETOWAĆ OBRAZY VW-MRI?

Zmiany w obrębie ścian naczyń na obrazach VW-MRI :

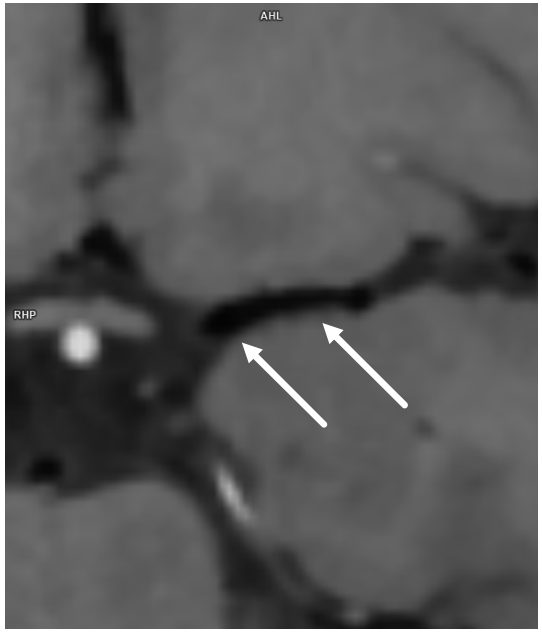
- pogrubienie i/lub wzmocnienie kontrastowe ściany naczynia
- zmiany ekscentryczne lub koncentryczne



zmiana ekscentryczna



zmiana koncentryczna

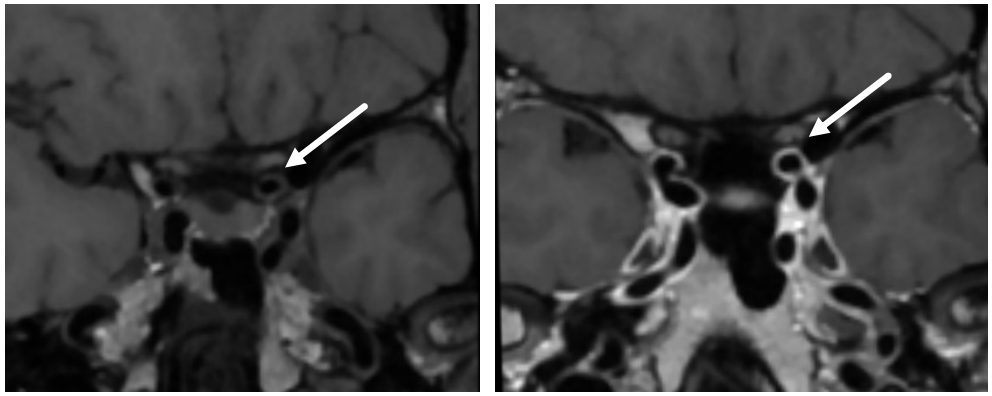


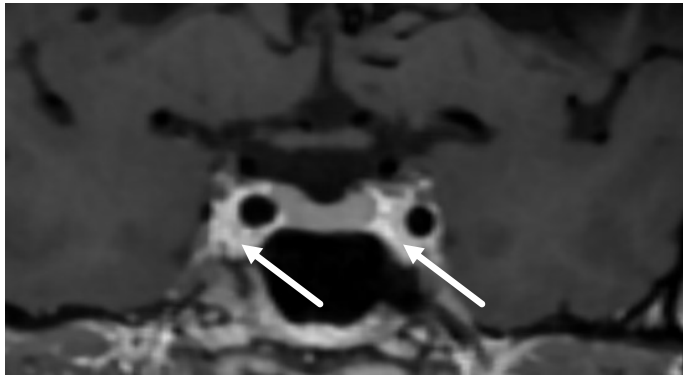
Prawidłowy obraz ścian tętnic wewnątrzczaszkowych.

JAK INTERPRETOWAĆ OBRAZY VW-MRI?

Ocena wzmocnienia kontrastowego ścian naczyń – pitfalls:

- ściany ICA oraz VA mogą ulec w prawidłowych warunkach wzmocnieniu kontrastowemu w miejscu przebicia opony twardej
- utrudniona ocena zmian rzutujących się na zatokę jamistą
- artefakt wolnego przepływu



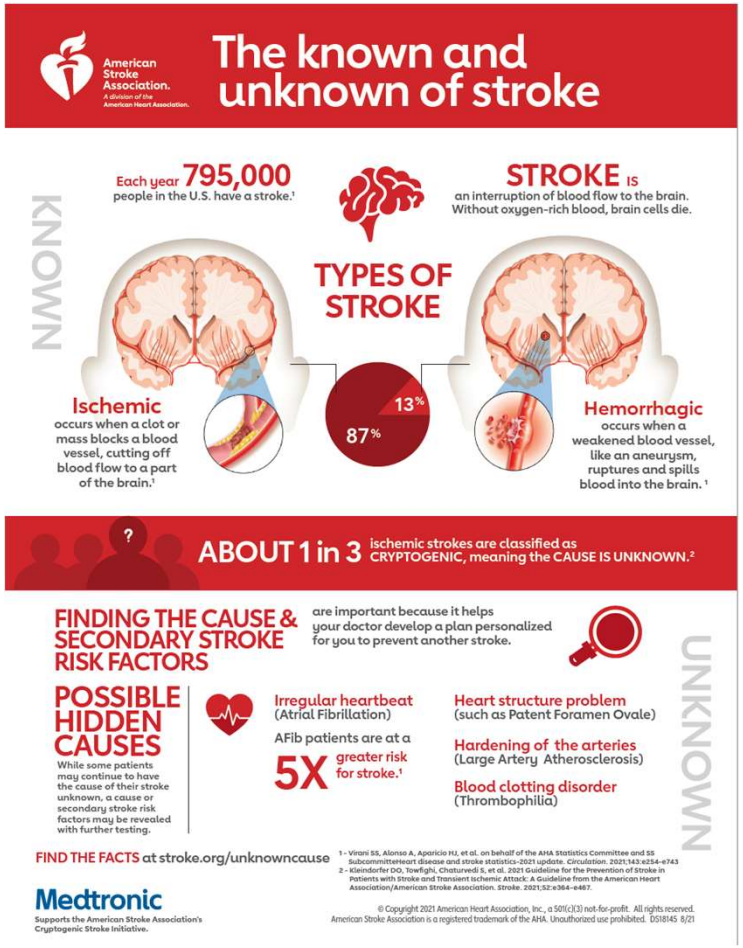


POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

ETIOLOGIA UDARU NIEDOKRWIENNEGO MÓZGU (KLASYFIKACJA TOAST):

- Choroba dużych naczyń – 16-20% przypadków
- Udar sercowozatorowy – 26-30% przpadków
- Choroba małych naczyń – 16-20% przypadków
- Udar mózgu o rzadkiej etiologii – 2-4%
- **Udar o nieustalonej etiologii (kryptogenny) – 30-36% przypadków**

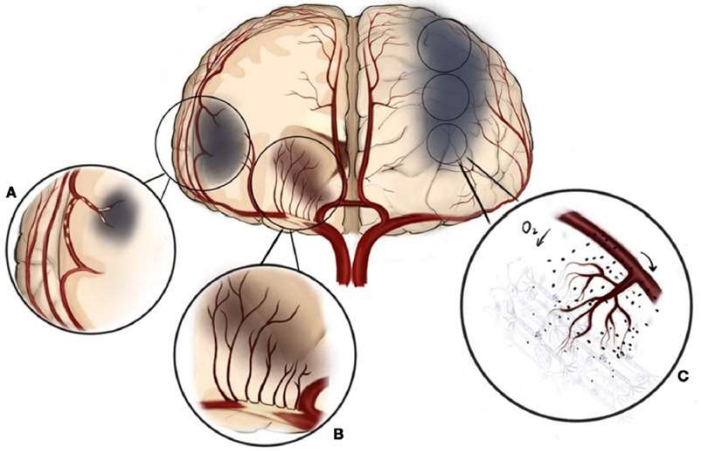
Udar kryptogenny – brak przyczyny udaru pomimo pełnego panelu badań diagnostycznych (zator z nieokreślonego źródła? niezidentyfikowana trombofilia? waskulopatie wewnątrzczaszkowe?)



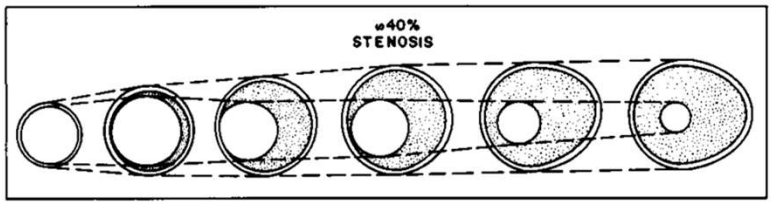
POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

Miażdżyca wewnątrzczaszkowa (intracranial atherosclerotic disease, ICAD)

- jedna z głównych przyczyn udaru mózgu na świecie;
- większe ryzyko ponownego udaru (pomimo leczenia) niż w przypadku pozostałych etiologii (25-30% u pacjentów z objawową ICAD);
- znaczące różnice w częstości występowania pomiędzy badaniami neuroobrazowymi (zwężenie kanału przepływu – surogat ICAD) a autopsyjnymi;



różne mechanizmy udaru niedokrwiennego mózgu w ICAD



zjawisko pozytywnego remodelingu

Yaghi S et al. Intracranial Atherosclerotic Disease. Stroke. 2019 May;50(5):1286-1293.
Glagov S et al. Compensatory enlargement of human atherosclerotic coronary arteries. N Engl J Med. 1987 May 28;316(22):1371-5
Luo J et al. Endovascular Treatment of Intracranial Atherosclerotic Stenosis: Current Debates and Future Prospects. Front Neurol. 2018; 9: 666.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

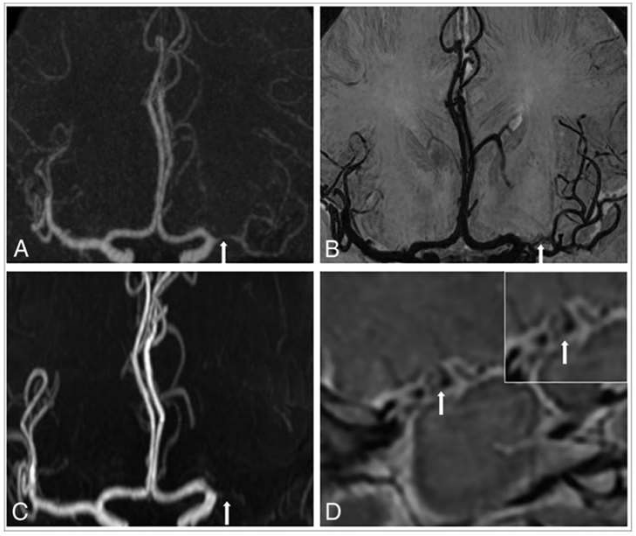
ICAD, ocena stenozy

AJNR AMERICAN JOURNAL OF NEURORADIOLOGY

3D Black-Blood Luminal Angiography Derived from High-Resolution MR Vessel Wall Imaging in Detecting MCA Stenosis: A Preliminary Study

X. Bai, P. Lv, K. Liu, Q. Li, J. Ding, J. Qu, and J. Lin

„Black-blood luminal angiography is better than TOF-MRA in detecting severe stenosis and occlusion of the MCA."

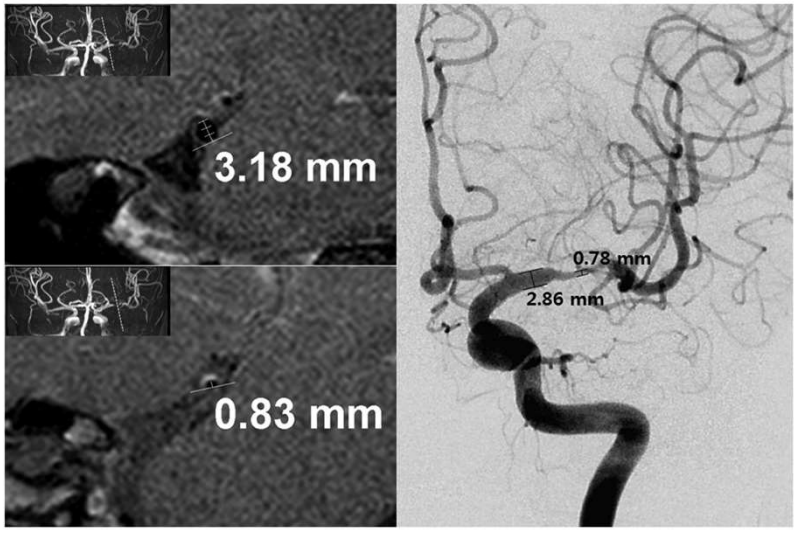


AJNR AMERICAN JOURNAL OF NEURORADIOLOGY

Comparison of High-Resolution MR Imaging and Digital Subtraction Angiography for the Characterization and Diagnosis of Intracranial Artery Disease

N.J. Lee, M.S. Chung, S.C. Jung, H.S. Kim, C.-G. Choi, S.J. Kim, D.H. Lee, D.C. Suh, S.U. Kwon, D.-W. Kang, and J.S. Kim

„High-resolution MR imaging may be an imaging method comparable with DSA for the characterization and diagnosis of various intracranial artery diseases."



Lee Nj et al. Comparison of High-Resolution MR Imaging and Digital Subtraction Angiography for the Characterization and Diagnosis of Intracranial Artery Disease. AJNR Am J Neuroradiol. 2016 Dec;37(12):2245-2250.
Bai X et al. 3D Black-Blood Luminal Angiography Derived from High-Resolution MR Vessel Wall Imaging in Detecting MCA Stenosis: A Preliminary Study. AJNR Am J Neuroradiol. 2018;39(10):1827-1832.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

ICAD, zjawisko remodeling'u naczyń

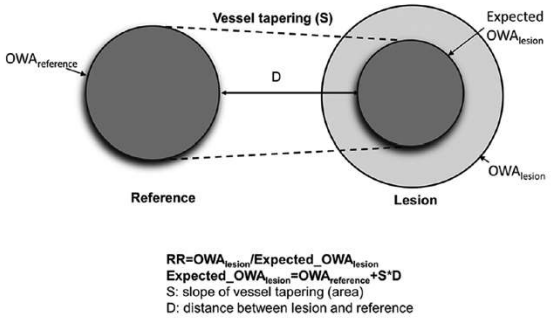
Patterns and Implications of Intracranial Arterial Remodeling in Stroke Patients

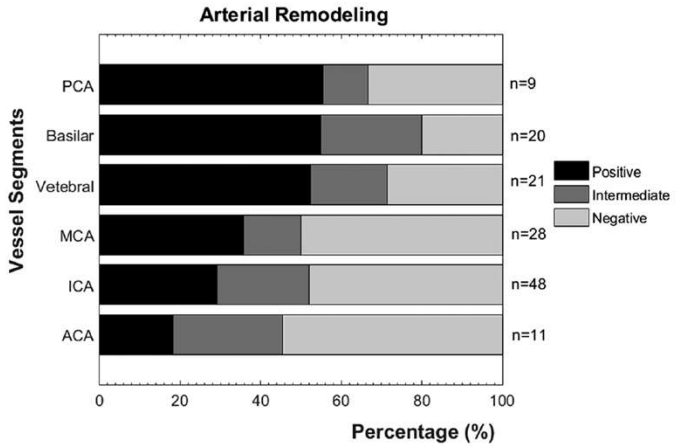
Ye Qiao, PhD, Zeeshan Anwar, MD, Jarunee Intrapiromkul, MD, Li Liu, MS, Steven R. Zeiler, MD, PhD, Richard Leigh, MD, Yiyi Zhang, PhD, Eliseo Guallar, MD, and Bruce A. Wasserman, MD

Stroke
Journal of the American Heart Association

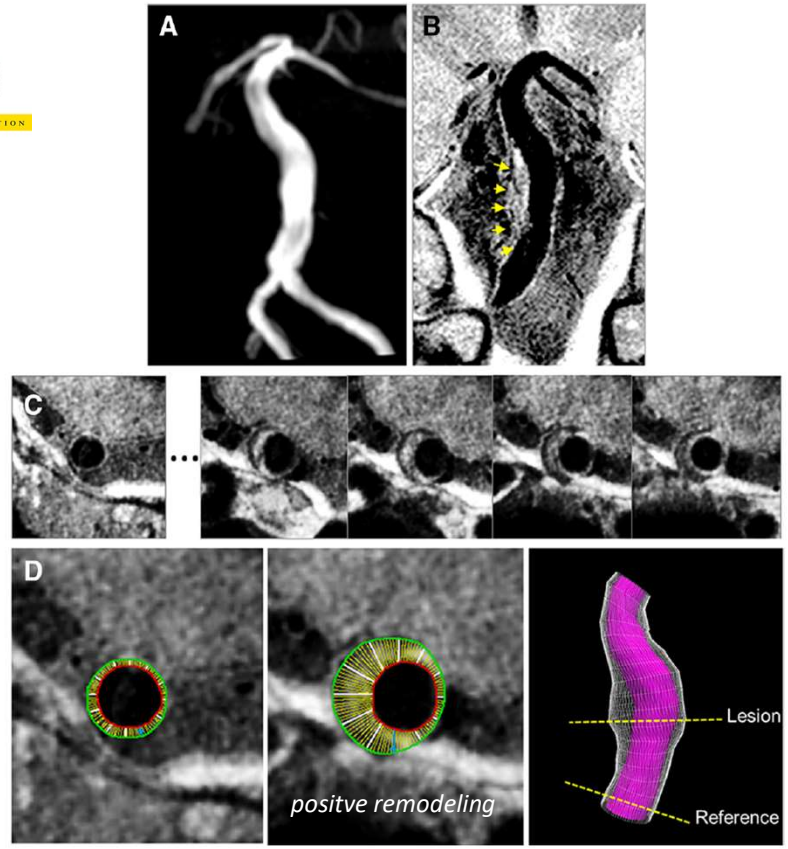
„Positive remodeling was marginally associated with downstream stroke presence when adjusted for plaque burden (odds ratio 1.34, 95% confidence interval: 0.99–1.81)."

