Distinguishing Infundibular Dilatation from an Aneurysm at a Rare Location of Anterior Cerebral Artery: A Case Report

Jacub Pandelaki, MD, PhD[1]*, Heltara Ramandika, MD[1], Amyra Fitria Jasmin, MD[1], Herlien Widjaja, MD[1], Jason[2]

[1]*Department of Radiology, Dr. Cipto Mangunkusumo National General Hospital - Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia*

[2]*Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia*

***Correspondence:** Jacub Pandelaki, MD, PhD, Department of Radiology, Dr. Cipto Mangunkusumo Hospital-Faculty of Medicine Universitas Indonesia, Central Jakarta, Indonesia,

jacubp@gmail.com

Radiology Case. 2024 April; 18(5):1-9 :: DOI: 10.3941/jrcr.5321

Authors' Contributions

The first author was the patient's doctor-in-charge, conducting the medical mangements and also as the advisor of this study. The second author was the co-operator during the interventional procedures. The third and fourth author were the residents contributing in both the patient managements and in writing this study. The fifth author contributed in writing and formatting the manuscript.

Acknowledgements

The authors thank Stephen Kurniawan, MD and Irfan Hasyim Tadjoedin, MD for their assistance in writing the manuscript.

Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Consent

Absence (Due to the anonymosity, the author did not obtain written informed consent from the patient for submission of this manuscript for publication. Only verbal consent was given).

Human and animal rights

There is no experiment on human or animal subjects.

Ethical Statements

The authors assure that the material included in this study is the authors' original work, which has not been previously published elsewere and being considered for publication elsewhere.

ABSTRACT

Differentiating between infundibular dilatations and aneurysms might be challenging even with to-date modalities. While infundibular dilatation has been regarded as an incidental "leave alone" lesion, a more extended intervention might be needed for an aneurysm. This study presented a 23-year-old woman with an infundibular dilatation at an unusual site at the A1 segment of the anterior cerebral artery from 3D digital subtraction angiography, initially identified as an aneurysm on magnetic resonance imaging and computed tomography angiography. Points in differentiating infundibular dilatation and aneurysm are thoroughly elaborated in the discussion.

CASE REPORT

BACKGROUND

Infundibular dilatation is a funnel-shaped symmetrical enlargement in the origin of cerebral arteries, which is deemed as a benign lesion and also being considered as a normal variant [1,2]. It is one of the differential diagnosis of aneurysm, a focal bulging of the vessel wall, with higher risk of rupture when occuring in the cerebral arteries [3]. Because of the significant difference in the pathological nature and treatment considerations, the correct differentiation of infundibular dilatation and aneurysm is a necessity [4,5]. This study presented a case of an infundibular dilatation at a rare cerebral location, with a thorough review of infundibular dilatation and aneurysm differentiation.

CASE REPORT

A 23-year-old female patient had been experiencing frequent headaches for two months with speech impairment during headache episodes. Since exhibiting the symptoms, the patient has also briefly experienced syncope. The patient also has had seronegative spondyloarthropathy for five years and is currently on medication. There was no history of trauma.

The brain magnetic resonance imaging (MRI) demonstrated the absence of parenchymal pathology in the cerebral hemisphere and basal ganglia. However, further evaluation of the vascular structure on the T2 sequence showed a subtle outpouching lesion in the A1 segment of the left Anterior Cerebral Artery (ACA; Figure 1). We hypothesized the presence of a vascular abnormality, specifically an aneurysm. Computed tomography angiography (CTA) showed an outpouching lesion on the left ACA at the A1 segment (Figure 2**)**, which aligned with the MRI. We considered the outpouching lesion at the A1 segment of the left ACA as a small-sized wide neck aneurysm in the neck (2.71 mm) and dome (1.99 mm).

The conventional angiography of this patient shows no aneurysms or other vascular malformations in the arterial or venous phases of the right and left cerebral arteries. Furthermore, the morphology of the left A1 infundibular dilatation is rough to delineate (Figure 3). More detailed structural evaluations were performed using the 3D-DSA. The 3D-DSA showed an outpouching lesion in the A1 segment of the left anterior cerebral artery with a conical shape and a broad base, with a 0.97 mm neck diameter and 0.78 mm in height (Figure 3), showing discrepancy compared to previous CTA measurements. The lesion arose at the junction with the anterior communicating artery (AcomA) and A2. The 3D-DSA also revealed a thin anterior branch from the apex of the lesion, which was not seen in the conventional DSA. These findings confirmed the diagnosis of infundibular dilatation.

