Received: 13 February 2024 | Revised: 17 June 2024 | Accepted: 27 June 2024

DOI: 10.1002/ccr3.9202

CASE REPORT

Clinical Case Reports Open Access WILEY

# Challenges in identifying ruptured aneurysms in cases of multiple aneurysms: Utilizing MRI with contrast for surgical planning—A case report

Ehsan Mohammad Hosseini[1] | Saber Zafarshamspour[1,2] | Oday Atallah[3] | Alireza Rasekhi[4] | Abdolkarim Rahmanian[1] | Mohammad Jamali[1]

[1]Department of Neurosurgery, Shiraz University of Medical Sciences, Shiraz, Fars, Iran

[2]Department of Surgery, Rafsanjan University of Medical Sciences, Rafsanjan, Kerman, Iran

[3]Department of Neurosurgery, Hannover Medical School, Hannover, Germany

[4]Department of Radiology, Shiraz University of Medical Sciences, Shiraz, Fars, Iran

**Correspondence**
Saber Zafarshamspour, Department of Surgery, Rafsanjan University of Medical Sciences, Rafsanjan 7717933777, Kerman, Iran.
Email: saberzsp@gmail.com

**Key Clinical Message**

Accurately identifying the ruptured aneurysm in patients with subarachnoid hemorrhage and multiple aneurysms is critical to prevent rebleeding and optimize outcomes. Vessel wall MRI with contrast can aid in pinpointing the culprit aneurysm, informing a tailored surgical or endovascular management strategy for these complex cases. In patients with subarachnoid hemorrhage (SAH) and multiple intracranial aneurysms, MRI with contrast and DSA are crucial for identifying the ruptured aneurysm, guiding a shift from endovascular to microsurgical clipping. Successful single-session treatment and absence of postsurgical deficits highlight the effectiveness of a multidisciplinary approach. Further research on optimal strategies is needed.

**Abstract**

Multiple intracranial aneurysms make up approximately 20% of cases of aneurysmal SAH. In patients with aneurysmal SAH and multiple intracranial aneurysms, definite treatment of the ruptured aneurysm causing SAH is of the highest priority. However, identifying the bleeding source can be challenging, and it may not be recognizable by the hemorrhage pattern. Misdiagnosis and mistreatment of a ruptured aneurysm in a patient with multiple aneurysms can lead to bleeding recurrence and an undesirable outcome. We report a 65-year-old woman who presented with severe sudden onset headache. Neuroimaging studies revealed diffuse SAH and concurrent PICA and ACom aneurysm with triplicate A2. However, the ruptured aneurysm responsible for the patient's symptoms was not obvious based on routine neuroimaging studies. Magnetic resonance imaging with contrast was performed, revealing circumferential enhancement of the PICA aneurysm. In this report, we demonstrate the real-world effect of vessel wall MRI with contrast on decision-making regarding identifying the ruptured aneurysm and surgical planning in cases of multiple aneurysms. Furthermore, we show that MRI and aneurysm wall enhancement could be a promising option in detecting ruptured aneurysms in cases of multiple aneurysms.

**KEYWORDS**

aneurysmal subarachnoid hemorrhage, multiple intracranial aneurysms, ruptured aneurysm, vessel wall MRI

## 1 | INTRODUCTION

Aneurysmal subarachnoid hemorrhage (SAH) is a life-threatening condition that results from the rupture of an intracranial aneurysm. Up to 20% of patients with SAH have multiple intracranial aneurysms (MIAs), which pose a challenge in the definitive treatment of the ruptured aneurysm.[1] Identifying the bleeding source in patients with MIAs is crucial to prevent bleeding recurrence and improve outcomes.