„Intracranial arteries remodel in response to plaque formation, and posterior circulation arteries have a greater capacity for positive remodeling and, consequently, may more likely elude angiographic detection. Arterial remodeling may provide insight into stroke risk."





positve remodeling: RR >1.05
intermediate remodeling: 0.95≤RR≤1.05
negative remodeling: RR<0.95



Qiao Y et al. Patterns and Implications of Intracranial Arterial Remodeling in Stroke Patients. Stroke. 2016 Feb;47(2):434-40.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

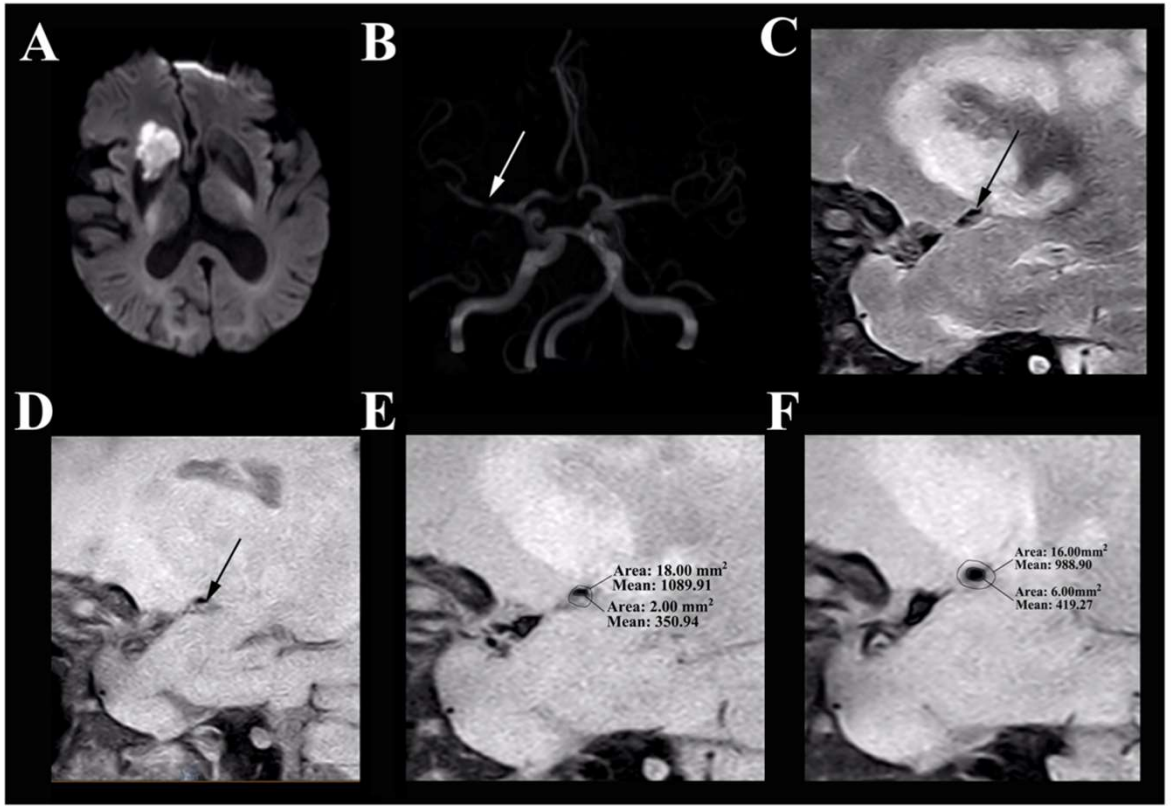
- **ICAD, zjawisko remodeling'u naczyń**

frontiers in Aging Neuroscience

A High-Resolution MRI Study of Relationship between Remodeling Patterns and Ischemic Stroke in Patients with Atherosclerotic Middle Cerebral Artery Stenosis

Dan-Feng Zhang[†], Yu-Chen Chen[1,2†], Huiyou Chen[1], Wei-Dong Zhang[1], Jun Sun[1], Cun-Nan Mao[1], Wen Su[1], Peng Wang[1] and Xindao Yin[1*]*

„The current study suggests that the HR-MRI has emerged as a promising tool to detect the characteristics of intracranial arteries wall and reveal the relationship between remodeling patterns and ischemic stroke. The PR is an unsafe remodeling way and is prone to cause acute ischemic stroke."



Zhang DF et al. A High-Resolution MRI Study of Relationship between Remodeling Patterns and Ischemic Stroke in Patients with Atherosclerotic Middle Cerebral Artery Stenosis. Front Aing Neurosci. 2017 May 9;9:140.

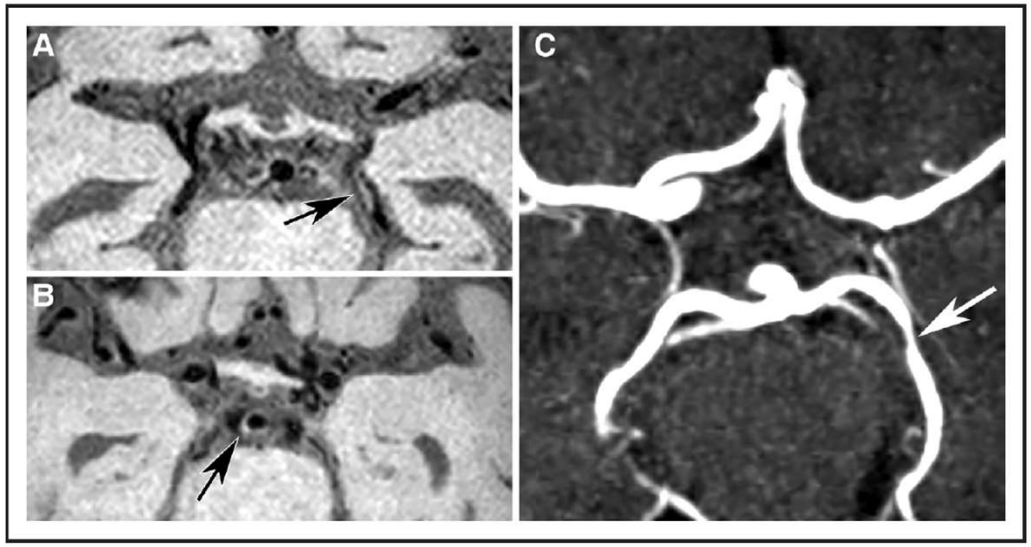
POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- ICAD, lokalizacja blaszki miażdżycowej

Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION

Magnetic Resonance Imaging of Plaque Morphology, Burden, and Distribution in Patients With Symptomatic Middle Cerebral Artery Stenosis

Nikki Dieleman, MSc*; Wenjie Yang, MD*; Jill M. Abrigo, MD; Winnie Chiu Wing Chu, MD, PhD; Anja G. van der Kolk, MD, PhD; Jeroen C.W. Siero, PhD; Ka Sing Wong, MD, PhD; Jeroen Hendrikse, MD, PhD; Xiang Yan Chen, MD, PhD



Plaque Characteristic	Anterior Circulation*	Posterior Circulation*	Total (n=57)*
Enhancement			
Yes	24	1	25
No	16	5	21
NA	7	4	11
Configuration			
Concentric	12	2	14
Eccentric	35	8	43
Thickening			
Focal	33	9	42
Diffuse	14	1	15
MRA			
Normal	21	6	27
Irregular	10	2	12
Stenosis	12	2	14
Occluded	1	0	1
Irregular and occluded	3	0	3

Dieleman N et al. Magnetic Resonance Imaging of Plaque Morphology, Burden, and Distribution in Patients With Symptomatic Middle Cerebral Artery Stenosis. Stroke. 2016 Jul;47(7):1797-802.

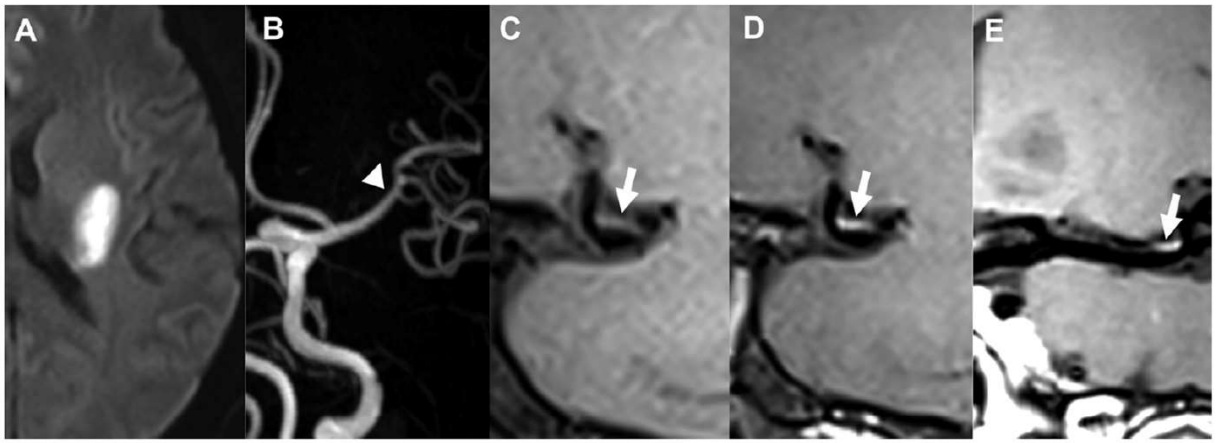
POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **ICAD, lokalizacja blaszki miażdżycowej**

Plaque Distribution and Characteristics in Low-Grade Middle Cerebral Artery Stenosis and Its Clinical Relevance: A 3-Dimensional High-Resolution Magnetic Resonance Imaging Study

Shan shan Lu, MD, PhD,* Song Ge, MD,† Chun qiu Su, MD,* Jun Xie, MD,*
Hai bin Shi, MD, PhD,* and Xun ning Hong, MD, PhD*

„Contrast enhancement and superior distribution may serve as indicators of culprit plaques in low-grade MCA stenosis, and they were significantly related to a recent ischemic stroke."

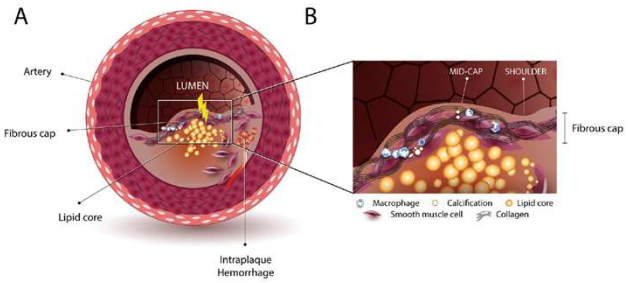


Plaque distribution*	Culprit	Nonculprit	*P* value
Superior	15 (46.9%)	7 (17.5%)	.007
Inferior	6 (18.8%)	16 (40.0%)	.052
Dorsal	3 (9.4%)	3 (7.5%)	1.000
Ventral	8 (25.0%)	14 (35.0%)	.360

Lu SS et al. Plaque Distribution and Characteristics in Low-Grade Middle Cerebral Artery Stenosis and Its Clinical Relevance: A 3-Dimensional High-Resolution Magnetic Resonance Imaging Study. J Stroke Cerebrovasc Dis. 2018 Aug;27(8):2243-2249.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

ICAD, intraplaque hemorrhage (IPH)



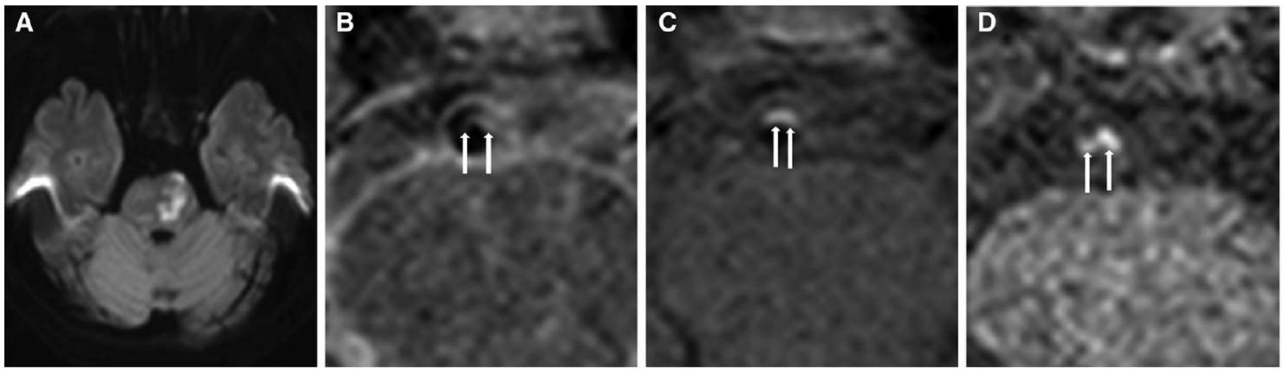
Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION

Association of Intraplaque Hemorrhage and Acute Infarction in Patients With Basilar Artery Plaque

Jin Hee Yu, MD, Hyo Sung Kwak, MD, PhD, Gyung Ho Chung, MD, PhD, Seung Bae Hwang, MD, Mi Sung Park, MD, PhD, and Seong Hoon Park, MD, PhD

„The relative risk of an acute focal stroke event among patients who were magnetization-prepared rapid acquisition with gradient-echo–positive for IPH compared with patients who were magnetization-prepared rapid acquisition with gradient-echo–negative was 1.64."

„IPH within a BA plaque region on HRMRI is highly prevalent and is associated with acute stroke."



Wissing TB et al. Tissue-engineered collagenous fibrous cap models to systematically elucidate atherosclerotic plaque rupture. Sci Rep. 2022 Mar 31;12(1):5434.
Yu JH et al. Association of Intraplaque Hemorrhage and Acute Infarction in Patients With Basilar Artery Plaque. Stroke. 2015 Oct;46(10):2768-72.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

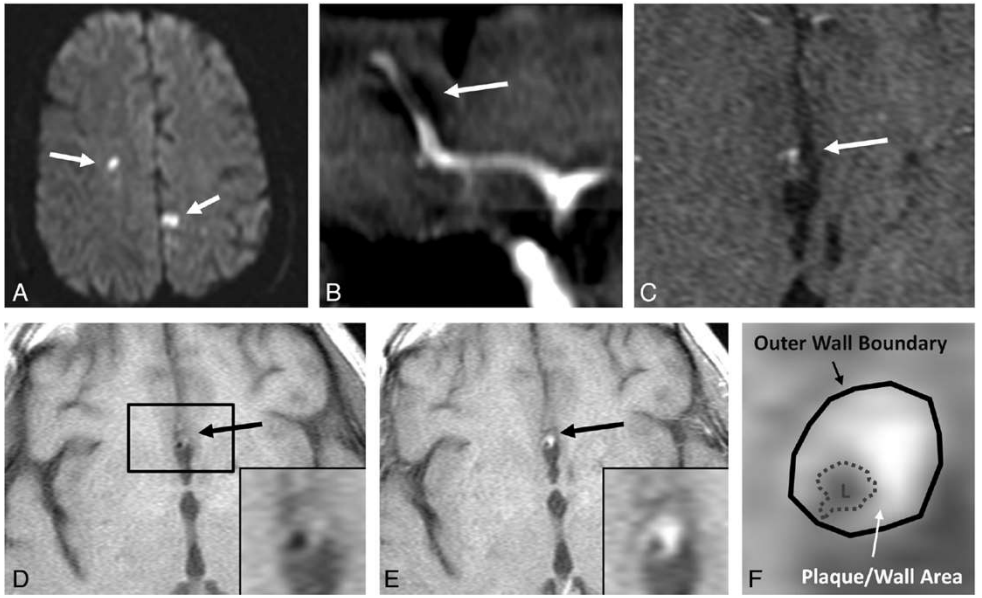
- **ICAD, plaque enhancement**

AJNR
AMERICAN JOURNAL OF NEURORADIOLOGY

T1 Gadolinium Enhancement of Intracranial Atherosclerotic Plaques Associated with Symptomatic Ischemic Presentations

P. Vakil, J. Vranic, M.C. Hurley, R.A. Bernstein, A.W. Korutz, A. Habib, A. Shaibani, F.H. Dehkordi, T.J. Carroll, and S.A. Ansari

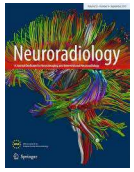
„In this pilot study, we determined that intraplaque enhancement could be reliably evaluated with the use of crosssectional imaging and analysis of vessels/plaques by use of conventional neuroanatomic MR imaging protocols. In addition, we observed a strong association between intraplaque enhancement in severe intracranial atherosclerotic disease lesions and ischemic events with the use of conventional MR imaging. Our preliminary study suggests that T1 gadolinium-enhancing plaques may be an indicator of progressing or symptomatic intracranial atherosclerotic disease."