DISCUSSION

Etiology & Demographics

Infundibular dilatation, also known as the funnel-shaped symmetrical enlargement in the origin of cerebral arteries, is a common incidental finding seen in 7 to 25% of otherwise normal angiograms [1-6]. The most common infundibular dilatation location arises from the posterior communicating artery (PcomA) [5-8]. Tarkianen et al., in their recent study, recorded 77 out of 97 patients (79.4%) having PcomA origin, with other uncommon locations at the anterior choroidal artery (6.2%) and the middle cerebral artery (4.1%). In this study, ACA origin (2.1%) was one of the rare infundibular dilatation sites among the anterior communicating artery, posterior cerebral artery, ophthalmic artery, and other internal carotid artery perforants [9]. Furthermore, Miyasaka et al. reported no infundibular dilatation discovered at ACA in their early studies [10]. Additionally, Yoshimura et al. and Kihira et al. documented unique examples of infundibular dilatation occurring at the accessory middle cerebral artery and the callosomarginal artery [11,12].

Differential Diagnoses

An outpouching vascular lesion occurring in the intracranial vascular system more often leads to the diagnosis of aneurysm. Intracranial aneurysm resulted from focal bulging of vessel wall, usually occurring at bifurcations of cerebral arteries in the circle of Willis [13]. The difficulty in distinguishing between aneurysm and infundibular dilatation at the origin of an artery is one of several pitfalls of CTA. In cases, such as when the branch originating from the tip is beyond the resolution of the CTA, it may be challenging to distinguish between an infundibular dilatation from a small aneurysm [14].

True aneurysm consists of the typical saccular type or the uncommon fusiform type. Several conditions, such as pseudoaneurysm following arterial dissection or dolichoectasia, might mimic aneurysms [15]. Intracranial saccular-type aneurism appears on DSA as a radioopaque, smooth-margined, saccular outpouching of the vascular structure. There is a wide variety of definitions for types of aneurysm size and neck. The UCAS classified aneurysms according to their size and the chance of rupture, which are small (<5 mm), medium (5 mm–10 mm), large (10 mm–25 mm), and giant (>25 mm) [16].

Clinical & Imaging Findings

Most infundibular dilatations remain asymptomatics and rarely cause severe events [17]. Some also considered infundibular dilatation to be pure variants of the normal cerebrovascular anatomy due to the absence of any histopathologic abnormalities [4,9,18]. Dmytriw et al. successfully followed-up infundibular dilatations in over 86 pediatric patient-years, showing no significant change in the infundibulum over time and without any internal evolution to aneurysm [19].

The identification of infundibular dilatation on noninvasive imaging techniques may be difficult due to its small structure and low vascular flow. However, when deciding a treatment option, it's critical to distinguish infundibular dilatation from aneurysm [1]. Digital subtraction angiography (DSA) has long been the mandatory modality for diagnosing cerebral vascular disorders [3]. The gold standard for diagnosing aneurysms is 3D rotational DSA (3D-DSA), which may be performed during a conventional catheter DSA but requires for a separate contrast injection. For this reason, if there is any uncertainty regarding whether an infundibular dilatation is an aneurysm, whether due to the structure or size, a DSA catheterization should be carried out for confirmation [3,7,20].

The angiographic criteria for diagnosis of infundibular dilatations are: (1) the maximum diameter is less than 4 mm; (2) the shape is funnel/conical or round, not saccular or irregular; (3) the infundibular widening has no aneurysm-like neck; and (4) presence of a branching vessel continuing from the apex of the lesion [6,9,21]. Thus, an infundibular dilatation should appear as a symmetrical bulge without a neck. In contrast, an intracranial aneurysm bulges asymmetrically from a well-defined neck [6]. Any lesion unfulfilling the criteria, such as a lesion with more than one branching vessel originating from the

lesion or branching vessel originating from the wall other than the apex, should be suspected as an aneurysmal lesion (Figure 4) [9].

