Intracranial Aneurysm Diagnosis

Early and accurate diagnosis is critical for management and prevention of complications.

1. Clinical Presentation

Patients with an intracranial aneurysm may present with:

- **Asymptomatic** (incidental finding in imaging)
- **Warning signs** (sentinel headaches, cranial nerve palsies)
- **Acute rupture → Subarachnoid Hemorrhage (SAH)**
    1. Sudden, severe “thunderclap” headache
    2. Nausea, vomiting
    3. Photophobia, neck stiffness (meningeal irritation)
    4. Altered consciousness, seizures
    5. Focal neurological deficits (depending on aneurysm location)

2. Imaging Modalities

Different imaging techniques are used for **aneurysm detection and characterization**.

Imaging Technique	Sensitivity	Specificity	Advantages	Limitations
Computed Tomography Angiography (CTA)	85-95%	90-98%	Rapid, non-invasive, good for screening	Lower resolution for small aneurysms (<3mm), bone artifacts
Multiphase CTA (MP-CTA)	High	High	Improves detection in slow-flow aneurysms	Lacks dynamic flow assessment
Magnetic Resonance Angiography (MRA)	85-95%	High	No radiation, good for follow-up	Longer acquisition time, motion artifacts
Digital Subtraction Angiography (DSA)	Nearly 100%	Nearly 100%	Gold standard, dynamic blood flow assessment	Invasive, risk of stroke/vascular injury
Non-Contrast CT (NCCT)	Low	High for SAH	Best for acute SAH detection	Cannot visualize unruptured aneurysms

3. When to Use Each Modality

- **First-line screening → CTA or MRA**
- **Acute SAH suspicion → NCCT**, followed by **CTA**
- **Definitive diagnosis** (unclear cases, pre-surgical planning) → **DSA**
- **Long-term follow-up → MRA (preferred for radiation avoidance), CTA if needed**

4. Risk Factors for Aneurysm Development

- **Genetic predisposition** (family history, connective tissue disorders)
- **Hypertension**
- **Smoking**
- **Excessive alcohol consumption**
- **Female sex, postmenopausal status**
- **Previous SAH or multiple aneurysms**
- **Polycystic kidney disease (PKD)**

5. Management Considerations

- **Small, unruptured aneurysms (<5mm)**: Conservative management, risk factor control, follow-up imaging
- **Aneurysms ≥5mm or symptomatic**: Endovascular (coiling) or surgical (clipping) intervention
- **Ruptured aneurysm**: Urgent **aneurysm occlusion** and **SAH management** (ICU care, BP control, vasospasm prevention)

6. Conclusion

Intracranial aneurysm diagnosis requires a **multi-modal imaging approach** based on clinical presentation. **CTA and MRA** are useful for screening, while **DSA remains the gold standard** for definitive evaluation and treatment planning.

Screening

The low 1.14% per-person year risk of DNIA detection and small DNIA size at detection cannot justify routine screening for DNIAs in all patients with a personal history of IAs. If imaging follow-up is considered for selected patients, early screening will likely yield the most benefit in patients who continue to smoke cigarettes [1].

Since its introduction, digital subtraction angiography has been considered the gold standard in diagnostic imaging for neurovascular disease. Modern post-processing techniques have made angiography even more informative to the cerebrovascular neurosurgeon or neurointerventionalist.

In patients with a head computed tomography scan performed less than 6 h after headache onset and reported negative by a staff radiologist, lumbar puncture can be withheld. [2]. Intracranial vascular lesions, such as a vascular loop, infundibulum, and stump of an occluded vessel, are sometimes misdiagnosed as aneurysms during imaging examinations [3].

It is difficult to differentiate such lesions from aneurysms on the basis of imaging findings [4] [5].

For Aneurysmal subarachnoid hemorrhage diagnosis in the early phase, during the first 24 hours, cerebral CT, combined with intracranial CT angiography is recommended to make a positive diagnosis of SAH, to identify the cause and to investigate for an intracranial aneurysm.