Vakil P et al. T1 gadolinium enhancement of intracranial atherosclerotic plaques associated with symptomatic ischemic presentations. AJNR Am J Neuroradiol. 2013 Dec;34(12):2252-8.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

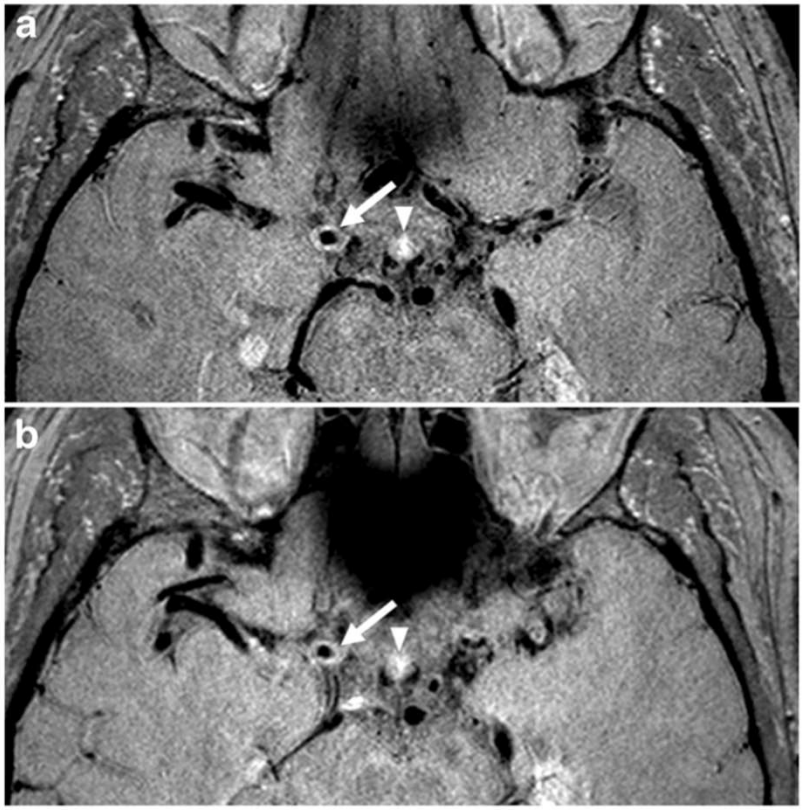
ICAD, plaque enhancement



Temporal course and implications of intracranial atherosclerotic plaque enhancement on high-resolution vessel wall MRI

Robert M. Kwee[1,2] · Ye Qiao[1] · Li Liu[1] · Steven R. Zeiler[3] · Bruce A. Wasserman[1]

„Contrast enhancement of ICAD can persist months after the ischemic event. Lack of enhancement at baseline or a decrease in enhancement at follow-up suggests that the plaque is not culprit. Persistent enhancement from baseline to follow-up improves accuracy in identifying culprit plaques. „



Kwee RM et al. Temporal course and implications of intracranial atherosclerotic plaque enhancement on high-resolution vessel wall MRI. Neuroradiology. 2019 Jun;61(6):651-657

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

ICAD, plaque enhancement

Intracranial plaque enhancement from high resolution vessel wall magnetic resonance imaging predicts stroke recurrence

Jeong-Min Kim*, Keun-Hwa Jung*, Chul-Ho Sohn, Jangsup Moon, Jung-Hwan Shin, Jaeseok Park, Seung-Hoon Lee, Moon Hee Han, Jae-Kyu Roh

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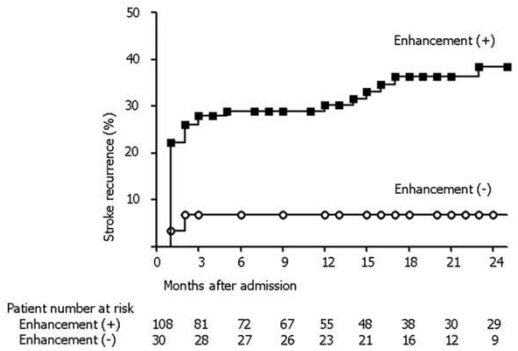
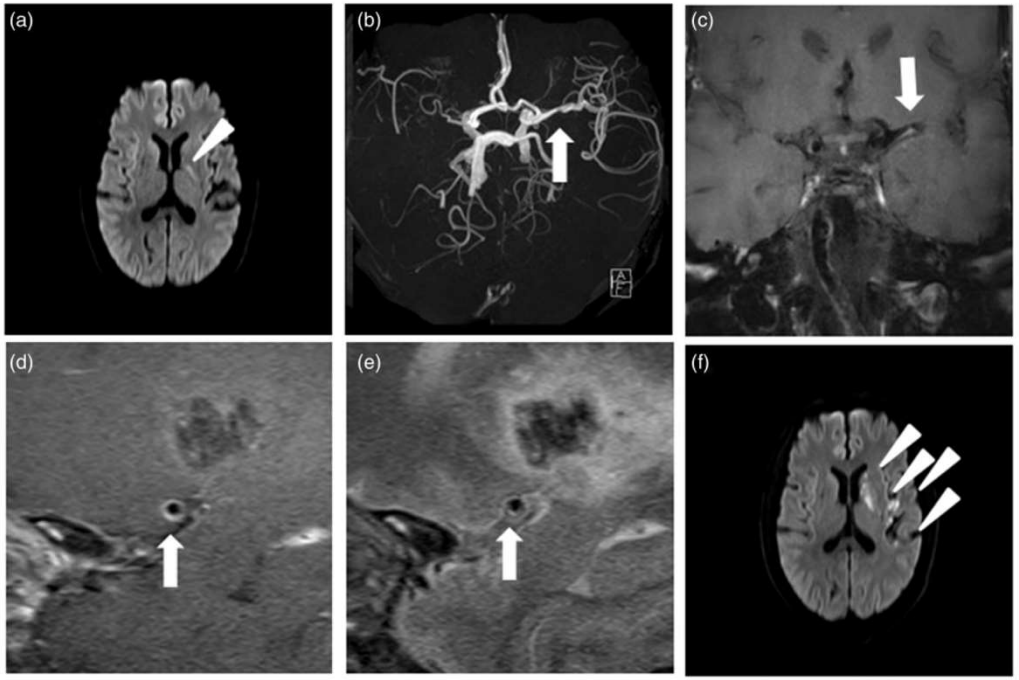
International Journal of Stroke WSO

„Kaplan–Meier curves demonstrated a significant difference in event free survival between the patients with plaque enhancement and those patients without plaque enhancement (event rates at year 1: 30.3% vs. 6.8%, log-rank test, p.0.004). Multivariate Cox-regression analysis showed that the plaque enhancement from HRMRI was independently associated with stroke recurrence (hazard ratio: 7.42, 95% confidence interval: 1.74–31.75, p.0.007).”





Kim JM et al. Intracranial plaque enhancement from high resolution vessel wall magnetic resonance imaging predicts stroke recurrence. Int J Stroke. 2016 Feb;11(2):171-9.

Vessel Wall Magnetic Resonance Imaging Biomarkers of Symptomatic Intracranial Atherosclerosis

A Meta-Analysis

Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION

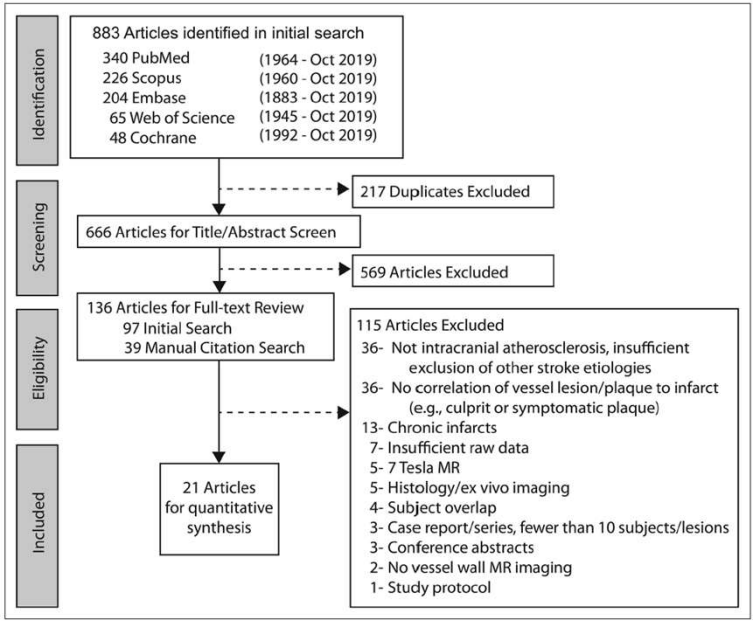
Jae W. Song, MD; Athanasios Pavlou, MD; Jiayu Xiao, MD; Scott E. Kasner, MD; Zhaoyang Fan, PhD; Steven R. Messé, MD

BACKGROUND AND PURPOSE: Intracranial atherosclerotic disease is a common cause of stroke worldwide. Intracranial vessel wall magnetic resonance imaging may be able to identify imaging biomarkers of symptomatic plaque. We performed a meta-analysis to evaluate the strength of association of imaging features of symptomatic plaque leading to downstream ischemic events. Effects on the strength of association were also assessed accounting for possible sources of bias and variability related to study design and magnetic resonance parameters.

METHODS: PubMed, Scopus, Web of Science, EMBASE, and Cochrane databases were searched up to October 2019. Two independent reviewers extracted data on study design, vessel wall magnetic resonance imaging techniques, and imaging end points. Per-lesion odds ratios (OR) were calculated and pooled using a bivariate random-effects model. Subgroup analyses, sensitivity analysis, and evaluation of publication bias were also performed.

RESULTS: Twenty-one articles met inclusion criteria (1750 lesions; 1542 subjects). Plaque enhancement (OR, 7.42 [95% CI, 3.35–16.43]), positive remodeling (OR, 5.60 [95% CI, 2.23–14.03]), T1 hyperintensity (OR, 2.05 [95% CI, 1.27–3.32]), and surface irregularity (OR, 4.50 [95% CI, 1.39–8.57]) were significantly associated with downstream ischemic events. T2 signal intensity was not significant (P=0.59). Plaque enhancement was significantly associated with downstream ischemic events in all subgroup analyses and showed stronger associations when measured in retrospectively designed studies (P=0.02), by a radiologist as a rater (P<0.001), and on lower vessel wall magnetic resonance imaging spatial resolution sequences (P=0.02).

CONCLUSIONS: Plaque enhancement, positive remodeling, T1 hyperintensity, and surface irregularity emerged as strong imaging biomarkers of symptomatic plaque in patients with ischemic events. Plaque enhancement remained significant accounting for sources of bias and variability in both study design and instrument. Future studies evaluating plaque enhancement as a predictive marker for stroke recurrence with larger sample sizes would be valuable.



Song JW et al. Vessel Wall Magnetic Resonance Imaging Biomarkers of Symptomatic Intracranial Atherosclerosis: A Meta-Analysis. Stroke. 2021 Jan;52(1):193-202

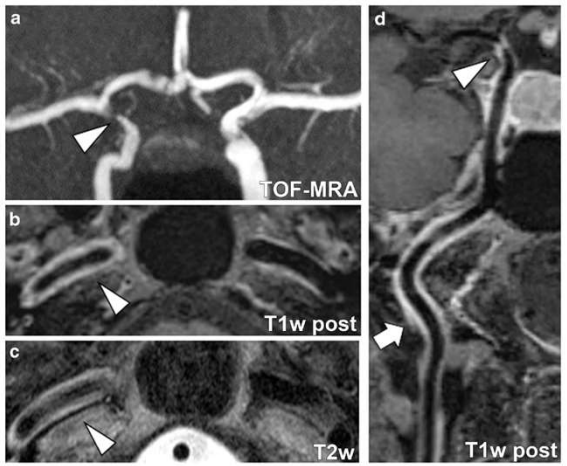
POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

zapalenie naczyń OUN

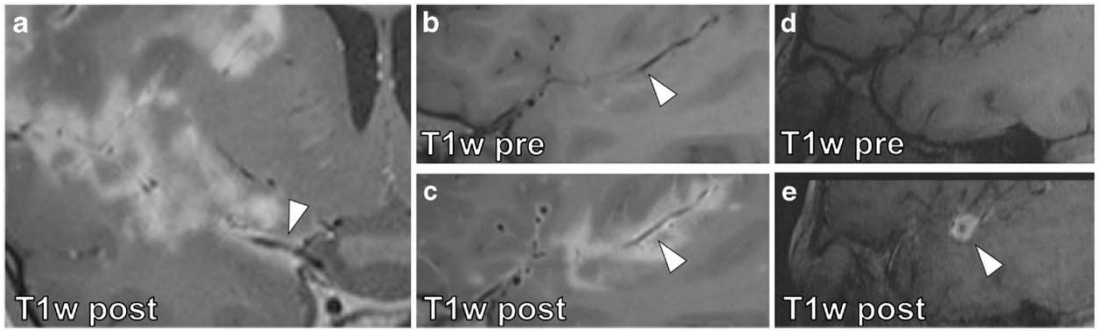
- koncentryczne wzmocnienie pokontrastowe ściany naczynia, któremu może towarzyszyć pogrubienie ściany ze zwężeniem kanału przepływu; zmiany często wieloogniskowe

Vessel wall MR imaging of central nervous system vasculitis: a systematic review

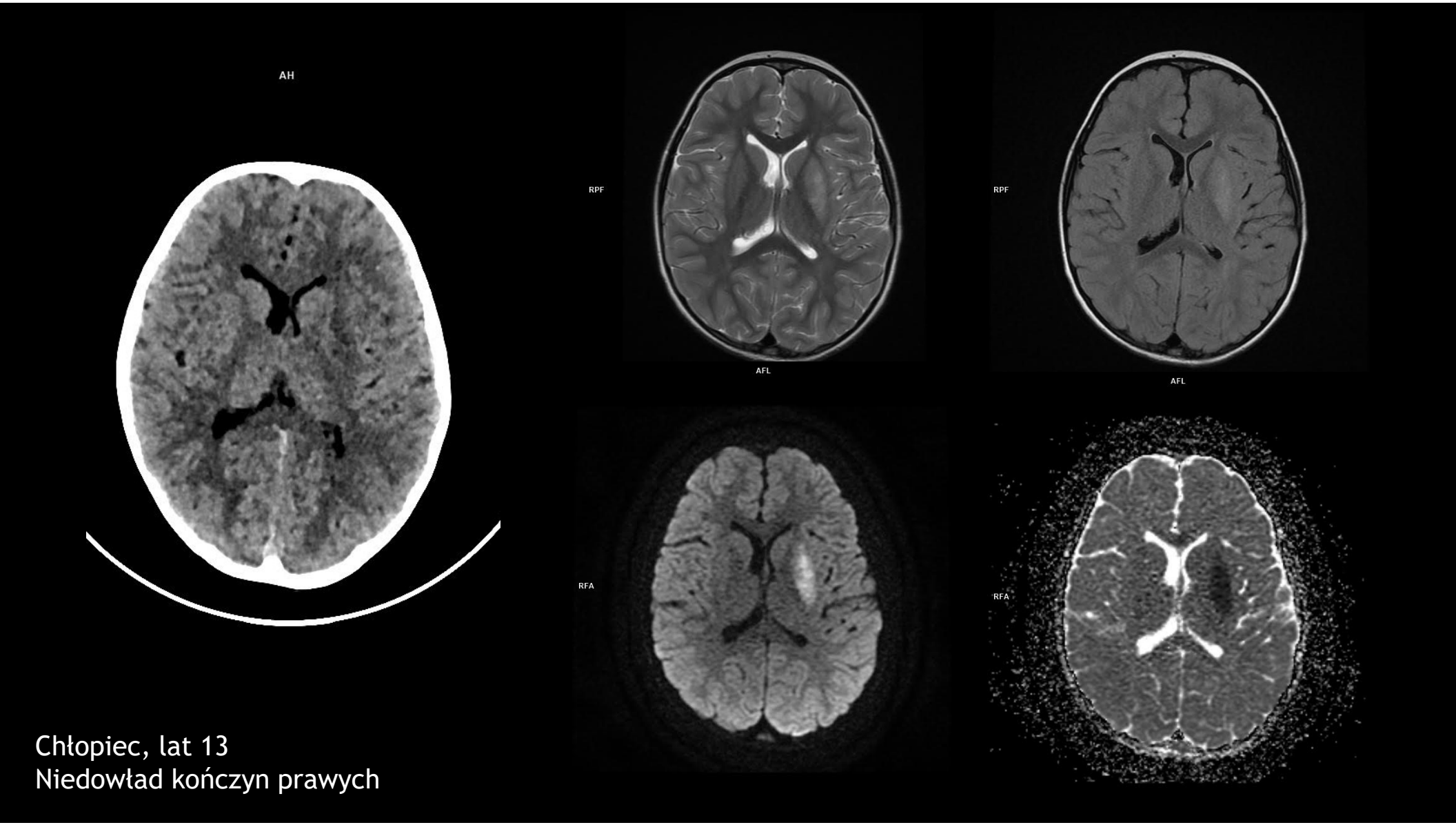
Nathan Arnett[1] · Athanasios Pavlou[2] · Morgan P. Burke[2] · Brett L. Cucchiara[3] · Rennie L. Rhee[4] · Jae W. Song[2]