Treatment & Prognosis

Most studies regarding infundibular dilatation did not state any need for treatment due to the excellent prognosis [17]. Despite that, several studies reported that an infundibulum may be considered as a potential source of future subarachnoid haemorrhage, where infundibulum could have been the primary site of rupture in cases without associated aneurysm [22]. On the other hand, aneurysm should be subjected to a more aggressive treatment, naturally having higher risk of rupture. Endovascular treatments e.g., coil embolization is preferred after evaluating the size of the aneurysm and the risk of complications [16].

TEACHING POINT

Cross-sectional imaging such as MRI, CTA, and at times, conventional DSA is sometimes not enough to delineate and define the diagnosis of a small outpouching vascular lesion. A 3D-DSA examination should be helpful in differentiating infundibular dilatations and true aneurysms, especially in uncommon locations.

QUESTION AND ANSWERS

1. Which is the most common clinical presentation of infundibular dilatation?
A. Headache
B. Asymptomatic (applies)
C. Dizziness
D. Tinnitus
E. Epistaxis

2. Below are imaging findings of infundibular dilatation, except …
A. Diameter is more than 3 mm (applies)
B. Most common shape found is saccular (applies)
C. The sac diameter is narrower than the neck
D. Presence of intralesional calcification (applies)
E. Symmetrical bulging

3. The most common location of infundibular dilatation is ...
A. Anterior communicating artery
B. Posterior communicating artery (applies)
C. Anterior cerebral artery
D. Middle cerebral artery
E. Callosomarginal artery

4. The following are the forms of true aneurysm, except …
A. Fusiform (applies)
B. Cone
C. Heart
D. Spiral
E. Saccular (applies)

5. Which is the best statement in describing the prognosis of infundibular dilatation?
A. Poor prognosis, even with aggressive treatment
B. Good prognosis with aggressive treatment
C. Good prognosis with life-long medications
D. Good prognosis without the need for any treatment, but with frequent observation for progression
E. Good prognosis even without routine observation or treatment (applies)

EXPLANATION

1. Which is the most common clinical presentation of infundibular dilatation?
A. Headache is one symptoms that might occur in infundibular dilatation, just as our case. However, it is not the most common clinical presentation. [Most infundibular dilatations remain asymptomatics and rarely cause severe events]
B. Most infundibular dilatations are asymptomatic [Most infundibular dilatations remain asymptomatics and rarely cause severe events]
C. Dizziness is one symptoms that might occur in infundibular dilatation, however, is not the most common clinical presentation. [Most infundibular dilatations remain asymptomatics and rarely cause severe events]
D. Tinnitus in infundibular dilatation has not yet been reported. [Most infundibular dilatations remain asymptomatics and rarely cause severe events]
E. Epistaxis in infundibular dilatation has not yet been reported. [Most infundibular dilatations remain asymptomatics and rarely cause severe events]

2. Below are imaging findings of infundibular dilatation, except …
A. Diameter of more than 3 mm should be considered for aneurysm. [The angiographic criteria for diagnosis of infundibular dilatations are: (1) the maximum diameter is less than 3 mm; (3) the shape is round or conical, not saccular or irregular and (2) the infundibular widening has no aneurysm-like neck]
B. The shape is usually round or conical, saccular shape is typical for aneurysm. [The angiographic criteria for diagnosis of infundibular dilatations are: (1) the maximum diameter is less than 3 mm; (3) the shape is round or conical, not saccular or irregular and (2) the infundibular widening has no aneurysm-like neck]
C. A narrower neck than the lesion dilatation should be suspected for aneurysm. [Thus, an infundibular dilatation should appear as a symmetrical bulge without a neck. In contrast, an intracranial aneurysm bulges asymmetrically from a well-defined neck]
D. Intralesional calcification in infundibular dilatation has not yet been reported. [The angiographic criteria for diagnosis of infundibular dilatations are: (1) the maximum diameter is less than 3 mm; (3) the shape is round or conical, not saccular or irregular and (2) the infundibular widening has no aneurysm-like neck]

E. Symmetrical bulging, creating a conical shape, is suggesting an infundibular dilatation. [Thus, an infundibular dilatation should appear as a symmetrical bulge without a neck. In contrast, an intracranial aneurysm bulges asymmetrically from a well-defined neck]