Cranial magnetic resonance imaging may be proposed if the patient's clinical condition allows it. FLAIR imaging is more sensitive than CT to demonstrate a subarachnoid hemorrhage and offers greater degrees of sensitivity for the diagnosis of restricted subarachnoid hemorrhage in cortical sulcus. A lumbar puncture should be performed if these investigations are normal while clinical suspicion is high [6)].

CT angiography is an appropriate initial investigation to detect macrovascular causes of non-traumatic Intracerebral hemorrhage, but accuracy is modest. Additional MRI/MRA may find cavernomas or alternative diagnoses, but DSA is needed to diagnose macrovascular causes undetected by CT angiography or MRI/MRA [7)].

Spinal magnetic resonance imaging

The yield and clinical relevance of MRI of the spinal axis in patients who present with nonperimesencephalic subarachnoid hemorrhage (NPSAH) is low. Germans et al. do not recommend routine MRI of the spinal axis in this patient population, but it might be justified in a subgroup of patients [8)].

The yield and clinical relevance of MRI of the spinal axis in patients who present with NPSAH is low. Germans et al. do not recommend routine MRI of the spinal axis in this patient population, but it might be justified in a subgroup of patients [9)] [10)].

Computed tomography angiography

see Computed tomography angiography for subarachnoid hemorrhage.

Cerebral angiography

Cerebral angiography for subarachnoid hemorrhage

Feature	Multiphase CT Angiography (MP-CTA)	Digital Subtraction Angiography (DSA)
Sensitivity	85-95% (lower for small aneurysms)	Nearly 100% (gold standard)
Specificity	90-98%	Nearly 100%
Invasiveness	Non-invasive	Invasive (catheter-based)
Risk of complications	Minimal (radiation & contrast risks)	Higher (stroke, vessel injury, hematoma)
Imaging speed	Fast (minutes)	Longer procedure

Feature	**Multiphase CT Angiography (MP-CTA)**	**Digital Subtraction Angiography (DSA)**
Visualization of small aneurysms (<3mm)	Limited accuracy	Superior resolution
Dynamic flow assessment	No (static images)	Yes (real-time blood flow visualization)
Artifact issues	Bone & vessel overlap may affect clarity	Minimal artifacts
Best for…	Screening, emergency cases, preoperative planning in some cases	Definitive diagnosis, pre-surgical/endovascular planning
Limitations	May miss small/complex aneurysms, no dynamic blood flow info	Requires arterial access, risk of complications

see Subarachnoid hemorrhage diagnosis.

Although intracranial arterial aneurysms (IAAs) of childhood are usually idiopathic, it is possible that underlying arteriopathy escapes detection when using conventional diagnostic tools. Quantitative arterial tortuosity (QAT) has been studied as a biomarker of arteriopathy. The authors analyzed cervicocerebral QAT in children with idiopathic IAAs to assess the possibility of arteriopathy.

METHODS: Cases were identified by text-string searches of imaging reports spanning the period January 1993 through June 2017. QAT of cervicocerebral arterial segments was measured from cross-sectional studies using image-processing software. Other imaging and clinical data were confirmed by retrospective electronic record review. Children with idiopathic IAAs and positive case controls, with congenital arteriopathy differentiated according to aneurysm status (with and without an aneurysm), were compared to each other and to healthy controls without vascular risk factors.

RESULTS: Cervicocerebral QAT was measured in 314 children: 24 with idiopathic IAAs, 163 with congenital arteriopathy (including 14 arteriopathic IAAs), and 127 healthy controls. QAT of all vertebrobasilar segments was larger in children with IAAs (idiopathic and arteriopathic forms) ($p < 0.05$). In children with congenital arteriopathy without an aneurysm, QAT was decreased for the distal cervical vertebral arteries and increased for the supraspinal vertebral artery relative to healthy children. QAT of specific cervicocerebral segments correlated with IAA size and rupture status.

CONCLUSIONS: Cervicocerebral QAT is a biomarker of arteriopathy in children with IAA, even in the absence of other disease markers. Additional findings suggest a correlation of cervicocerebral QAT with IAA size and rupture status and with the presence of IAA in children with congenital arteriopathy [11].

Cerebral angiography for intracranial aneurysm

Cerebral angiography for intracranial aneurysm.