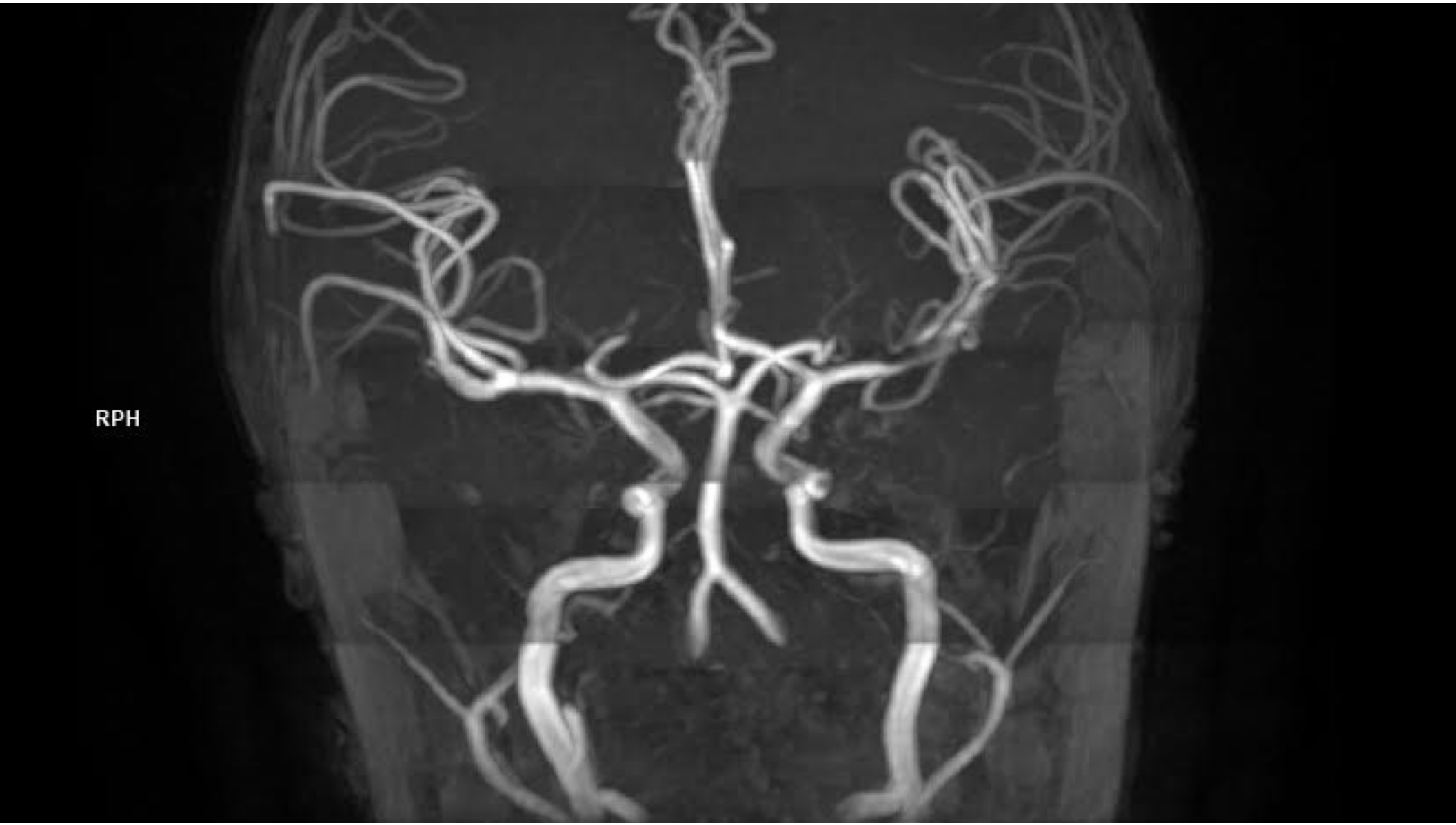
- **VW-MRI u pacjentów z CNS vasculitis:**
  - wzmocnienie pokontrastowe ściany naczynia - 89% (zmiany w większości przypadków koncentryczne)
  - pogrubienie ściany naczynia -72%
  - obrzęk ściany naczynia - 10%
  - okołonaczyniowe wzmocnienie pokontrastowe - 16% (VZV, TBC)



Arnett N et al. Vessel wall MR imaging of central nervous system vasculitis: a systematic review. Neuroradiology. 2022 Jan;64(1):43-58.



Chłopiec, lat 13
Niedowład kończyn prawych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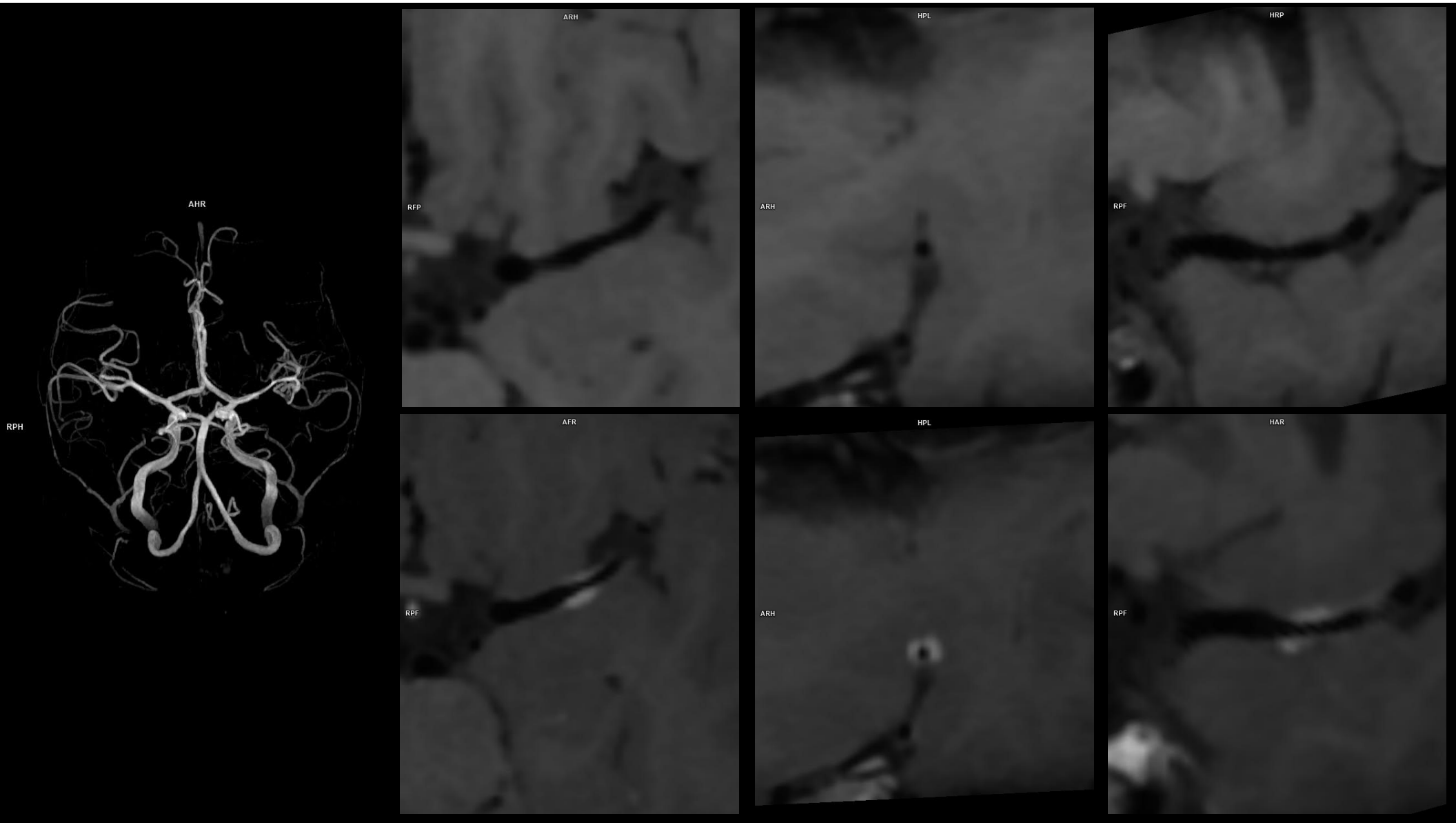
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POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

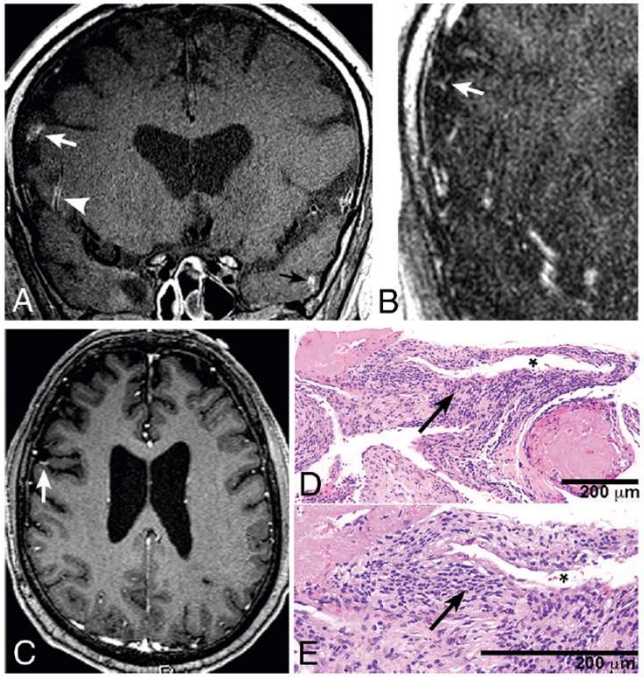
- zapalenie naczyń OUN

AJNR
AMERICAN JOURNAL OF NEURORADIOLOGY

Vessel Wall MRI for Targeting Biopsies of Intracranial Vasculitis

S.R. Zeiler, Y. Qiao, C.A. Pardo, M. Lim, and B.A. Wasserman

„Central nervous system vasculitides are elusive diseases that are challenging to diagnose because brain biopsies have high false-negative rates. We sought to test the ability of contrast-enhanced, high-resolution 3D vessel wall MR imaging to identify vascular inflammation and direct open biopsies of intracranial target vessels and adjacent brain parenchyma. Eight of 9 specimens revealed vascular inflammation. ***We conclude that vessel wall MR imaging can identify inflamed intracranial vessels, enabling precise localization of biopsy targets.*** *”*



Zeiler SR et al. Vessel Wall MRI for Targeting Biopsies of Intracranial Vasculitis. AJNR AM J Neuroradiol. 2018 Nov;39(11):2034-2036.

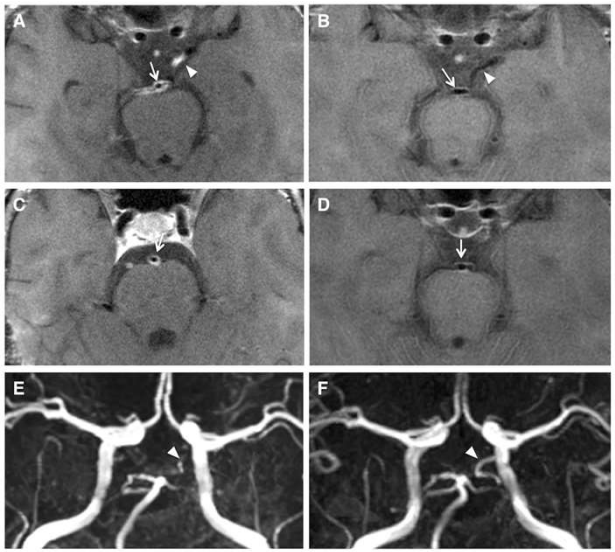
POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

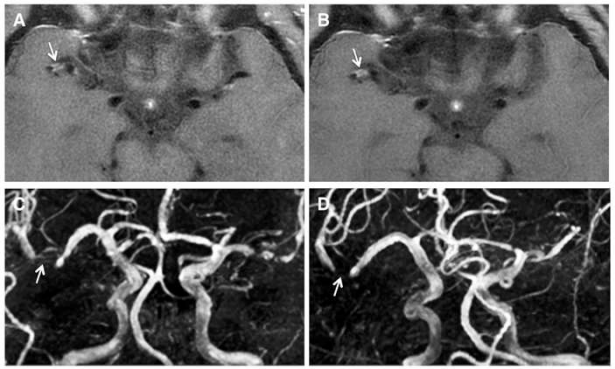
zapalenie naczyń OUN

Diagnosis and follow-up evaluation of central nervous system vasculitis: an evaluation of vessel-wall MRI findings

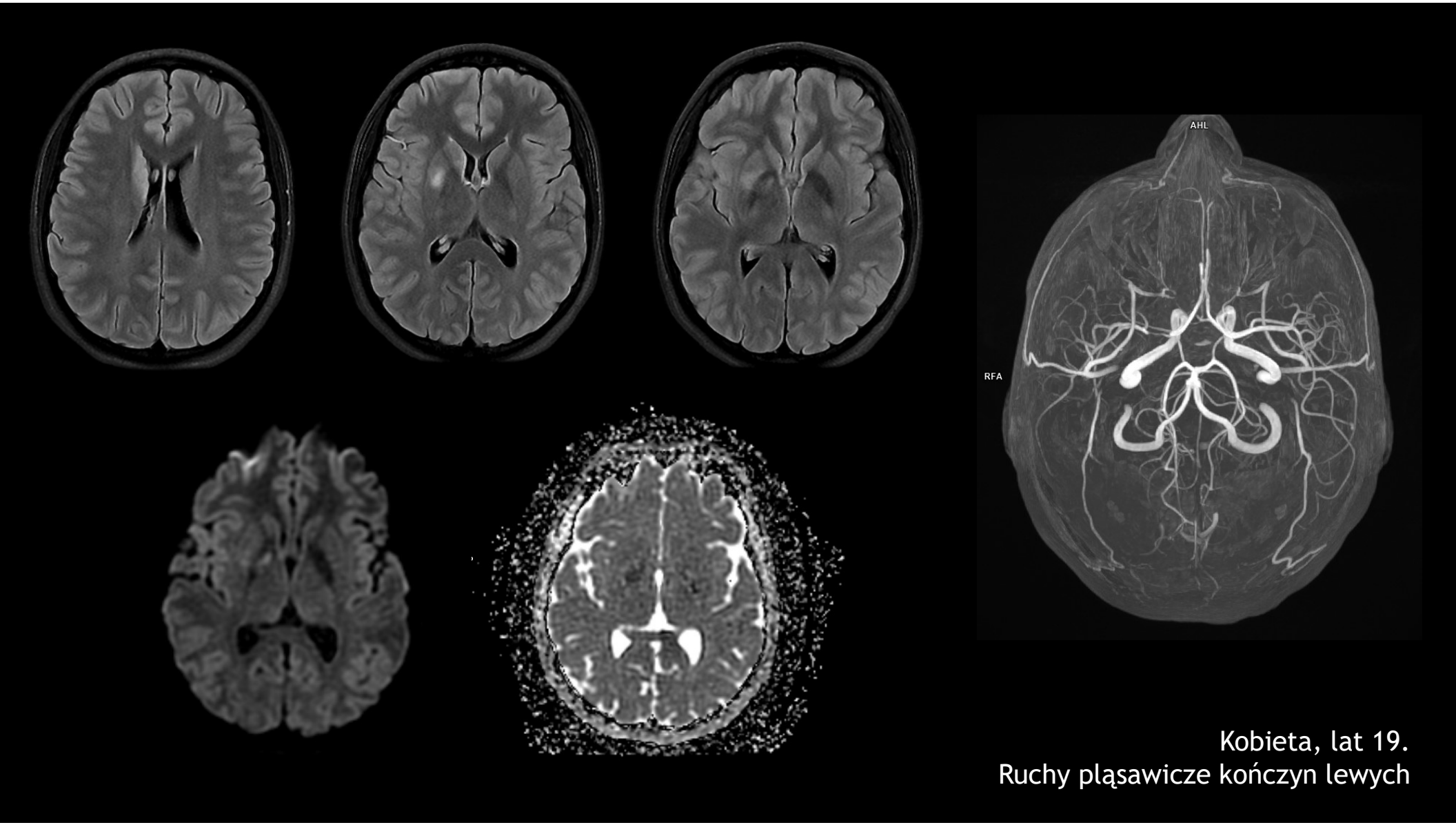
Maximilian Patzig[1] · Robert Forbrig[1] · Clemens Küpper[2] · Ozan Eren[2] · Tobias Saam[3,4] · Lars Kellert[2] · Thomas Liebig[1] · Florian Schöberl[2]

- 45 pacjentów z CNSV: VW-CE u 28/28 MRA-positive, 2/17 MRA-negative
- VW-CE: w 79.1% zwężeń (zmiany koncentryczne w 88.3%, ekscentryczne w 11.7% przypadków)
- DWI (+): częściej wtórnie do zwężeń z towarzyszącym VW-CE niż bez ($p<0.05$)
- VW-CE w follow-up (23 pacjentów z 48 zmianami; mediana follow-up 239.5 dnia):
  - całkowita regresja – 27.1%,
  - częściowa regresja – 29.2%,
  - stabilne – 35.4%,
  - progresja – 8.3%
- nawrót: częściej u pacjentów ze stabilnym/postępującym VW-CE niż u pacjentów z częściową/całkowitą regresją VW-CE ($p<0.05$)