3. The most common location of infundibular dilatation is ...

A. Infundibular dilatation in the AcomA has been reported, but not the most common location. [Narducci et al. reported the case of an infundibular dilatation at an uncommon AcomA]

B. PcomA is the most common location of infundibular dilatation. [The most common infundibular dilatation location arises from the posterior communicating artery (PcomA)]

C. Our study is reporting infundibular dilatation in ACA. However, it is not the most common location. [Tarkiainen et al. reported only 2 cases out of 97 patient of infundibular dilatation originating from ACA, while Miyasaka et al. reported that no cases of infundibular dilatation were discovered at ACA in their early studies]

D. Infundibular dilatation in the MCA has been reported, but not the most common location. [Additionally, Yoshimura et al. and Kihira et al., also documented unique examples of infundibular dilatation occurring at the accessory middle cerebral artery and the callosomarginal artery]

E. Infundibular dilatation in the callosomarginal artery has been reported, but not the most common location. [Additionally, Yoshimura et al. and Kihira et al., also documented unique examples of infundibular dilatation occurring at the accessory middle cerebral artery and the callosomarginal artery]

4. The following are the forms of true aneurysm, except …

A. Fusiform type is the uncommon form of true aneurysm. [True aneurysm consists of the typical saccular type or the uncommon fusiform type.]

B. True aneurysm only consist of two type, saccular and fusiform. Hence, cone shaped is not suggesting a true aneurysm. [True aneurysm consists of the typical saccular type or the uncommon fusiform type.]

C. Heart-shaped aneurysm has not yet been reported. [True aneurysm consists of the typical saccular type or the uncommon fusiform type.]

D. Spiral-shaped aneurysm has not yet been reported. [True aneurysm consists of the typical saccular type or the uncommon fusiform type.]

E. Saccular type is the typical form of true aneurysm. [True aneurysm consists of the typical saccular type or the uncommon fusiform type.]

5. Which is the best statement in describing the prognosis of infundibular dilatation?

A. Infundibular dilatation has good prognosis even without any treatment. [Most studies regarding infundibular dilatation did not state any need for treatment due to the excellent prognosis]

B. Infundibular dilatation has good prognosis even without any treatment. [Most studies regarding infundibular dilatation did not state any need for treatment due to the excellent prognosis]

C. Infundibular dilatation has good prognosis even without any treatment. [Most studies regarding infundibular dilatation did not state any need for treatment due to the excellent prognosis]

D. Although progression to aneurysm or spontaneous rupture is possible, frequent examination for progression is not needed. [Most studies regarding infundibular dilatation did not state any need for treatment due to the excellent prognosis]

E. Infundibular dilatation does not need any treatment or frequent examination. [Most studies regarding infundibular dilatation did not state any need for treatment due to the excellent prognosis]

REFERENCES

1. McLaughlin N, Villablanca PJ, Jahan R, Martin NA. An infundibulum of thalamoperforator arteries: Importance of angiographic images for appropriate diagnosis. *Surg Neurol Int.* 2013; PMID: 23607066.

2. Epstein F, Ransohoff J, Budzilovich GN. The clinical significance of junctional dilatation of the posterior communicating artery. *J Neurosurg.* 1970; 33(5): 529–531. PMID: 5479491.

3. McKinney AM. Atlas of Normal Imaging Variations of the Brain, Skull, and Craniocervical Vasculature [Internet]. Cham: Springer International Publishing; 2017 [cited 2022 Dec 22]. Available from: http://link.springer.com/10.1007/978-3-319-39790-0

4. Narducci A, Ronchetti G, Nannucci F, Vaudano GP, Griva F. Infundibulum of Accessory Anterior Cerebral Artery: Rare, Likely Benign Malformation of Anterior Communicating Artery Complex to Keep in Mind. *World Neurosurg*. 2019; 132: 399–402. PMID: 31505294.

5. Yuan J, Li Z, Jiang X, et al. Hemodynamic and Morphological Differences Between Unruptured Carotid-Posterior Communicating Artery Bifurcation Aneurysms and Infundibular Dilations of the Posterior Communicating Artery. *Front Neurol.* 2020; 24;11:741. PMID: 32793106.