Alexis Hadjiathanasiou et al. reported that size, shape, and location are essential factors in differentiating ruptured aneurysms.[1] In another study, size ratio was found to be the best predictor among individual morphologic attributes.[2] Daan Backe et al. concluded that size ratio ≥1.3 and irregular shape were associated with aneurysm rupture independent of aneurysm size and location, with the largest aneurysm not being the culprit in 29% of patients.[3] Matouk employed vessel wall MRI to study patients with SAH who had MIAs. They showed that enhancement in the wall of the aneurysms was associated with their rupture.[4] Another study demonstrated that focal aneurysm wall enhancement (AWE) accompanied by intramural thrombus of the aneurysms suggested the presence of rupture points.[5] Shunsuke Omodaka et al. reported that circumferential wall enhancement in the aneurysm is associated with rupture of intracranial aneurysm independent of aneurysm size and patient characteristics.[6] A recent meta-analysis on more than 500 aneurysms coming from six studies showed that aneurysm wall enhancement (AWE) was highly sensitive in screening unstable intracranial aneurysms (95%). Additionally, the absence of AWE was strongly associated with stability (negative predictive value of 96%).[7]

Definitive treatment of the ruptured aneurysm is of the highest priority in patients with aneurysmal SAH. However, identifying the bleeding source in patients with MIAs can be challenging and not recognizable by the hemorrhage pattern. Advances in imaging techniques, such as vessel wall MRI, have shown promising results in identifying the site of rupture in patients with MIAs. Further studies are needed to validate the diagnostic accuracy of these techniques and to determine their role in the management of patients with MIAs.

## 2 | CASE HISTORY/EXAMINATION

A 65-year-old woman with unremarkable past medical history presented to our center with a severe sudden onset headache. She was alert and oriented (Glasgow Coma Score: 15/15), and her neurological examination was unremarkable.

## 3 | METHODS

A brain computed tomography (CT) scan revealed diffuse SAH (Fisher grade 2), which was more prominent in the interpeduncular, crural cistern, and right Sylvian fissure (Figure 1). Brain CT angiography (CTA) revealed two aneurysms in the anterior medullary segment of the right posterior inferior cerebellar artery (PICA) and anterior communicating artery (ACom), with an anomalous anterior cerebral artery (triplicate A2 segment) (Figure 2). However, the pattern of SAH on the initial brain CT scan failed to identify the culprit aneurysm. In cases of ruptured anterior communicating artery aneurysms, SAH is more pronounced in the suprasellar cistern, third ventricle, and interhemispheric fissure, while in ruptured PICA aneurysms, SAH is more prominent in the fourth ventricle, medullary cistern, and posterior fossa. Therefore, we decided to perform MRI with contrast to identify the ruptured aneurysm based on the enhancement of the aneurysm walls. In the coronal plane, wall enhancement in the ACom aneurysm was limited to the dome, while the PICA aneurysm had circumferential wall enhancement (Figure 3).

Two days after her admission, a digital subtraction angiography (DSA) of the right vertebral artery was carried out, which showed that the PICA aneurysm had grown in comparison with the previously mentioned CTA. Primary coiling of the PICA was then carried out, achieving complete aneurysm occlusion (Figure 4). After coiling the PICA aneurysm, we focused on the ACom aneurysm. In a DSA carried out through the right internal carotid artery, we detected involvement of one of the A2 arteries in the aneurysm neck, which changed the management from endovascular to microsurgical clipping (Figure 5).

Two days after coil embolization of the PICA aneurysm, the patient underwent microsurgical clipping of the