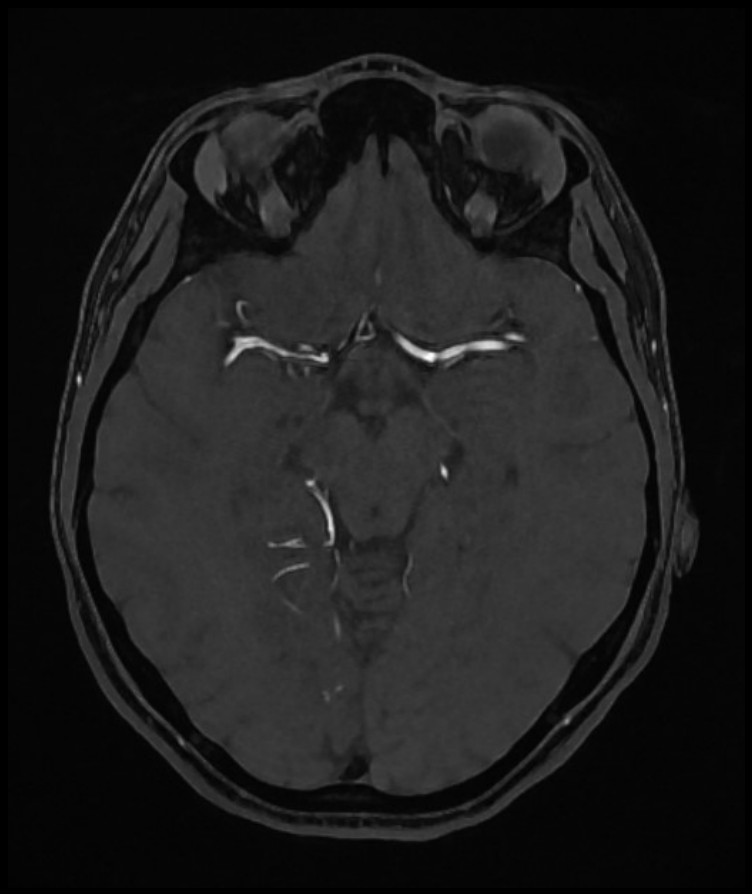


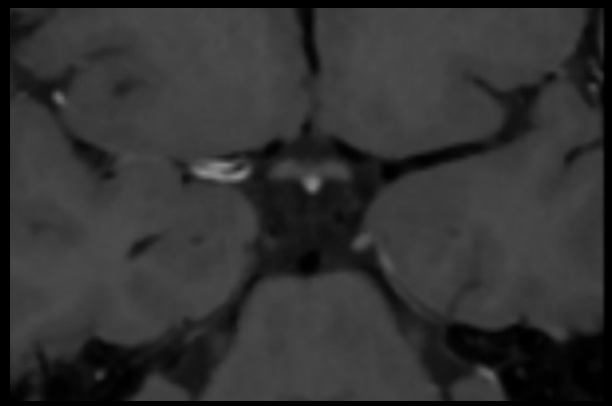


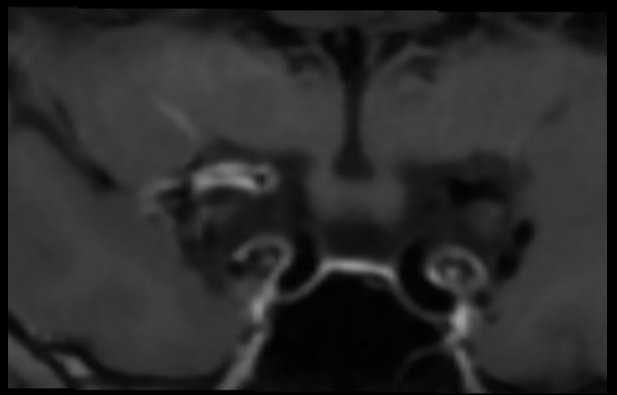
Patzig M et al. Diagnosis and follow-up evaluation of central nervous system vasculitis: an evaluation of vessel-wall MRI findings. J Neurol. 2022 Feb;269(2):982-996

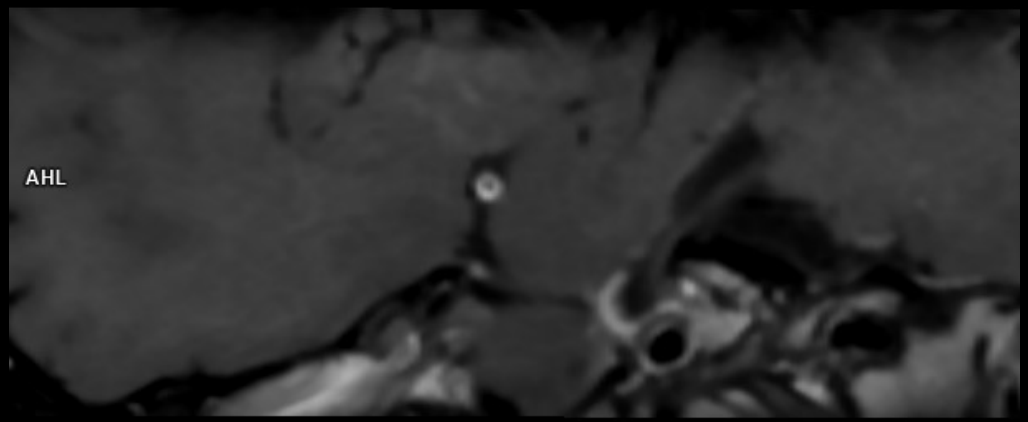


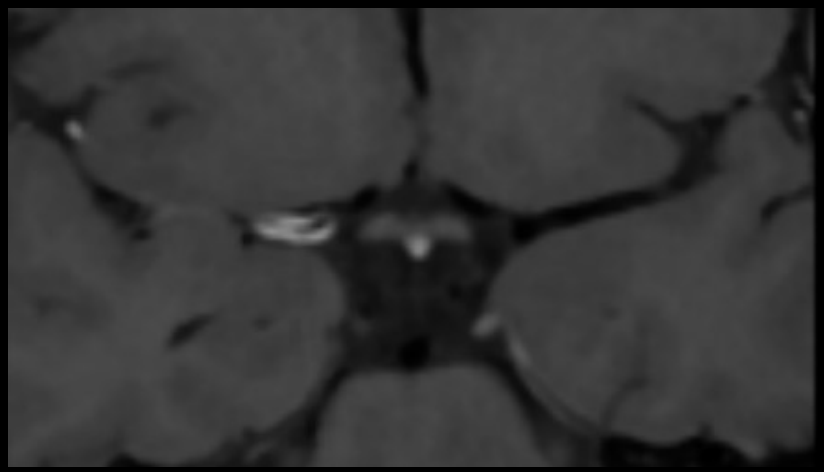
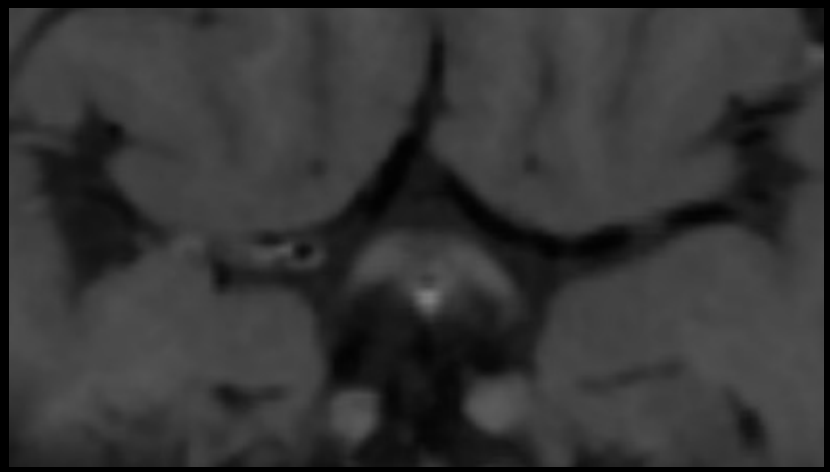
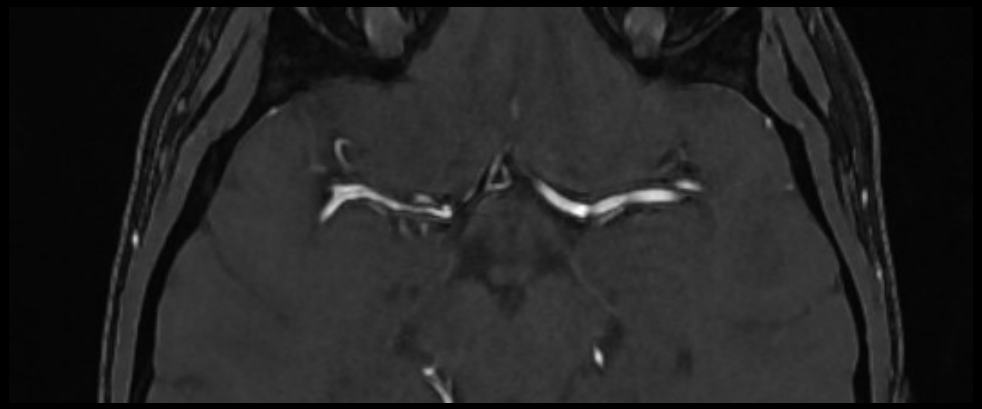
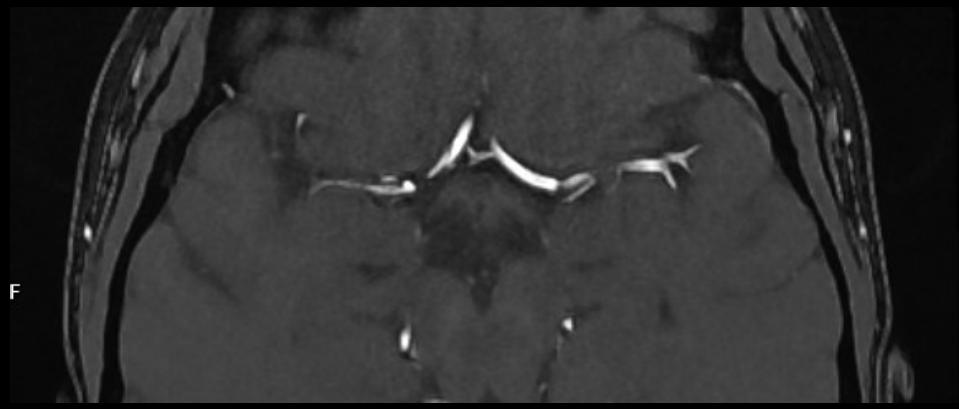
Kobieta, lat 19.
Ruchy pląsawicze kończyn lewych








AHL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POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

zespół odwracalnego skurczu naczyń mózgowych (RCVS)

- piorunujący/nawracający silny ból głowy
- wieloogniskowe i odcinkowe zwężenia tętnic mózgowych
- odwracalność zmian po 12 tygodniach
- możliwe powikłania:
  - SAH na sklepistości mózgu (22-34%)
  - krwiak śródmózgowy (6-20%)
  - zawał ostatniej łąki (29%)
  - obrzęk naczyniowy (38%)
- ddx: skurcz naczyniowy w przebiegu SAH, PACNS, rozwarstwienie

Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 4425
Singhal AB et al. Reversible cerebral vasoconstriction syndromes: analysis of 139 cases. Arch Neurol. 2011 Aug;68(8):1005-12.
Ducros A et al. The clinical and radiological spectrum of reversible cerebral vasoconstriction syndrome. A prospective series of 67 patients. Brain. 2007 Dec;130(Pt 12):3091-101.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

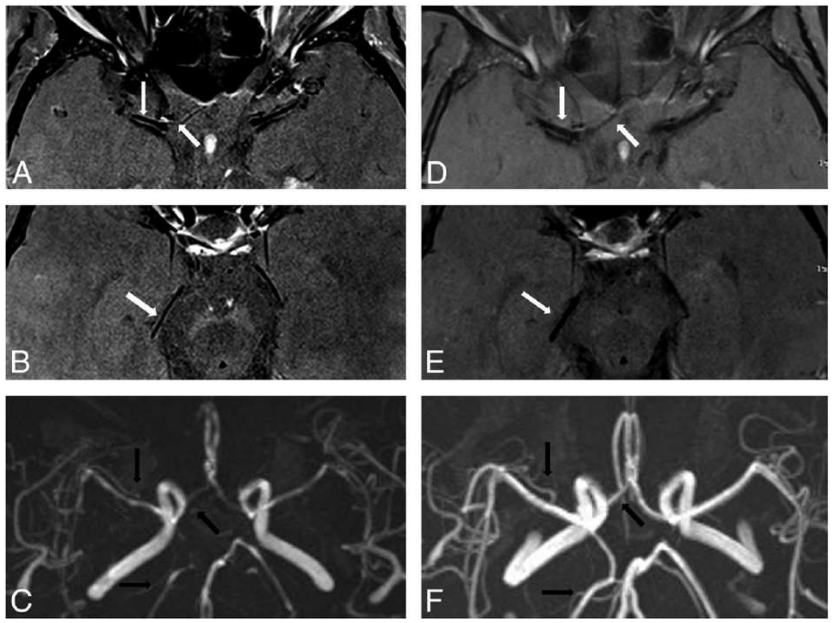
zespół odwracalnego skurczu naczyń mózgowych (RCVS)

High-Resolution MRI Vessel Wall Imaging: Spatial and Temporal Patterns of Reversible Cerebral Vasoconstriction Syndrome and Central Nervous System Vasculitis

E.C. Obusez, F. Hui, R.A. Hajj-ali, R. Cerejo, L.H. Calabrese, T. Hammad, and S.E. Jones

AJNR AMERICAN JOURNAL OF NEURORADIOLOGY

- **13 pacjentów z CNS vasculitis:**
  - gładkie, koncentryczne pogrubienie oraz wzmocnienie pokontrastowe ściany – 9/13;
  - gładkie, ekscentryczne pogrubienie oraz wzmocnienie pokontrastowe ściany – 3/13;
  - brak pogrubienia oraz wzmocnienia pokontrastowego ściany – 1/13;
  - follow-up up: 4/6 stabilny obraz zmian, 2/6 regresja zmian w ścianie
- **13 pacjentów z RCVS**
  - równomierne pogrubienie ściany z nieznacznym wzmocnieniem pokontrastowym – 4/13
  - równomierne pogrubienie ściany bez wzmocnienia pokontrastowego 6/13
  - prawidłowy obraz ściany – 3/13
  - follow-up: 1/9 stabilny obraz zmian; 8/9 regresja zmian



„Postgadolinium 3T-high-resolutionMRimaging appears to be a feasible tool in differentiating vessel wall patterns of CNS vasculitis and reversible cerebral vasoconstriction syndrome changes during a follow-up period.”

Obusez EC et al. High-resolution MRI vessel wall imaging: spatial and temporal patterns of reversible cerebral vasoconstriction syndrome and central nervous system vasculitis. AJNRR Am J Neuroradiol. 2014 Aug;35(8):1527-32

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

▶ rozwarstwienie tętnic wewnątrzczaszkowych

	Univariate Logistic Regression			Multivariate Logistic Regression		
	OR	95% CI	*P* Value	OR	95% CI	*P* Value
Anterior circulation	2.090	1.071–4.081	0.031*	1.837	0.788–4.284	0.159
Extracranial	1.250	0.547–2.854	0.596			
Double lumen	0.493	0.205–1.186	0.114			
Intimal flap	0.716	0.359–1.428	0.342			
Intramural hematoma	3.348	0.998–11.229	0.050*	4.045	0.790–20.725	0.094
Pseudoaneurysm	0.343	0.142–0.827	0.017*	0.485	0.136–1.736	0.266
Irregular surface	4.838	2.378–9.843	<0.001*	4.289	1.605–11.462	0.004
Intraluminal thrombus	16.705	4.832–57.746	<0.001*	7.476	1.640–34.074	0.009
Length	1.018	0.906–1.144	0.765			
Stenosis degree			0.010*			0.572
50%–69%	1.969	0.784–4.945	0.149	1.251	0.403–3.881	0.698
70%–100%	3.276	1.525–7.037	0.002	0.687	0.227–2.077	0.506
Heterogeneous signal of intramural hematoma	1.527	0.785–2.971	0.212			
Enhancement of intramural hematoma	0.654	0.220–1.948	0.446			

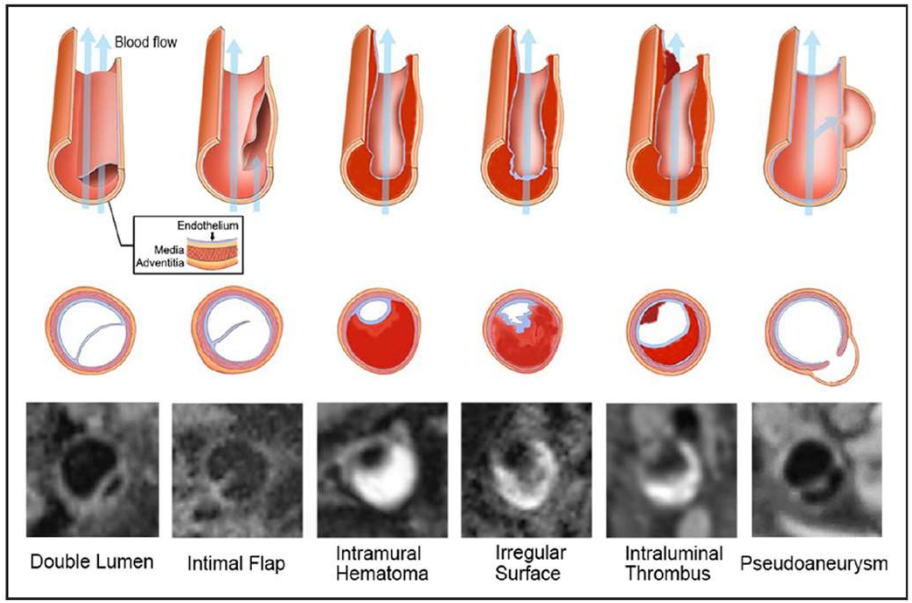
„High-resolution magnetic resonance imaging might give insights into pathogenesis of ischemic stroke in CCAD. It may be useful for individual prediction of ischemic stroke early in CCAD."