6. Pereira BJ, Holanda VM, de Holanda CV, de Oliveira JG. Intracranial aneurysm arising from infundibular dilation. *BMJ Case Rep.* 2013; PMID: 23904431.

7. Min KJ, Yoon DY, Kim HC, Lee JY, Cho BM. Infundibular dilation and aneurysm at the origin of the posterior communicating artery: differential diagnosis by CT angiography. Neuroradiology. 2014; 56(11): 917–923. PMID: 25103608.

8. Endo S, Furuichi S, Takaba M, Hirashima Y, Nishijima M, Takaku A. Clinical study of enlarged infundibular dilation of the origin of the posterior communicating artery. *J Neurosurg.* 1995; 83(3): 421–425. PMID: 7666216.

9. Tarkiainen J, Pyysalo L, Hinkka T, Pienimäki JP, Ronkainen A, Frösen J. Stability of infundibular dilatations: a single center follow-up study and systematic review of the literature. *Acta Neurochir (Wien).* 2024; 166(1): 48. PMID: 38286939.
10. Miyasaka K, Wolpert SM, Prager RJ. The association of cerebral aneurysms, infundibula, and intracranial arteriovenous malformations. *Stroke*. 1982; 13(2): 196–203. PMID: 7064191.
11. Yoshimura S, Somagawa C, Satoh K, et al. [A Rare Case of Ruptured/Unruptured Miniature Aneurysms Originating from the Infundibular Dilatation of the Callosomarginal Artery, Branching from the Infracallosal (A2) Segment of the Azygos Anterior Cerebral Artery]. *No Shinkei Geka.* 2017; 45(10): 897–904. PMID: 29046469.
12. Kihira S, Fifi JT, Doshi AH, Xuan D, Belani P. Infundibulum at the origin of an accessory middle cerebral artery. *Clin Imaging.* 2021; 72: 19–21. PMID: 33197712.
13. Acosta JM, Cayron AF, Dupuy N, et al. Effect of Aneurysm and Patient Characteristics on Intracranial Aneurysm Wall Thickness. *Front Cardiovasc Med*. 2021; PMID: 34957259.
14. Takhtani D. CT Neuroangiography: A Glance at the Common Pitfalls and Their Prevention. *AJR Am J Roentgenol.* 2005; 185(3): 772–783. PMID: 16120933.
15. Kurtelius A, Väntti N, Rezai Jahromi B, et al. Association of Intracranial Aneurysms With Aortic Aneurysms in 125 Patients With Fusiform and 4253 Patients With Saccular Intracranial Aneurysms and Their Family Members and Population Controls. J Am Heart Assoc. 2019; 8(18): e013277. PMID: 31538843.
16. Merritt WC, Berns HF, Ducruet AF, Becker TA. Definitions of intracranial aneurysm size and morphology: A call for standardization. *Surg Neurol Int.* 2021; PMID: 34754556.
17. Griffin AS, Oppong MD, Hauck EF. Infundibular Dilations and Subarachnoid Hemorrhage: to Treat or Not to Treat? *World Neurosurg.* 2019; 123: 188–92. PMID: 30576822.
18. Ebina K, Ohkuma H, Iwabuchi T. An angiographic study of incidence and morphology of infundibular dilatation of the posterior communicating artery. *Neuroradiology.* 1986; 28(1): 23–29. PMID: 3951684.
19. Dmytriw AA, Bisson DA, Phan K, et al. Locations, associations and temporal evolution of intracranial arterial infundibular dilatations in children. *J Neurointerv Surg.* 2020; 12(5): 495–498. PMID: 31699885.
20. Kim YJ, Yoon DY, Kim ES, et al. Geometric parameters on MRA source images to differentiate small Proximal Posterior communicating artery aneurysms from Infundibular dilation. *J Neuroimaging*. 2021; 31(3): 532–540. PMID: 33848017.
21. Fox JL, Baiz TC, Jakoby RK. Differentiation of Aneurism from Infundibulum of the Posterior Communicating Artery. *J Neurosurg*. 1964; 21(2): 135–138. PMID: 14113951.
22. Dowlati E, Rotter J, Zhou T, Jha RT, Armonda RA. Posterior communicating artery infundibulum with oculomotor nerve palsy treated with microvascular decompression: a case report and 2-dimensional technical operative video. *Br J Neurosurg.* 2020; 1–4.