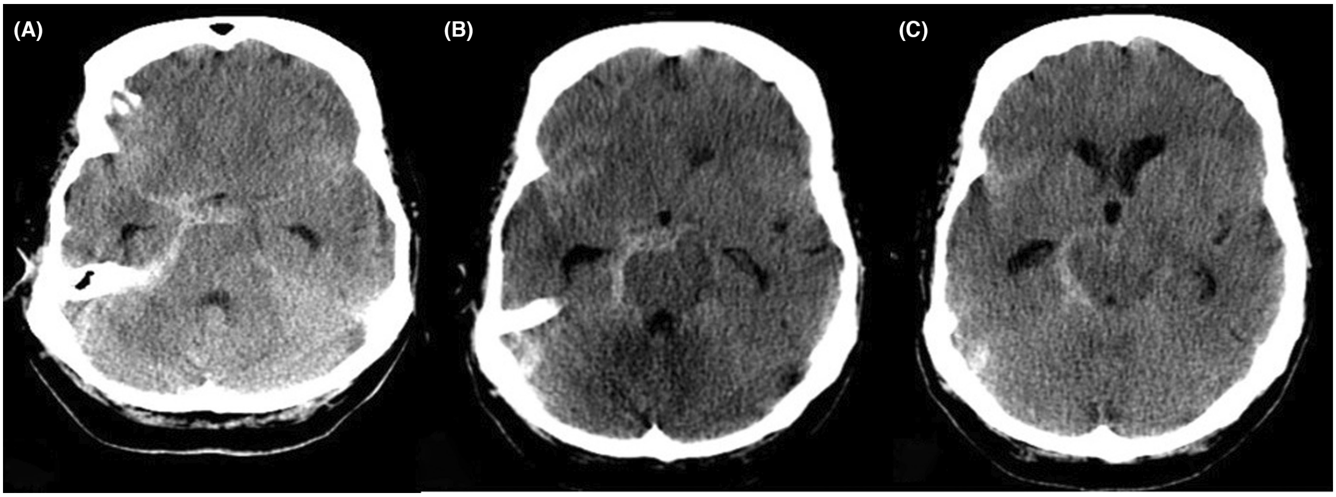


FIGURE 1 Diffuse subarachnoid hemorrhage (SAH) in the right Sylvian fissure, suprasellar cistern, interpeduncular and ambient cistern are shown. (A) SAH is visible in the prepontine and lateral medullary cistern. (B, C) SAH is visible in the interpeduncular and crural and right Sylvian cistern.

FIGURE 2 Brain CT angiography showing two aneurysms in the P1 segment of the right posterior inferior cerebellar artery and anterior communicating artery (ACom), with an anomalous anterior cerebral artery (triplicate A2 segment).

AComA aneurysm. Her head was fixed in a Sugita frame, and a 4×4 cm craniotomy through the right lateral supra-orbital approach was performed. The Sylvian fissure was widely dissected, and the AComA complex, including bilateral A1s, three A2s, right recurrent Heubner artery, AComA and aneurysm, were exposed. The proximal and distal aneurysm neck were then exposed and dissected from surrounding structures. There was no evidence in favor of rupture of the AComA aneurysm. Using a straight clip, we secured the aneurysm.

### 3.1 | Outcome and follow-up

Four days following microsurgical clipping, the patient was discharged home without any neurological deficit. Postoperative imaging of the AComA clip and brain CT scan revealed complete occlusion of the aneurysm and no visible infarction (Figure 6).

## 4 | DISCUSSION

MIAs are more prevalent in women and older patients. Patients with MIAs are generally more likely to have a hereditary susceptibility for IA, and longitudinal studies showed a higher rate of aneurysm growth.[8] Endovascular techniques might be a particularly suitable method for treating multiple intracranial aneurysms.[9]

Detecting ruptured aneurysms in patients with numerous intracranial aneurysms is a difficult task in clinical practice.[10] This requires the use of advanced diagnostic methods to effectively plan for surgery. Misdiagnosis of the culprit aneurysm can have severe consequences for the patient, such as rebleeding and death. Although aneurysms accompanied by anomalies in the ACom complex are more likely to be ruptured, this is not enough to single out the ruptured aneurysm.[11] Therefore, there is a pressing need for advanced imaging techniques that offer enhanced diagnostic accuracy.

However, digital subtraction angiography has been widely regarded as the most reliable method for seeing aneurysms.[12,13] However, DSA frequently fails to definitely determine which aneurysm has ruptured, particularly when the features of the bleeding are unclear or when the aneurysms are located close together.