Stroke

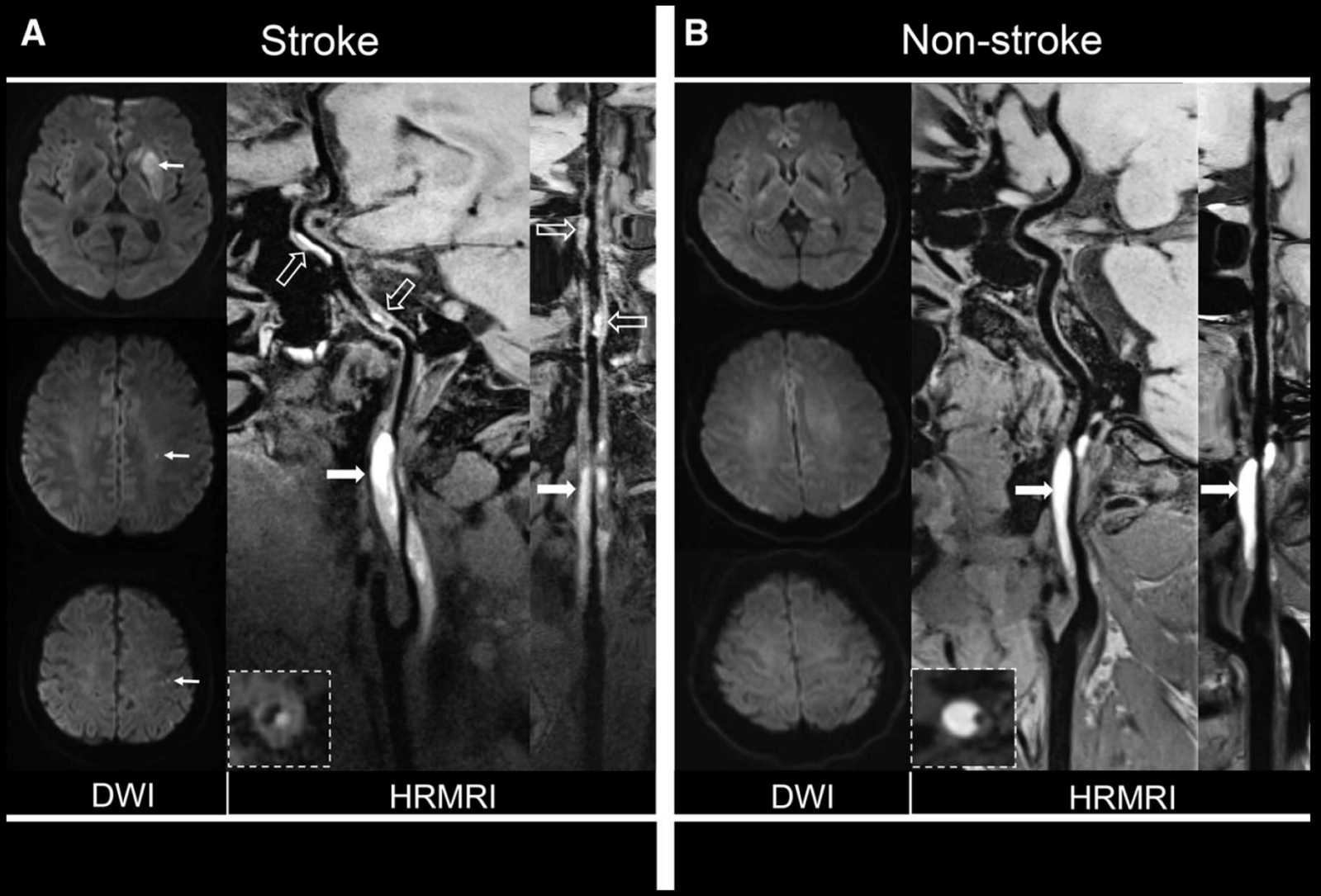
High-Resolution Magnetic Resonance Imaging of Cervicocranial Artery Dissection

Imaging Features Associated With Stroke

Ye Wu, MD*, Fang Wu, MD*, Yuehong Liu, MD, Zhaoyang Fan, PhD, Marc Fisher, MD, Debiao Li, PhD, Weihai Xu, MD, Tao Jiang, MD, Jingliang Cheng, MD, Bin Sun, MD, Xunming Ji, MD, PhD, and Qi Yang, MD, PhD



Wu Y et al. High-Resolution Magnetic Resonance Imaging of Cervicocranial Artery Dissection: Imaging Features Associated With Stroke. Stroke. 2019 Nov;50(11):3101-3107.



Wu Y et al. High-Resolution Magnetic Resonance Imaging of Cervicocranial Artery Dissection: Imaging Features Associated With Stroke. Stroke. 2019 Nov;50(11):3101-3107.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **tętniaki wewnątrzczaszkowe:**
  - występują u ok. 3-5% populacji ogólnej
  - pęknięcie tętniaka jest najczęstszą przyczyną nieurazowego SAH
  - pomimo zidentyfikowanych czynników ryzyka pęknięcia, kwalifikacja do leczenia niepękniętych tętniaków pozostaje problematyczna (zwłaszcza u pacjentów z małymi tętniakami)

Small Aneurysms Account for the Majority and Increasing Percentage of Aneurysmal Subarachnoid Hemorrhage: A 25-Year, Single Institution Study

BACKGROUND: Prospective studies of unruptured aneurysms have shown very low rates of rupture for small aneurysms (<10 mm) and suggested that the risk of treatment outweighs benefit. However, common clinical practice shows that patients with aneurysmal subarachnoid hemorrhage (aSAH) frequently have small aneurysms.

OBJECTIVE: To investigate trends in size and location of ruptured aneurysms over a 25-yr period.

METHODS: A prospective, Institutional Review Board-approved database of all patients presenting to our institution with aSAH from 1991 to 2016 was analyzed. Cerebral angiography identified the source of hemorrhage. Patients with nonaneurysmal etiologies were excluded.

RESULTS: Complete data were available for 1306/1562 patients (84%) with aSAH from 1991 to 2016. The average age was 53 yr and 72% of patients were female. The average size of ruptured aneurysms over 25 yr was 8.0 mm. The average size of ruptured aneurysms decreased steadily with each 5-yr interval from 10.1 mm (1991-1996) to 6.6 mm (2012-2016; $P < .001$). Overall, very small aneurysms (<5 mm) were responsible for aSAH in 41% of patients. The percentage of very small ruptured aneurysms rose from 29% during the initial 5-yr period (1991-1996) to 50% in the most recent period. Likewise, the percentage of ruptured aneurysms that were 5 to 9 mm rose from 26% to 34% ($P < .001$). In the past 5 yr, aneurysms <10 mm accounted for 84% of aSAH. Vessel of origin ($P = .097$) and aneurysm location ($P = .322$) did not vary with time.

CONCLUSION: Ruptured small and very small aneurysms represent a majority and increasing share of aSAH. Identification and prophylactic treatment of these aneurysms remains an important clinical role for cerebrovascular neurosurgery.

KEY WORDS: Subarachnoid hemorrhage, Cerebral aneurysm

Neurosurgery 0:1–8, 2017 DOI:10.1093/neuros/nyx484 www.neurosurgery-online.com

Bender MT et al. Small Aneurysms Account for the Majority and Increasing Percentage of Aneurysmal Subarachnoid Hemorrhage: A 25-Year, Single Institution Study. Neurosurgery. 2018 Oct 1;83(4):692-699.
Rutledge C et al. Small Aneurysms with Low PHASES Scores Account for Most Subarachnoid Hemorrhage Cases. rld Neurosurg. 2020 Jul;139:e580-e584.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

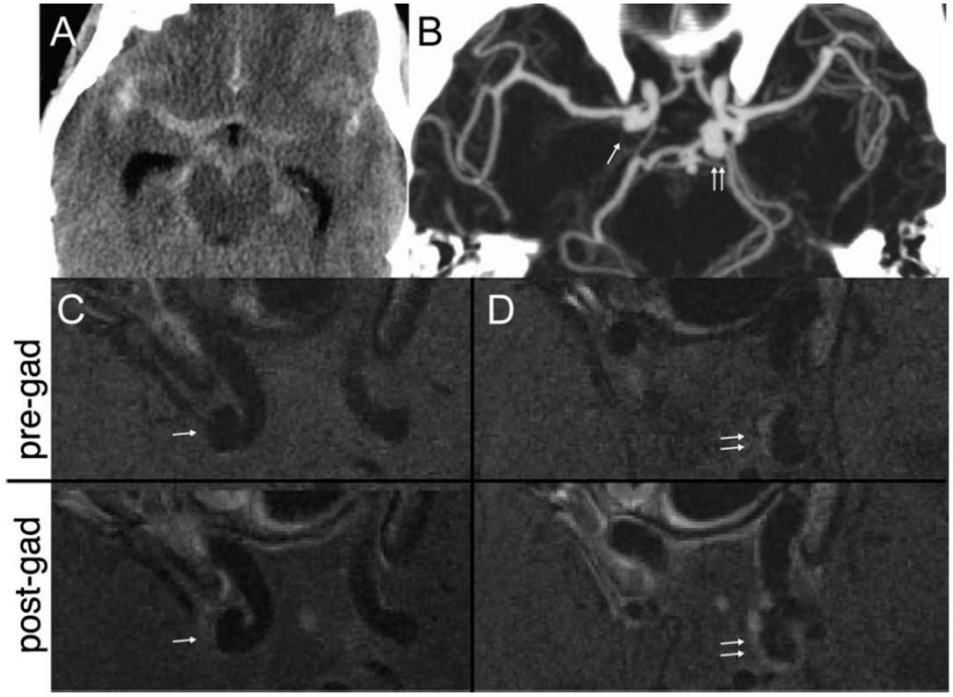
- **tętniaki wewnątrzczaszkowe; identyfikacja źródła SAH u pacjentów z mnogimi tętniakami**

NEUROSURGERY
THE REGISTER OF THE NEUROSURGICAL MEME

Vessel Wall Magnetic Resonance Imaging Identifies the Site of Rupture in Patients With Multiple Intracranial Aneurysms
Proof of Principle

Matouk, Charles C. MD*†; Mandell, Daniel M. MD§; Günel, Murat MD*; Bulsara, Ketan R. MD*; Malhotra, Ajay MBBS‡; Hebert, Ryan MD*; Johnson, Michele H. MD*†; Mikulis, David J. MD§; Minja, Frank J. MD*

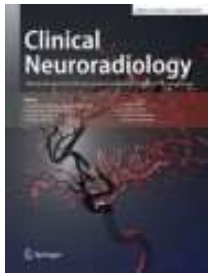
„High-resolution MR-VWI identified the site of rupture in patients with aneurysmal SAH, including those patients harboring multiple intracranial aneurysms. It may represent a useful tool in the investigation of aneurysmal SAH."



Matouk CC et al. Vessel wall magnetic resonance imaging identifies the site of rupture in patients with multiple intracranial aneurysms: proof of principle. Neurosurgery. 2013 Mar;72(3):492-6;

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

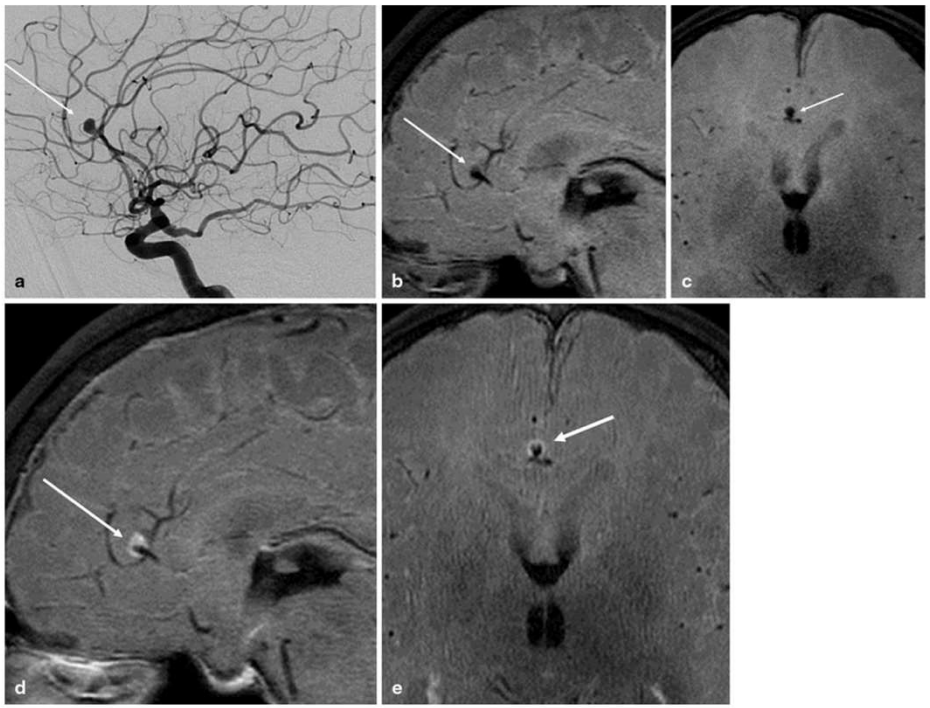
- **tętniaki wewnątrzczaszkowe; identyfikacja źródła SAH u pacjentów z mnogimi tętniakami**



Wall Enhancement of the Intracranial Aneurysms Revealed by Magnetic Resonance Vessel Wall Imaging Using Three-Dimensional Turbo Spin-Echo Sequence with Motion-Sensitized Driven-Equilibrium: A Sign of Ruptured Aneurysm?

S. Nagahata · M. Nagahata · M. Obara · R. Kondo · N. Minagawa · S. Sato · S. Sato · W. Mouri · S. Saito · T. Kayama

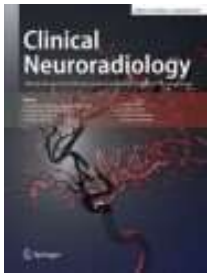
„ Remaining 11 SAH patients had multiple aneurysms (double aneurysms in 8 patients, triple aneurysms in 3 patients). Clipping surgery confirmed the ruptured site in these 11 patients.”



Nagahata S et al. Wall Enhancement of the Intracranial Aneurysms Revealed by Magnetic Resonance Vessel Wall Imaging Using Three-Dimensional Turbo Spin-Echo Sequence with Motion-Sensitized Driven-Equilibrium: A Sign of Ruptured Aneurysm? Clin Neuroradiol. 2016 Sep;26(3):277-83.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

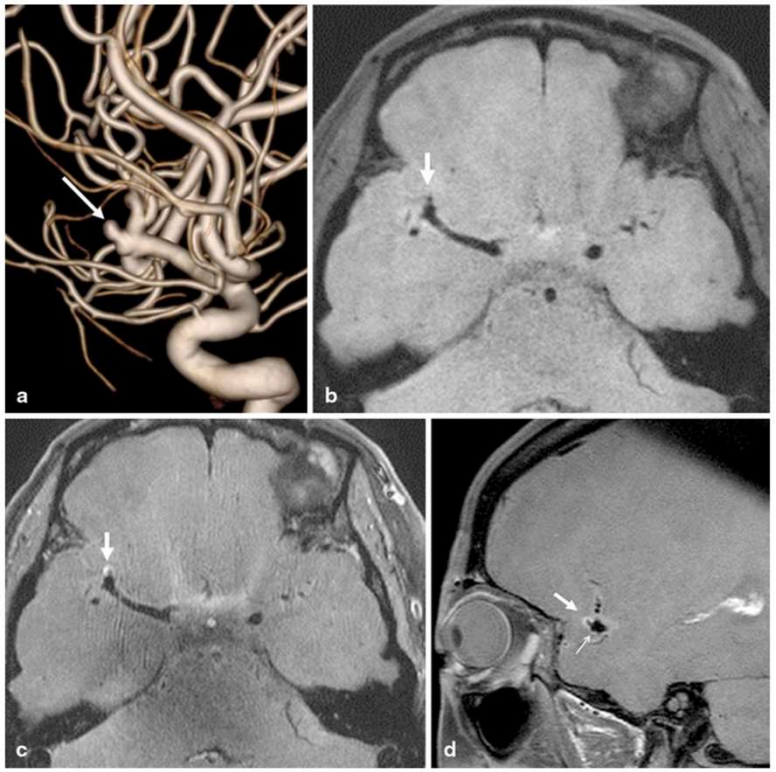
- **tętniaki wewnątrzczaszkowe; identyfikacja źródła SAH**



Wall Enhancement of the Intracranial Aneurysms Revealed by Magnetic Resonance Vessel Wall Imaging Using Three-Dimensional Turbo Spin-Echo Sequence with Motion-Sensitized Driven-Equilibrium: A Sign of Ruptured Aneurysm?