FIGURES

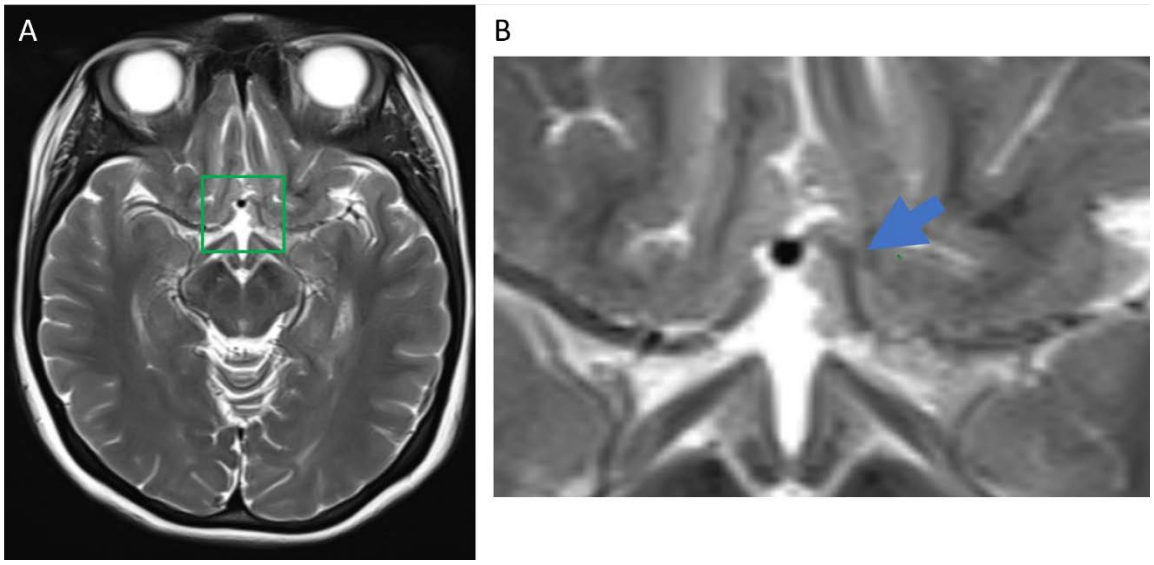

Figure 1: A 23-year-old female patient with infundibular dilatation of the A1 Segment of the Anterior Cerebral Artery
Findings: A1 segment of the left anterior cerebral artery (ACA) with suspected outpouching lesion (blue arrow).
Technique: Cerebral MRI, T2-WI sequence, axial plane (1A) with magnification (1B).