High-resolution vessel wall imaging using MRI has emerged as a promising tool in the preoperative assessment. The intramural hematoma associated with recent rupture exhibits hyperintensity on

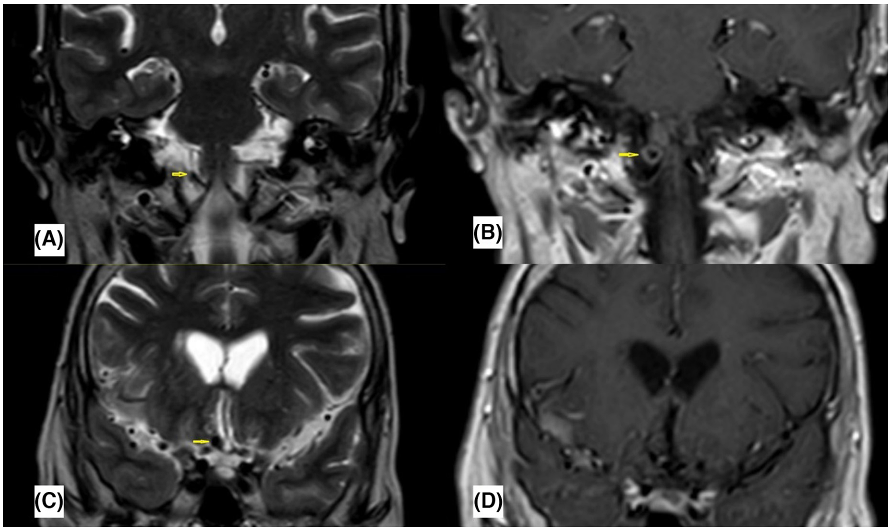


FIGURE 3 Coronal images of T2-weighted and T1-weighted MRI with gadolinium show (A, B) circumferential enhancement of the posterior inferior cerebellar artery aneurysm and (C, D) minimal enhancement of the ACom aneurysm.

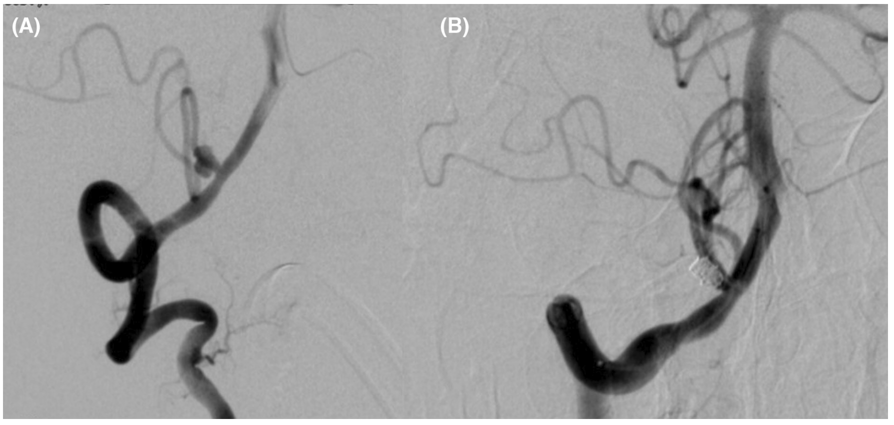


FIGURE 4 Digital subtraction angiography of the right vertebral artery demonstrates (A) pre-coiling and (B) post-coiling of the posterior inferior cerebellar artery.

FIGURE 5 Digital subtraction angiography, performed through the right internal carotid artery, shows involvement of one of the A2 arteries in the aneurysm neck, which changed the surgical management from endovascular to microsurgical clipping.