S. Nagahata · M. Nagahata · M. Obara · R. Kondo · N. Minagawa · S. Sato · S. Sato · W. Mouri · S. Saito · T. Kayama

„ Among the 45 cases of ruptured aneurysms with "Strong enhancement," 15 aneurysms showed partial enhancement at the bleb or apex of the aneurysm. Of these 15 aneurysms, 7 underwent clipping surgery. Neurosurgeons could confirm the ruptured point at the aneurysmal apex during the surgery in these 7 cases."



Nagahata S et al. Wall Enhancement of the Intracranial Aneurysms Revealed by Magnetic Resonance Vessel Wall Imaging Using Three-Dimensional Turbo Spin-Echo Sequence with Motion-Sensitized Driven-Equilibrium: A Sign of Ruptured Aneurysm? Clin Neuroradiol. 2016 Sep;26(3):277-83.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **wzmocnienie kontrastowe ściany tętniaka mózgu – cecha tętniaków niestabilnych?**

Circumferential Thick Enhancement at Vessel Wall MRI Has High Specificity for Intracranial Aneurysm Instability

Myriam Edjlali, MD, PhD • Alexis Guédon, MD • Wagih Ben Hassen, MD • Grégoire Boulouis, MD • Joseph Benzakoun, MD • Christine Rodriguez-Régent, MD • Denis Trystram, MD • François Nataf, MD • Jean-Francois Meder, PhD • Patrick Turski, MD • Catherine Oppenheim, PhD • Olivier Naggara, PhD

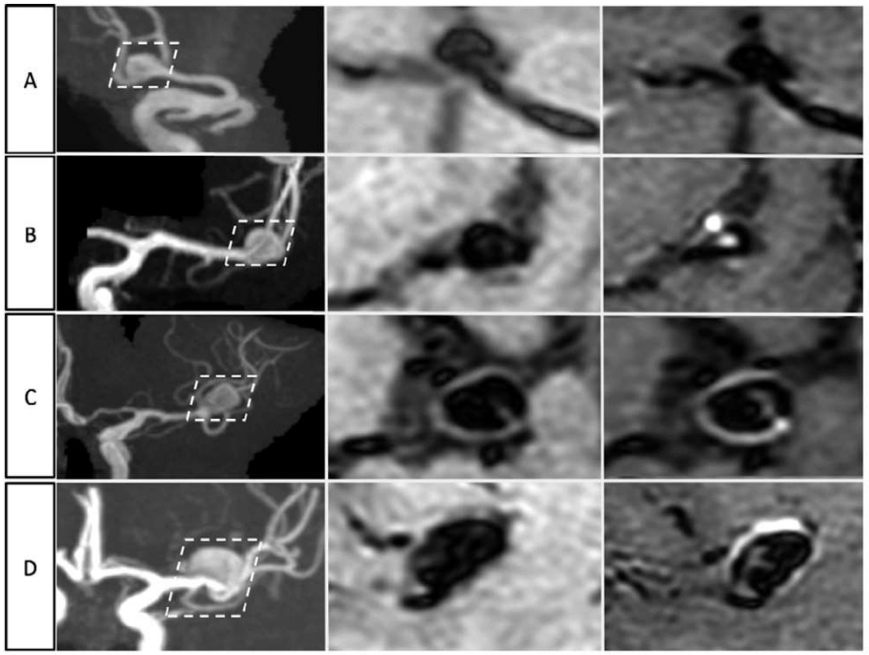
Results: The study included 263 patients with 333 aneurysms. Inter- and intrareader agreement was excellent for both the presence of enhancement (κ values, 0.82 [95% CI: 0.67, 0.99] and 0.87 [95% CI: 0.7, 1.0], respectively) and enhancement grade (κ = 0.92 [95% CI: 0.87, 0.95]). In unruptured aneurysms (n = 307), grade 3 enhancement exhibited the highest specificity (84.4%; 233 of 276; 95% CI: 80.1%, 88.7%; P = .02) and negative predictive value (94.3%; 233 of 247) for differentiating between stable and unstable lesions. There was a significant association between grade 3 enhancement and aneurysm instability ($P < .0001$).

Conclusion: In patients with intracranial aneurysm, a thick (>1 mm) circumferential pattern of wall enhancement demonstrated the highest specificity for differentiating between stable and unstable aneurysms.

Table 3: Diagnostic Accuracy of Enhancement Pattern in 307 Stable and Unstable Unruptured Intracranial Aneurysms

Parameter	Sensitivity	Specificity	PPV	NPV	Accuracy
Any enhancement	70.9 (55.0, 86.9) [22/31]	61.6 (55.9, 67.3) [170/276]	17.2 [22/128]	94.9 [170/179]	62.5
CAWE, grade 2 and grade 3	64.5 (47.6, 81.3) [20/31]	68.1 (62.6, 73.6) [188/276]	18.5 [20/108]	94.4 [188/199]	67.7
Grade 3	61.3 (44.1, 78.4) [17/31]	84.4 (80.1, 88.7) [233/276]	28.3 [17/60]	94.3 [233/247]	76.2

Note.—Data are percentages; data in parentheses are 95% confidence intervals; data in brackets are numerator/denominator. CAWE = circumferential arterial wall enhancement, PPV = positive predictive value, NPV = negative predictive value.



Edjlali, M et alCircumferential Thick Enhancement at Vessel Wall MRI Has High Specificity for Intracranial Aneurysm Instabilityy. *Radiology*,. 2018.

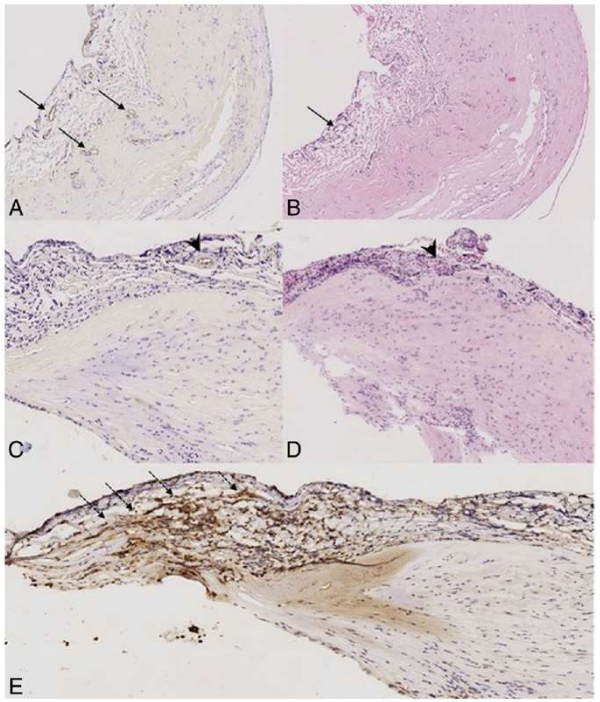
POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **korelacja wzmocnienia kontrastowego ściany tętniaków z wynikami badań histopatologicznych**

Vessel Wall Enhancement in Unruptured Intracranial Aneurysms: An Indicator for Higher Risk of Rupture? High-Resolution MR Imaging and Correlated Histologic Findings

N. Larsen, C. von der Brelie, D. Trick, C.H. Riedel, T. Lindner, J. Madjidyar, O. Jansen, M. Synowitz, and C. Flüh

„ Wall enhancement in MR vessel wall imaging is associated with inflammatory cell invasion, neovascularization, and the presence of vasa vasorum. Enhancement does not occur when histologic signs of inflammation are absent. Our results support the hypothesis that MR vessel wall imaging could provide valuable information for risk stratification..”



Larsen N. et al. Vessel Wall Enhancement in Unruptured Intracranial Aneurysms: An Indicator for Higher Risk of Rupture? High-Resolution MR Imaging and Correlated Histologic Findings?. *Clin Neuroradiol*, 2014.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **korelacja wzmocnienia kontrastowego ściany tętniaków ze znanymi czynnikami ryzyka pęknięcia tętniaków**

NEUROSURGERY
THE REGISTER OF THE NEUROSURGICAL MEME

Relationship Between Aneurysm Wall Enhancement in Vessel Wall Magnetic Resonance Imaging and Rupture Risk of Unruptured Intracranial Aneurysms

Lv, Nan MD; Karmonik, Christof PhD; Chen, Shiyue PhD; Wang, Xinrui MD; Fang, Yibin MD; Huang, Qinghai MD; Liu, Jianmin MD

„ The presence of AWE on VW-MRI was highly associated with conventional rupture-related characteristics, including aneurysmal size and location, and was detected more frequently in unruptured IAs with high rupture risk based on the PHASES score."

TABLE 1. Characteristics of Unruptured Intracranial Aneurysms With and Without Wall Enhancement

	Enhancement n = 82	Non-enhancement n = 58	*P* Value
Age (yr)	58 (51, 66)	55 (50, 63)	.315
≥70	15 (11.7)	5 (8.6)	.107
Female	57 (68.7)	39 (67.2)	.857
Hypertension	38 (46.3)	24 (41.4)	.560
Early SAH History	6 (7.3)	3 (3.4)	.547
Smoking	7 (8.5)	2 (3.4)	.390
Diabetes	7 (8.5)	4 (6.9)	.971
Daily Aspirin Intake	12 (14.6)	9 (15.5)	.885
Daily Statin Intake	9 (11.0)	8 (13.8)	.615
Multiple Aneurysms	30 (36.6)	31 (53.4)	**.047**
Irregular Shape	35 (42.7)	11 (19.0)	**.003**
Bifurcation Aneurysms	36 (43.9)	17 (29.3)	.080
Size (mm)	10.4 (6.4, 14.1)	5.6 (4.1, 7.0)	**<.001**
0.0-6.9	22 (26.8)	44 (75.9)	**<.001**
7.0-9.9	16 (19.5)	6 (10.3)	
10.0-19.9	33 (40.2)	7 (12.1)	
20	11 (13.4)	1 (1.7)	
Location			**.023**
ICA	36 (43.9)	39 (67.2)	
MCA	17 (20.7)	8 (13.8)	
ACA/PComA/PC	29 (35.4)	11 (19.0)	
Rupture Risk Score	6 (4, 10)	2 (0, 5)	**<.001**
0-4	21 (25.6)	41 (70.7)	**<.001**
5-7	24 (29.3)	13 (22.4)	
8-9	13 (15.9)	2 (3.4)	
≥10	24 (29.3)	2 (3.4)	

PHASES aneurysm risk score	Points
(P) Population	
North American, European (other than Finnish)	0
Japanese	3
Finnish	5
(H) Hypertension	
No	0
Yes	1
(A) Age	
<70 years	0
≥70 years	1
(S) Size of aneurysm	
<7·0 mm	0
7·0–9·9 mm	3
10·0–19·9 mm	6
≥20 mm	10
(E) Earlier SAH from another aneurysm	
No	0
Yes	1
(S) Site of aneurysm	
ICA	0
MCA	2
ACA/Pcom/posterior	4

Lv N.. et al. Relationship Between Aneurysm Wall Enhancement in Vessel Wall Magnetic Resonance Imaging and Rupture Risk of Unruptured Intracranial Aneurysms. *Neurosurgery*, *2018*

Greving JP et al. Development of the PHASES score for prediction of risk of rupture of intracranial aneurysms: a pooled analysis of six prospective cohort studies. Lancet Neurol. 2014 Jan;13(1):59-66.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

Journal of *Clinical Medicine*

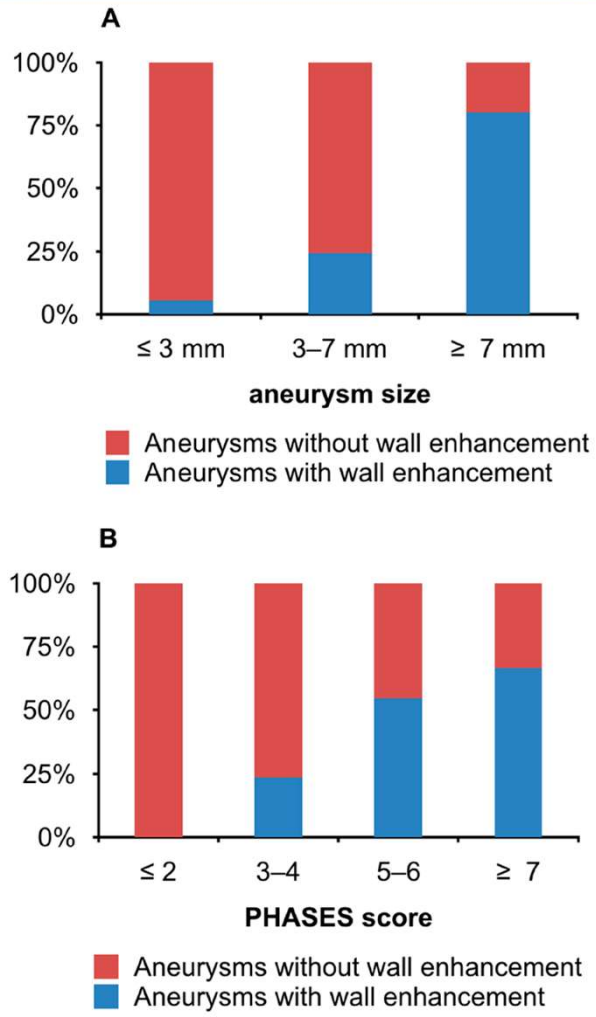
MDPI

Article

High-Resolution Vessel Wall Magnetic Resonance Imaging of Small Unruptured Intracranial Aneurysms

Łukasz Zwarzany [1,*], Ernest Tyburski [2] and Wojciech Poncyljusz [1]

Abstract: *Background*: We decided to investigate whether aneurysm wall enhancement (AWE) on high-resolution vessel wall magnetic resonance imaging (HR VW-MRI) coexists with the conventional risk factors for aneurysm rupture. *Methods*: We performed HR VW-MRI in 46 patients with 64 unruptured small intracranial aneurysms. Patient demographics and clinical characteristics were recorded. The PHASES score was calculated for each aneurysm. *Results*: Of the 64 aneurysms, 15 (23.4%) showed wall enhancement on post-contrast HR VW-MRI. Aneurysms with wall enhancement had significantly larger size ($p = 0.001$), higher dome-to-neck ratio ($p = 0.024$), and a more irregular shape ($p = 0.003$) than aneurysms without wall enhancement. The proportion of aneurysms with wall enhancement was significantly higher in older patients ($p = 0.011$), and those with a history of prior aneurysmal SAH. The mean PHASES score was significantly higher in aneurysms with wall enhancement ($p < 0.000$). The multivariate logistic regression analysis revealed that aneurysm irregularity and the PHASES score are independently associated with the presence of AWE. *Conclusions*: Aneurysm wall enhancement on HR VW-MRI coexists with the conventional risk factors for aneurysm rupture.



POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

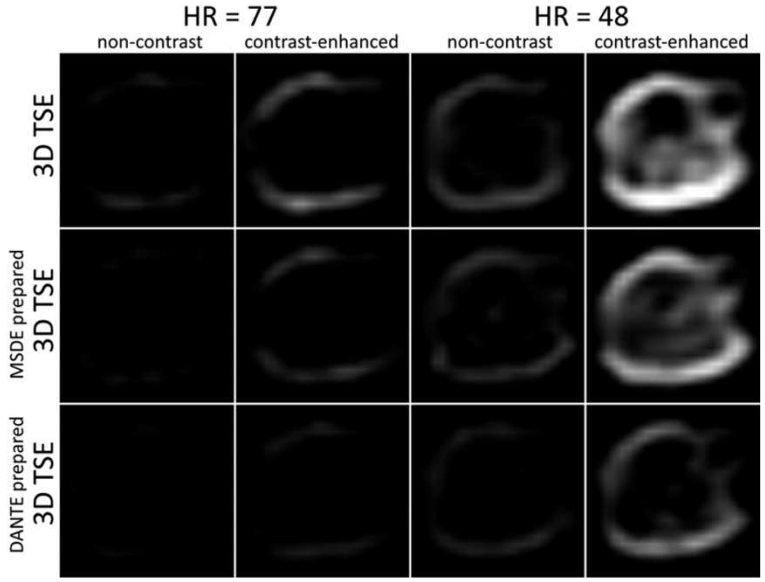
- **wzmocnienie kontrastowe ściany tętniaka mózgu – cecha tętniaków niestabilnych?**

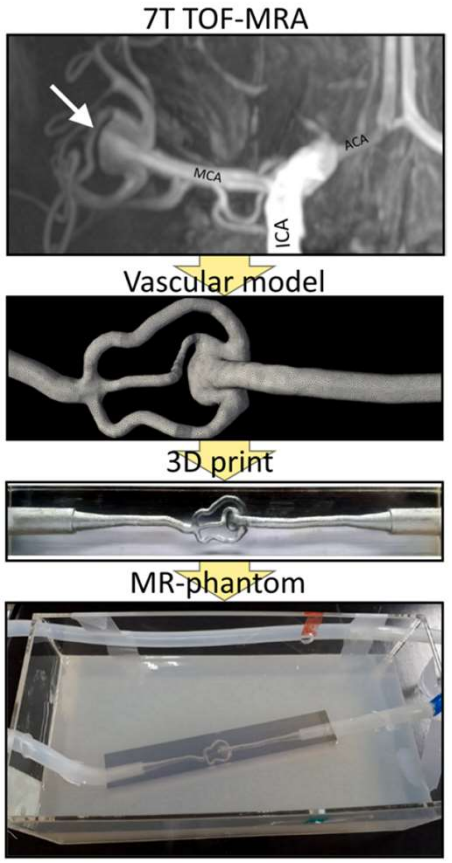
NEUROSURGICAL FOCUS

Insufficient slow-flow suppression mimicking aneurysm wall enhancement in magnetic resonance vessel wall imaging: a phantom study

Bart M. W. Cornelissen, MSc,[1–3] Eva L. Leemans, MSc,[1,2] Bram F. Coolen, PhD,[2] Eva S. Peper, MSc,[1] René van den Berg, MD, PhD,[1] Henk A. Marquering, PhD,[1,2] Cornelis H. Slump, PhD,[3] and Charles B. L. M. Majoie, MD, PhD[1]

„Near-wall slow flow mimics wall enhancement in VWI protocols. Therefore, VWI should be carefully interpreted. Preparation pulses improve slow-flow suppression, and therefore the authors encourage further development and clinical implementation of these techniques.”