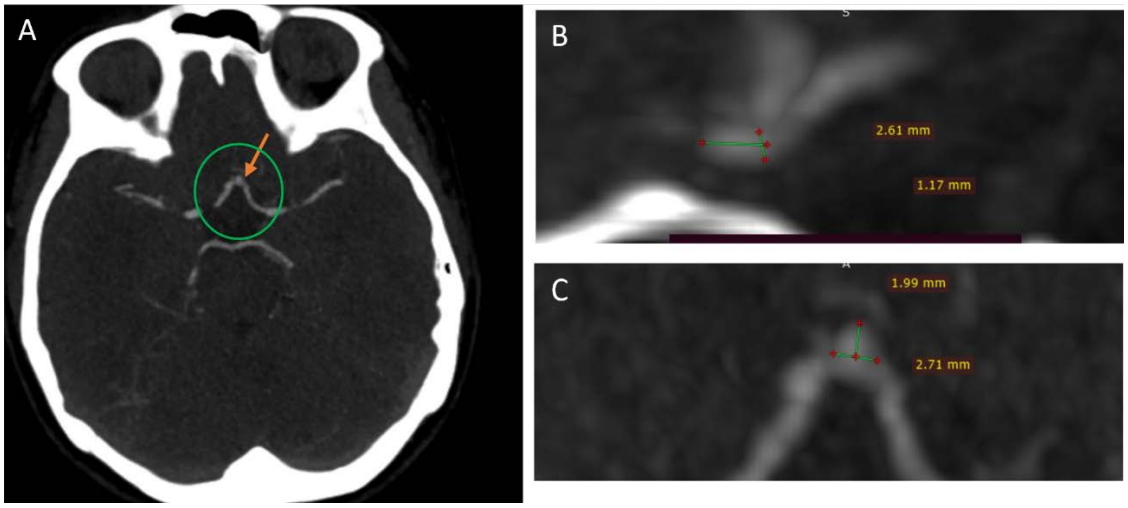

Figure 2: A 23-year-old female patient with infundibular dilatation of the A1 Segment of the Anterior Cerebral Artery
Findings: An outpouching lesion on left Anterior Cerebral Artery (ACA) at the A1 segment (green circle/orange arrow), which was suspected as a wide-neck aneurysm.
Technique: Cerebral CT Angiography, contrast enhanced, axial plane (1A), with magnification in the sagittal plane (1B) and the axial plane (1C), provided with measurements.

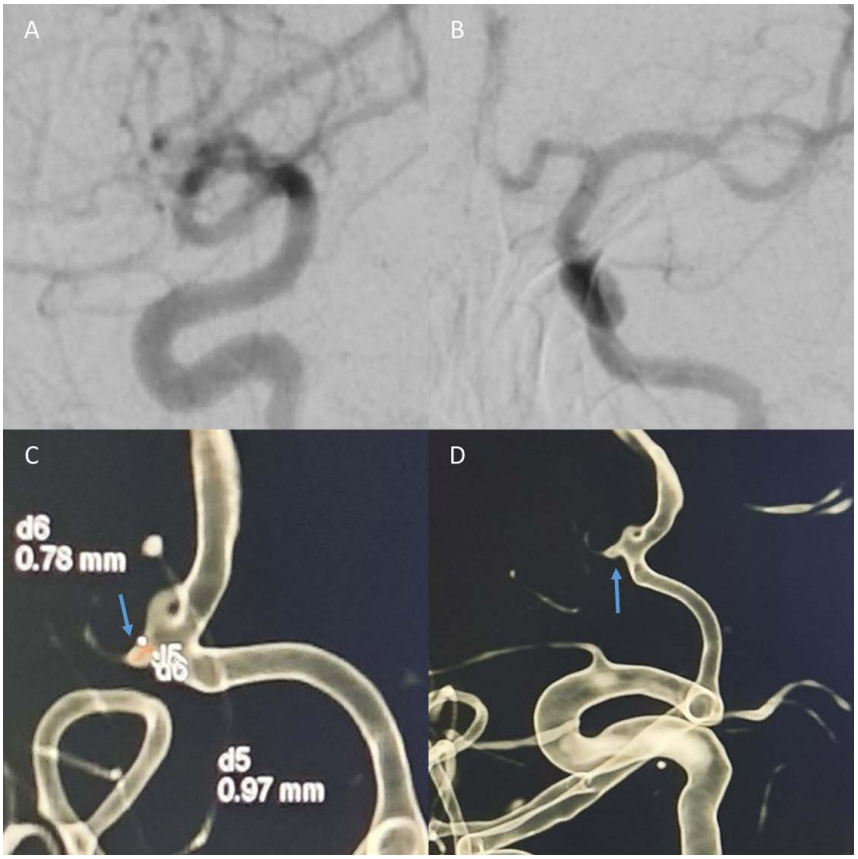

Figure 3: A 23-year-old female patient with infundibular dilatation of the A1 Segment of the Anterior Cerebral Artery
Findings: The morphology of the left A1 infundibular dilatation is hard to delineate with only using the conventional DSA (1A and 1B). Infundibular dilatation (blue arrow) was visible with the help of 3D-DSA with MIP reconstruction.
Technique: Conventional digital substraction angiography (DSA), anteroposterior projection (1A) and lateral projection (1B). Three dimensional DSA (3D-DSA) with maximum intensity projection (MIP) reconstruction (1C and 1D) and measurements (1C).