Magnetic resonance angiography for intracranial aneurysm

Magnetic resonance angiography for intracranial aneurysm

1)

Wang JY, Smith R, Ye X, Yang W, Caplan JM, Radvany MG, Colby GP, Coon AL, Tamargo RJ, Huang J. Serial Imaging Surveillance for Patients With a History of Intracranial Aneurysm: Risk of De Novo Aneurysm Formation. Neurosurgery. 2015 Jul;77(1):32-43. doi: 10.1227/NEU.0000000000000730. PubMed PMID: 25790068.

2)

Rinkel GJ. Management of patients with aneurysmal subarachnoid haemorrhage. Curr Opin Neurol. 2016 Feb;29(1):37-41. doi: 10.1097/WCO.0000000000000282. PubMed PMID: 26641816.

3)

Park J, Baik SK, Kim Y, Hamm IS. Occluded vascular stump mimicking middle cerebral artery bifurcation aneurysm: report of 2 cases. Surg Neurol. 2008;70(6):664–667.

4)

Komiyama M, Ishiguro T, Morikawa T, Nishikawa M, Yasui T. Distal stump of an occluded intracranial vertebral artery at the vertebrobasilar junction mimicking a basilar artery aneurysm. Acta Neurochir (Wien) 2001;143(10):1013–1017.

5)

Nakano S, Yokogami K, Ohta H, Wakisaka S. A Stump of Occluded Posterior Cerebral Artery Mimicking a Ruptured Aneurysm: Case Report. Int J Angiol. 2000;9(1):51–52.

6)

Edjlali M, Rodriguez-Régent C, Hodel J, Aboukais R, Trystram D, Pruvo JP, Meder JF, Oppenheim C, Lejeune JP, Leclerc X, Naggara O. Subarachnoid hemorrhage in ten questions. Diagn Interv Imaging. 2015 Jul-Aug;96(7-8):657-66. doi: 10.1016/j.diii.2015.06.003. Epub 2015 Jul 2. PubMed PMID: 26141485.

7)

van Asch CJ, Velthuis BK, Rinkel GJ, Algra A, de Kort GA, Witkamp TD, de Ridder JC, van Nieuwenhuizen KM, de Leeuw FE, Schonewille WJ, de Kort PL, Dippel DW, Raaymakers TW, Hofmeijer J, Wermer MJ, Kerkhoff H, Jellema K, Bronner IM, Remmers MJ, Bienfait HP, Witjes RJ, Greving JP, Klijn CJ; DIAGRAM Investigators. Diagnostic yield and accuracy of CT angiography, MR angiography, and digital subtraction angiography for detection of macrovascular causes of intracerebral haemorrhage: prospective, multicentre cohort study. BMJ. 2015 Nov 9;351:h5762. doi: 10.1136/bmj.h5762. PubMed PMID: 26553142; PubMed Central PMCID: PMC4637845.

8) , 9)

Germans MR, Coert BA, Majoie CB, van den Berg R, Lycklama À Nijeholt G, Rinkel GJ, Verbaan D, Vandertop WP. Yield of spinal imaging in nonaneurysmal, nonperimesencephalic subarachnoid hemorrhage. Neurology. 2015 Mar 31;84(13):1337-40. doi: 10.1212/WNL.0000000000001423. Epub 2015 Feb 27. PubMed PMID: 25724231.

10)

Germans MR, Coert BA, Majoie CB, van den Berg R, Verbaan D, Vandertop WP. Spinal axis imaging in non-aneurysmal subarachnoid hemorrhage: a prospective cohort study. J Neurol. 2014 Nov;261(11):2199-203. doi: 10.1007/s00415-014-7480-y. Epub 2014 Sep 3. PubMed PMID: 25182702.

11)

Chen AM, Karani KB, Taylor JM, Zhang B, Furthmiller A, De Vela G, Leach JL, Vadivelu S, Abruzzo TA. Cervicocerebral quantitative arterial tortuosity: a biomarker of arteriopathy in children with intracranial aneurysms. J Neurosurg Pediatr. 2019 Jul 26:1-8. doi: 10.3171/2019.5.PEDS1982. [Epub ahead of print] PubMed PMID: 31349231.