Cornelissen et al. Insufficient slow-flow suppression mimicking aneurysm wall enhancement in magnetic resonance vessel wall imaging: a phantom study. Neurosurg Focus. 2019 Jul 1;47(1):E19.

AJNR
AMERICAN JOURNAL OF NEURORADIOLOGY

Gadolinium Enhancement of the Aneurysm Wall in Unruptured Intracranial Aneurysms Is Associated with an Increased Risk of Aneurysm Instability: A Follow-Up Study

M.D.I. Vergouwen, D. Backes, I.C. van der Schaaf, J. Hendrikse, R. Kleinloog, A. Algra, and G.J.E. Rinkel

ABSTRACT

BACKGROUND AND PURPOSE: Previous studies have suggested that gadolinium enhancement of the wall of unruptured intracranial aneurysms on MR imaging may reflect aneurysm wall instability. However, all previous studies were cross-sectional. In this longitudinal study, we investigated whether aneurysm wall enhancement is associated with an increased risk of aneurysm instability.

MATERIALS AND METHODS: We included all patients 18 years of age or older with ≥1 unruptured aneurysm from the University Medical Center Utrecht, the Netherlands, who were included in 2 previous studies with either 3T or 7T aneurysm wall MR imaging and for whom it was decided not to treat the aneurysm but to monitor it with follow-up imaging. We investigated the risk of growth or rupture during follow-up of aneurysms with and without gadolinium enhancement of the aneurysm wall at baseline and calculated the risk difference between the 2 groups with corresponding 95% confidence intervals.

RESULTS: We included 57 patients with 65 unruptured intracranial aneurysms. After a median follow-up of 27 months (interquartile range, 20–31 months), growth ($n = 2$) or rupture ($n = 2$) was observed in 4 of 19 aneurysms (21%; 95% CI, 6%–54%) with wall enhancement and in zero of 46 aneurysms (0%; 95% CI, 0%–8%) without enhancement (risk difference, 21%; 95% CI, 3%–39%).

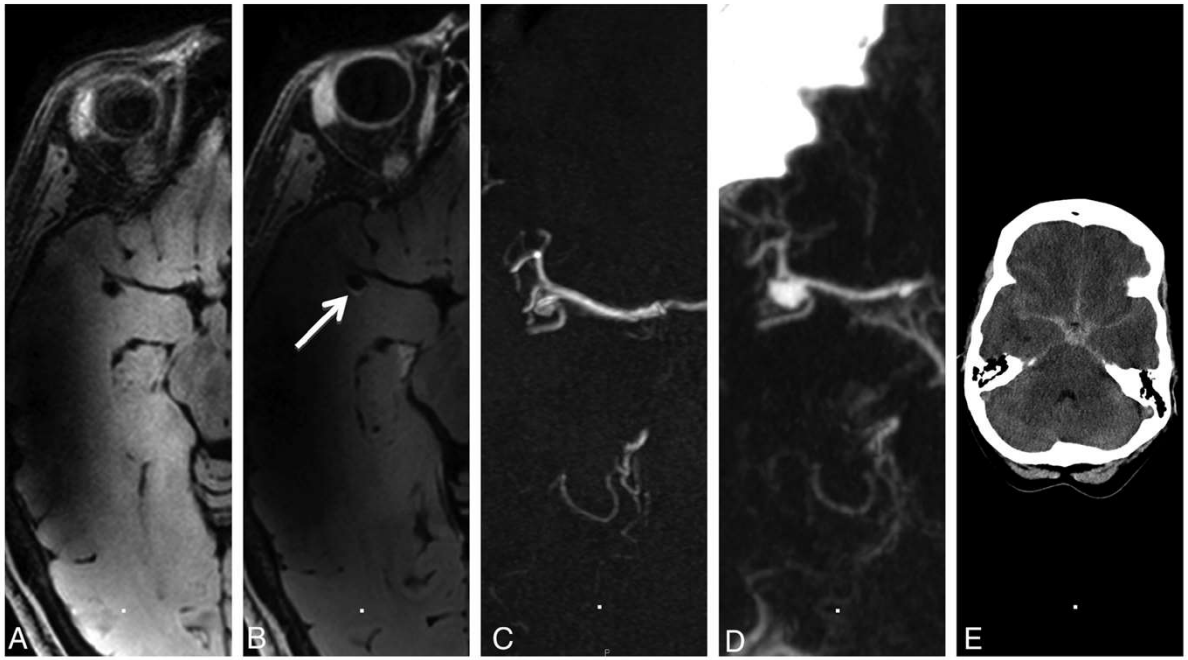
CONCLUSIONS: Gadolinium enhancement of the aneurysm wall on MR imaging is associated with an increased risk of aneurysm instability. The absence of wall enhancement makes it unlikely that the aneurysm will grow or rupture in the short term. Larger studies are needed to investigate whether aneurysm wall enhancement is an independent predictor of aneurysm instability.

Vergouwen, MDI, et al. Gadolinium Enhancement of the Aneurysm Wall in Unruptured Intracranial Aneurysms Is Associated with an Increased Risk of Aneurysm Instability: A Follow-Up Study. *AJNR Am J Neuroradiol*. 2019.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **wzmocnienie kontrastowe ściany tętniaka mózgu – cecha tętniaków niestabilnych?**

„Gadolinium enhancement of the aneurysm wall on MR imaging is associated with an increased risk of aneurysm instability. The absence of wall enhancement makes it unlikely that the aneurysm will grow or rupture in the short term.”



Vergouwen, MDI, et al. Gadolinium Enhancement of the Aneurysm Wall in Unruptured Intracranial Aneurysms Is Associated with an Increased Risk of Aneurysm Instability: A Follow-Up Study. *AJNR Am J Neuroradiol*. 2019.

POTENCJALNE ZASTOSOWANIA KLINICZNE VW-MRI

- **wzmocnienie kontrastowe ściany tętniaka mózgu – cecha tętniaków niestabilnych?**

Increased Wall Enhancement During Follow-Up as a Predictor of Subsequent Aneurysmal Growth

Florent Gariel, Wagih Ben Hassen, Grégoire Boulouis, Romain Bourcier, Denis Trystram, Laurence Legrand, Christine Rodriguez-Regent, David Saloner, Catherine Oppenheim, Olivier Naggara and Myriam Edjlali

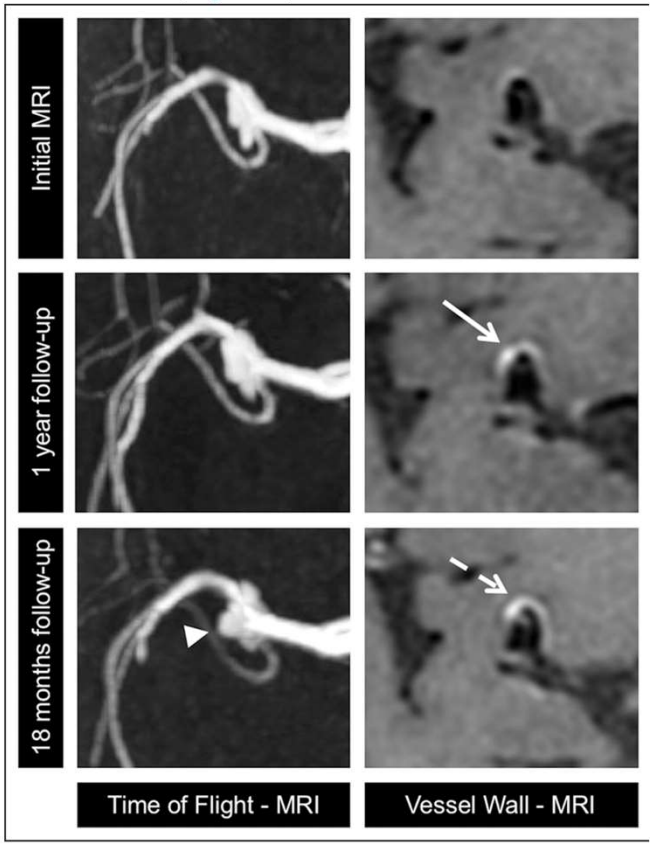
Stroke
Journal of the American Heart Association

Background and Purpose—Absence of arterial wall enhancement (AWE) of unruptured intracranial aneurysms (UIA) has shown promise at predicting which aneurysms will not rupture. We here tested the hypothesis that increased enhancement during follow-up (increased intensity, extension, or thickness or appearance of de novo enhancement), assessed using vessel wall magnetic resonance imaging, was associated with higher rates of subsequent growth.

Methods—Patients with UIA were included between 2012 and 2018. Two readers independently rated AWE modification on 3T vessel wall magnetic resonance imaging, and morphological changes on time-of-flight magnetic resonance angiography during follow-up.

Results—A total of 129 patients harboring 145 UIA (mean size 4.1 mm) met study criteria, of which 12 (8.3%) displayed morphological growth at 2 years. Of them, 8 demonstrated increased AWE during follow-up before or concurrently to morphological growth, and 4 had preexisting AWE that remained stable before growth. In the remaining 133 (nongrowing) UIAs, no AWE modifications were found. In multivariable analysis, increased AWE, not size, was associated with UIA growth (relative risk, 26.1 [95% CI, 7.4–91.7], $P<0.001$). Sensitivity, specificity, positive predictive value, and negative predictive value for UIA growth of increased AWE during follow-up were, respectively, of 67%, 100%, 96%, and 100%.

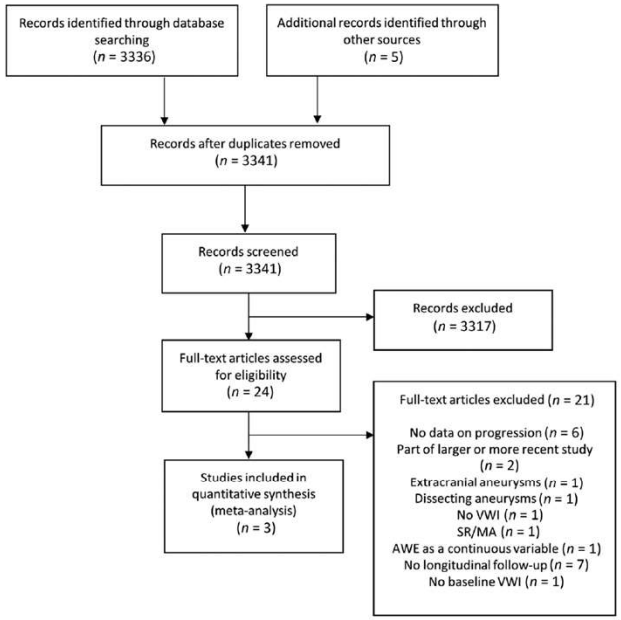
Conclusions—Increased AWE during follow-up of conservatively managed UIAs predicts aneurysm growth over a 2-year period. This may impact UIA management towards closer monitoring or preventive treatment. Replication in a different setting is warranted. **(*Stroke*. 2020;51:1868-1872. DOI: 10.1161/STROKEAHA.119.028431.)**



Gariel F etl al. Increased Wall Enhancement During Follow-Up as a Predictor of Subsequent Aneurysmal Growth. Stroke 2020 Jun;51(6):1868-1872.

Lack of Baseline Intracranial Aneurysm Wall Enhancement Predicts Future Stability: A Systematic Review and Meta-Analysis of Longitudinal Studies

A.S. Larson, V.T. Lehman, G. Lanzino, and W. Brinjikji



AJNR
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ABSTRACT

BACKGROUND: The utility of vessel wall MR imaging in identifying unstable intracranial aneurysms has been suggested but remains controversial.

PURPOSE: Our aim was to provide further insight into the potential relationship between aneurysm wall enhancement on initial vessel wall imaging and aneurysm instability at follow-up.

DATA SOURCES: Our sources were PubMed, Scopus, the Web of Science, and the Cochrane Central Register of Controlled Trials.

STUDY SELECTION: We searched for English language studies that reported the presence of vessel wall enhancement of unruptured intracranial aneurysms on baseline vessel wall imaging studies with longitudinal follow-up of aneurysm status.

DATA ANALYSIS: Aneurysms were grouped into "stable" and "unstable" groups at follow-up on the basis of growth, symptomatic manifestation, or rupture. The association of each group with aneurysm wall enhancement on initial vessel wall imaging was determined.

DATA SYNTHESIS: Three studies constituting 407 aneurysms were included. Aneurysms with wall enhancement were at higher risk of being unstable at follow-up (risk ratio = 3.6; 95% confidence interval, 1.7–7.5). The sensitivity of aneurysm wall enhancement on vessel wall imaging was 74.3% (95% CI, 56.7%–87.5%), specificity was 58.3% (95% CI, 53.1%–63.4%), positive predictive value was 14.4% (95% CI, 11.8%–17.4%), negative predictive value was 96.0% (95% CI, 93.2%–97.7%), and the overall accuracy of the test was 59.7% (95% CI, 54.8%–64.5%).

LIMITATIONS: Only 3 studies were identified for inclusion in this analysis. More longitudinal studies of vessel wall imaging and aneurysm progression are needed.

CONCLUSIONS: The lack of wall enhancement may be a predictor of aneurysm stability. The utility of vessel wall imaging in detecting unstable aneurysms requires more data.

ABBREVIATIONS: AWE = aneurysm wall enhancement; IA = intracranial aneurysm; VWI = vessel wall imaging

Larson AS et al. Lack of Baseline Intracranial Aneurysm Wall Enhancement Predicts Future Stability: A Systematic Review and Meta-Analysis of Longitudinal Studies. AJNR Am J Neuroradiol. 2020 Sep;41(9):1606-1610.

PODSUMOWANIE

- **VW-MRI pozwala na ocenę zmian miażdżycowych tętnic wewnątrzczaszkowych**
  - zidentyfikowane cechy blaszek niestabilnych to wzmocnienie kontrastowe, hiperintensywność w obrazach T1-zależnych (IPH), pozytywny remodelling, nieregularne zarysy
- **VW-MRI może być przydatnym narzędziem w diagnostyce zapalenia naczyń OUN**
  - najczęściej obserwuje się koncentryczne pogrubienie oraz wzmocnienie kontrastowe ścian naczyń
- **VW-MRI może być pomocne w diagnostyce różnicowej zapalenia naczyń OUN z RCVS**
  - wzmocnienie kontrastowe ścian naczyń mniej intensywne w przebiegu RCVS, częściej ulega regresji w badaniach kontrolnych
- **VW-MRI umożliwia dokładną charakterystykę zmian w przebiegu rozwarstwienia tętnic dogłowowych/mózgowych**
  - obecność przyściennych skrzeplin oraz nieregularne zarysy krwiaka śródściennego są istotnie powiązane z większym ryzykiem udaru niedokrwiennego mózgu
- **Zastosowanie VW-MRI u pacjentów z tętniakami wewnątrzczaszkowymi**
  - u pacjentów z SAH i mnogimi tętniakami wewnątrzczaszkowymi, wzmocnienie kontrastowe ściany tętniaka na obrazach VW-MRI jest objawem o wysokiej czułości, ale niskiej specyficzności w identyfikacji pękniętego tętniaka
  - potrzebne są dalsze badania, aby ostatecznie ustalić rolę wzmocnienia kontrastowego ściany tętniaka wewnątrzczaszkowego na obrazach VW- MRI w ocenie ryzyka pęknięcia tętniaka

DZIĘKUJĘ ZA UWAGĘ

PYTANIE

Cechą objawowej blaszki miażdżycowej w obrazach VW-MRI tętnic wewnątrzczaszkowych jest:

a) wysoki sygnał w obrazach T1-zależnych

b) wzmocnienie kontrastowe

c) nieregularna powierzchnia

d) remodeling pozytywny

e) wszystkie z wymienionych