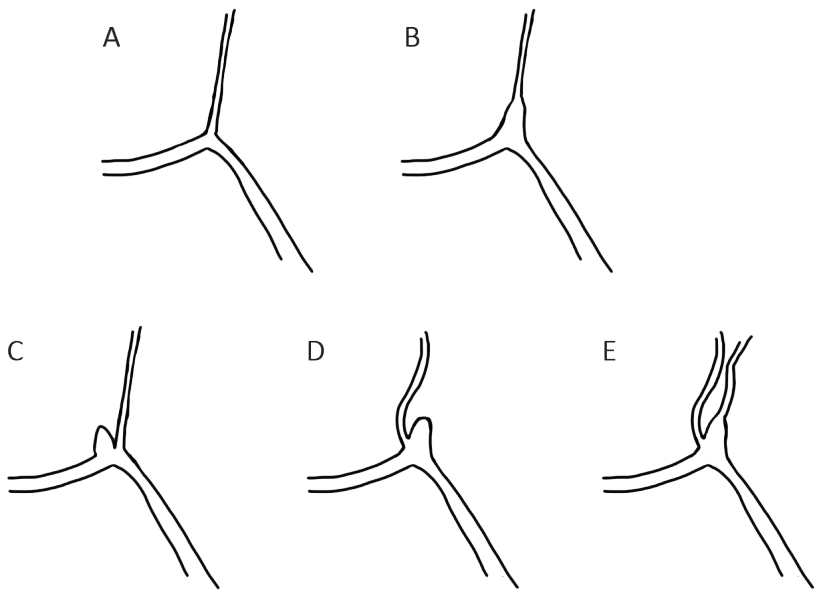

Figure 4: Illustration of normal vascular branching (A) compared to infundibular dilatation (B) with branching vessel originating from the apex. Figure C, D, and E illustrate lesions similar to infundibular dilatation, but considered to be aneurysm due to dilatation next to vascular branching (C), vascular branching not originating from the apex (D), and more than one vascular branching (E).

Table 1: Summary table of Infundibular Dilatation

Etiology	Infundibular dilatations might occur congenitally or due to developmental abnormalities in the cerebral vasculature.
Incidence	Incidental findings are common, around 7% to 25% of individuals undergoing cerebral angiography. Significant findings of non-cerebral infundibular dilatation have not yet been reported. Most common location is the posterior communicating artery.
Gender Ratio	Predilection in gender is not yet reported. Cases reported in studies are relatively equal between males and females.
Age Predilection	Most reports are incidental findings in adults. However, findings of all ages are possible.
Risk Factors	Specific risk factors are not well-defined, but abnormal vascular development conditions may play a role. Progression to the aneurysm is affected by disruption in normal vasculature (e.g., hypertension).
Clinical Symptoms	Usually asymptomatic but may present with headaches, neurological deficits, or compression symptoms in rare cases.
Imaging Findings	Appears in MRI, CTA, or DSA as symmetrical funnel-shaped outpouching in arterial walls, typically without a distinct neck.
Treatment	Often does not require any treatment unless symptoms are present or at risk of complications.
Prognosis	Generally favorable as most lesions stay asymptomatic without any progression. Progression to aneurysm or any complication (e.g., rupture) is very rare.

Table 2: Differential diagnosis table for Infundibular Dilatation

Differential Diagnosis	**Imaging Findings**
Infundibular Dilatation	- Symmetrical bulge without a distinct neck, typically appearing as a subtle outpouching on imaging studies such as MRI, CTA, or DSA. - Maximum diameter <4 mm. - Shape is funnel/conical or round, not saccular or irregular. - No aneurysm-like neck. - Presence of a single branching vessel originating from the apex of the lesion.
Aneurysm	- Asymmetrical bulging from a well-defined neck, often described as a "ballooning" of the vessel wall. - May appear as a saccular outpouching with smooth margins on DSA. - Classified based on size: small (<5 mm), medium (5 mm–10 mm), large (10 mm–25 mm), and giant (>25 mm).

KEYWORDS

Infundibular Dilatation, Infundibulum, 3D Digital Substraction Angiography, Aneurysm, Cerebrovascular Disorders,

ABBREVIATIONS

ACA = Anterior Cerebral Artery
AcomA = Anterior Communicating Artery
CTA = Computed Tomography Angiography
DSA = Digital Substraction Angiography
PcomA = Posterior Communicating Artery