T1-weighted sequences post-contrast, providing valuable clues to identify the rupture site among multiple aneurysms.[14,15]

Moreover, there is a correlation between imaging features, such as enhancement patterns and artery wall characteristics shown on MRI, and the instability and risk of rupture in aneurysms. This correlation supports the use of these imaging features in guiding therapeutic decision-making. Incorporating vascular wall MRI into the diagnostic algorithm might greatly improve the ability to identify the site of the ruptured aneurysm, hence optimizing the surgical strategy to minimize further bleeding and optimize patient outcomes.[16,17]

In our case report, we demonstrated the utility of vessel wall MRI with contrast for surgical planning in instances involving multiple aneurysms. The high sensitivity of this imaging technique in distinguishing between ruptured and unruptured aneurysms allows for a more targeted and informed approach to treatment. Surgical planning benefits immensely from the ability to accurately identify the culprit aneurysm, guiding the selection of appropriate interventions and minimizing the risk of postoperative complications.

The application of MRI has uncovered morphological features that could differentiate between ruptured and unruptured aneurysms. For example, ruptured aneurysms often display irregular or lobulated contours and aneurysmal wall enhancement, associating these MR imaging features with recent rupture. Furthermore, the presence of a "daughter sac" or localized outpouching has also been associated with rupture points in aneurysms. MRI's ability to detail these characteristics without the invasiveness of DSA renders it an attractive adjunct, especially considering that the typical clinical sequence of computed tomography and CT angiography may not always clarify the rupture site.[7,18,19]

The primary limitations include variations in field strengths and scanning protocols, the frequent lack of blood suppression techniques, and the interval between gadolinium administration and subsequent post-contrast vessel wall imaging.

## 5 | CONCLUSION

This case report emphasizes the importance of identifying the site of rupture in patients with SAH and multiple intracranial aneurysms. The use of MRI with contrast and DSA proved to be useful in identifying the ruptured aneurysm and changing the surgical management from endovascular to microsurgical clipping. The successful treatment of both aneurysms in one session and the absence of neurological deficits post-surgery demonstrate the effectiveness of a multidisciplinary approach to the management of patients with multiple intracranial


**FIGURE 6** Postoperative CT angiography imaging confirms complete occlusion of the anterior communicating artery aneurysm.

aneurysms. Further studies are warranted to investigate the optimal treatment strategies for patients with SAH and multiple intracranial aneurysms.

## AUTHOR CONTRIBUTIONS

**Ehsan Mohammad Hosseini:** Conceptualization; investigation; supervision; writing – review and editing. **Saber Zafarshamspour:** Methodology; supervision; writing – original draft; writing – review and editing. **Oday Atallah:** Writing – review and editing. **Alireza Rasekhi:** Investigation; methodology; writing – review and editing. **Abdolkarim Rahmanian:** Investigation; methodology; supervision; writing – review and editing. **Mohammad Jamali:** Investigation; methodology; writing – review and editing.

## FUNDING INFORMATION

The author(s) received NO financial support for the preparation, research, authorship, and publication of this manuscript.

## CONFLICT OF INTEREST STATEMENT

The author(s) do NOT have any potential conflicts of interest for this manuscript.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## ETHICS STATEMENT

Ethical approval was waived by the local Ethics Committee of University in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.There is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

## CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

## ORCID

*Saber Zafarshamspour* https://orcid.org/0000-0003-0124-3752

## REFERENCES

1. Hadjiathanasiou A, Schuss P, Brandecker S, et al. Multiple aneurysms in subarachnoid hemorrhage – identification of the ruptured aneurysm, when the bleeding pattern is not self-explanatory – development of a novel prediction score. *BMC Neurol*. 2020;20(1):70.
2. Rajabzadeh-Oghaz H, Wang J, Varble N, et al. Novel models for identification of the ruptured aneurysm in patients with subarachnoid hemorrhage with multiple aneurysms. *AJNR Am J Neuroradiol*. 2019;40(11):1939-1946.
3. Backes D, Vergouwen MDI, Velthuis BK, et al. Difference in aneurysm characteristics between ruptured and unruptured aneurysms in patients with multiple intracranial aneurysms. *Stroke*. 2014;45(5):1299-1303.
4. Matouk CC, Mandell DM, Günel M, et al. Vessel wall magnetic resonance imaging identifies the site of rupture in patients with multiple intracranial aneurysms: proof of principle. *Neurosurgery*. 2013;72(3):492-496.
5. Matsushige T, Shimonaga K, Mizoue T, et al. Focal aneurysm wall enhancement on magnetic resonance imaging indicates intraluminal thrombus and the rupture point. *World Neurosurg*. 2019;127:e578-e584.
6. Omodaka S, Endo H, Niizuma K, et al. Circumferential wall enhancement on magnetic resonance imaging is useful to identify rupture site in patients with multiple cerebral aneurysms. *Neurosurgery*. 2018;82(5):638-644.
7. Texakalidis P, Hilditch CA, Lehman V, Lanzino G, Pereira VM, Brinjikji W. Vessel wall imaging of intracranial aneurysms: systematic review and meta-analysis. *World Neurosurg*. 2018;117:453-458.
8. Jabbarli R, Dinger TF, Darkwah Oppong M, et al. Risk factors for and clinical consequences of multiple intracranial aneurysms: a systematic review and meta-analysis. *Stroke*. 2018;49(4):848-855.
9. Shen X, Xu T, Ding X, Wang W, Liu Z, Qin H. Multiple intracranial aneurysms: endovascular treatment and complications. *Interv Neuroradiol*. 2014;20(4):442-447.
10. Guan J, Karsy M, Couldwell WT, et al. Factors influencing management of unruptured intracranial aneurysms: an analysis of 424 consecutive patients. *J Neurosurg*. 2017;127(1):96-101.
11. Dimitriu CP, Ionescu C, Bordei P, Bulbuc I. The role of anatomical anomalies in anterior communicating artery aneurysm rupture. *ARS Medica Tomitana*. 2013;19(3):147-153.
12. Sui RD, Wang CG, Han DW, et al. Application of computed tomography angiography for evaluating clinical morphology in intracranial aneurysms - monocentric study. *J Int Med Res*. 2020;48(4):300060519894790.
13. Bharatha A, Yeung R, Durant D, et al. Comparison of computed tomography angiography with digital subtraction angiography in the assessment of clipped intracranial aneurysms. *J Comput Assist Tomogr*. 2010;34(3):440-445.
14. Molenberg R, Aalbers MW, Appelman APA, Uyttenboogaart M, van Dijk JMC. Intracranial aneurysm wall enhancement as an indicator of instability: a systematic review and meta-analysis. *Eur J Neurol*. 2021;28(11):3837-3848.
15. Larson AS, Lehman VT, Lanzino G, Brinjikji W. Lack of baseline intracranial aneurysm wall enhancement predicts future stability: a systematic review and meta-analysis of longitudinal studies. *JNR Am J Neuroradiol*. 2020;41(9):1606-1610.
16. Morel S, Bijlenga P, Kwak BR. Intracranial aneurysm wall (in) stability-current state of knowledge and clinical perspectives. *Neurosurg Rev*. 2022;45(2):1233-1253.

17. Cannizzaro D, Zaed I, Olei S, et al. Growth and rupture of an intracranial aneurysm: the role of wall aneurysmal enhancement and CD68. *Front Surg*. 2023;10:1-10.
18. Wang X, Zhu C, Leng Y, Degnan AJ, Lu J. Intracranial aneurysm wall enhancement associated with aneurysm rupture: a systematic review and meta-analysis. *Acad Radiol*. 2019;26(5):664-673.
19. Santarosa C, Cord B, Koo A, et al. Vessel wall magnetic resonance imaging in intracranial aneurysms: principles and emerging clinical applications. *Interv Neuroradiol*. 2020;26(2):135-146.

**How to cite this article:** Hosseini EM, Zafarshamspour S, Atallah O, Rasekhi A, Rahmanian A, Jamali M. Challenges in identifying ruptured aneurysms in cases of multiple aneurysms: Utilizing MRI with contrast for surgical planning—A case report. *Clin Case Rep*. 2024;12:e9202. doi:10.1002/ccr3.9202