Radiology Case Reports 19 (2024) 2905–2910

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/radcr

Case Report

Endovascular embolization of Spetzler-Martin Grade I brain arteriovenous malformations: A case report on patient-centered neurointervention ☆,☆☆

Al Rasyid, MD, PHD[a,*], *Nita Widjaya, MD*[a], *Salim Harris, MD, PhD*[a], *Mohammad Kurniawan, MD*[a], *Taufik Mesiano, MD*[a], *Rakhmad Hidayat, MD, PhD*[a], *Adrian Ridski Harsono, MD*[a], *Setyo Widi Nugroho, MD, PhD*[b], *Reyhan Eddy Yunus, MD*[c], *Elvan Wiyarta, MD*[a]

[a] *Department of Neurology, Faculty of Medicine, Universitas Indonesia-RSUPN Cipto Mangunkusumo, 10430, Jakarta, Indonesia*
[b] *Department of Neurosurgery, Faculty of Medicine, Universitas Indonesia-RSUPN Cipto Mangunkusumo, 10430, Jakarta, Indonesia*
[c] *Department of Radiology, Faculty of Medicine, Universitas Indonesia-RSUPN Cipto Mangunkusumo, 10430, Jakarta, Indonesia*

ARTICLE INFO

Article history:
Received 27 February 2024
Revised 26 March 2024
Accepted 28 March 2024

Keywords:
Arteriovenous malformations
Embolization
Patient-centered care
Neurointervention
Neuroradiology
Vascular surgery
Case report

ABSTRACT

Brain arteriovenous malformations (AVM) present complex treatment decisions, particularly for low-grade AVM where surgical resection is often considered the standard. This case report emphasizes the importance of patient preferences and cultural considerations in selecting endovascular embolization over traditional surgical approaches for Spetzler-Martin Grade I AVM management, highlighting the evolving practice of patient-centered care in neurointervention. A 30-year-old male presented with recurrent seizures, characterized by a sudden onset of headache followed by speech arrest, without any preceding medical history of neurological deficits. Initial physical examination revealed no focal neurological deficits. Non-contrast computed tomography, magnetic resonance imaging, and magnetic resonance angiography suggested an AVM involving the cortical-subcortical regions of the left frontal lobe, measuring approximately 1.7 × 2.6 × 1.5 cm, fed by the left middle cerebral artery M3 segment, and draining into the superior sagittal sinus. Spetzler-Martin Grade I classification was confirmed via digital subtraction angiography. Given the patient's strong preference against invasive procedures, driven by personal and cultural beliefs, endovascular embolization was selected as the treatment strategy. Post-embolization, the patient showed marked symptomatic improvement with no evidence of residual AVM on

☆ Acknowledgments: None.
☆☆ Competing Interests: 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.
* Corresponding author.
E-mail address: al-rasyid@ui.ac.id (A. Rasyid).
https://doi.org/10.1016/j.radcr.2024.03.078

follow-up imaging, and no postprocedure complications were reported. This case highlights the importance of considering patient preferences in AVM treatment planning, illustrating that endovascular embolization can be an effective and less invasive alternative to surgery in selected patients, reinforcing the need for personalized, patient-centered approaches in neurointerventional care.

Introduction

Arteriovenous malformations (AVM) of the brain represent a complex and potentially life-threatening condition characterized by abnormal connections between arteries and veins, bypassing the capillary system [1]. This vascular anomaly can lead to serious complications, including intracranial hemorrhage, seizures, neurological deficits, and headaches, due to the high-flow shunting that disrupts normal brain parenchyma and increases the risk of rupture [1]. AVM are relatively rare, with an estimated prevalence of 10-18 per 100,000 adults and an incidence rate of approximately 1 per 100,000 person-years [2]. Despite their rarity, AVM are a significant cause of hemorrhagic stroke in the pediatric population and young adults, accounting for considerable morbidity and mortality. The overall mortality rate for patients with AVM ranges from 0.7% to 2.9% per year, underscoring the critical need for effective management strategies to mitigate the risks associated with this condition [2]. The clinical presentation of AVM is highly variable, with around 45% of cases presenting with hemorrhage, while up to 88% of patients may be asymptomatic, making the diagnosis, and management of AVM particularly challenging [2].

The management of brain AVM is complex and requires a multidisciplinary approach, tailored to the individual patient's clinical presentation, AVM characteristics, and the associated risks of treatment. The traditional treatment modalities include microsurgical resection, endovascular embolization, and stereotactic radiosurgery, either alone or in combination, depending on the Spetzler-Martin (SM) grade of the AVM, which assesses the risk of surgical intervention based on the size of the AVM, its location in relation to eloquent brain areas, and the pattern of venous drainage [3,4]. For low-grade (SM Grade I and II) AVM, microsurgery is often considered the treatment of choice due to its potential for immediate and complete nidus obliteration, thereby eliminating the risk of hemorrhage [4,5]. However, the choice of treatment modality is influenced by various factors, including the patient's clinical status, the AVM's anatomical characteristics, and, importantly, patient preferences and cultural considerations [6].

The importance of this case report lies in its illustration of a patient-centered approach to the management of a brain AVM. Despite the consensus that open surgery is the preferred treatment for low-grade AVM, such as SM Grade I [4], our case highlights a scenario where embolization was chosen over surgery due to the patient's cultural beliefs and fear of open surgery. This decision underscores the need for a personalized treatment strategy that considers not only the clinical and anatomical aspects of the AVM but also the patient's values, preferences, and socio-cultural context. This case contributes to the growing body of evidence supporting the feasibility and efficacy of endovascular embolization in carefully selected case of brain AVM, highlighting the importance of individualized patient care in the field of neurointervention.

Case illustration

A 30-year-old male presented to the outpatient clinic with a history of seizures, describing his initial episode 4 months before admission, characterized by left-sided headache followed by an inability to speak, awareness of his surroundings without vocalization, facial twitching towards the right, and maintained consciousness for approximately 3 minutes. Subsequent to this episode, the patient did not seek immediate medical attention. He denied any history of seizures, hypertension, diabetes, or stroke. There was no significant past medical or surgical history that could contribute to his current condition. The patient reported no use of regular medications prior to admission and denied any significant family history of neurological disorders or genetic conditions. Socially, he was employed as a courier, unmarried, with a history of smoking a pack of cigarettes weekly and occasional alcohol consumption, which he had ceased. Two months before admission, the patient experienced 2 similar seizure episodes, each lasting about 2 minutes. Following these incidents, he sought medical care.

Upon physical examination, the patient was alert and oriented, with normal vital signs. Neurological examination revealed no focal deficits, with intact cranial nerve function, normal muscle strength, and sensation throughout. There were no signs of meningeal irritation. His body mass index was within the normal range, and no psychosocial factors were identified that could impact his treatment or recovery.

A non-contrast head computed tomography (CT) scan (Siemens SOMATOM Definition AS scanner, Siemens Healthineers, Germany) showed a hyperdense lesion in the left parietal lobe accompanied by a hypodense lesion surrounding perifocal edema, which suggested an AVM with differential diagnosis of brain tumor (Fig. 1A), prompting further investigation with magnetic resonance imaging (MRI). The MRI (GE Signa HDxt 1.5T, GE Healthcare, United States) showed multiple flow voids with ischemic components and left frontal lobe hemorrhage due to AVM (Fig. 1B). The patient then referred to a tertiary hospital.

Upon referral to a tertiary hospital, MRI and magnetic resonance angiography (MRA) (GE Signa HDxt 1.5T, GE Healthcare, United States) confirmed the presence of an AVM involving

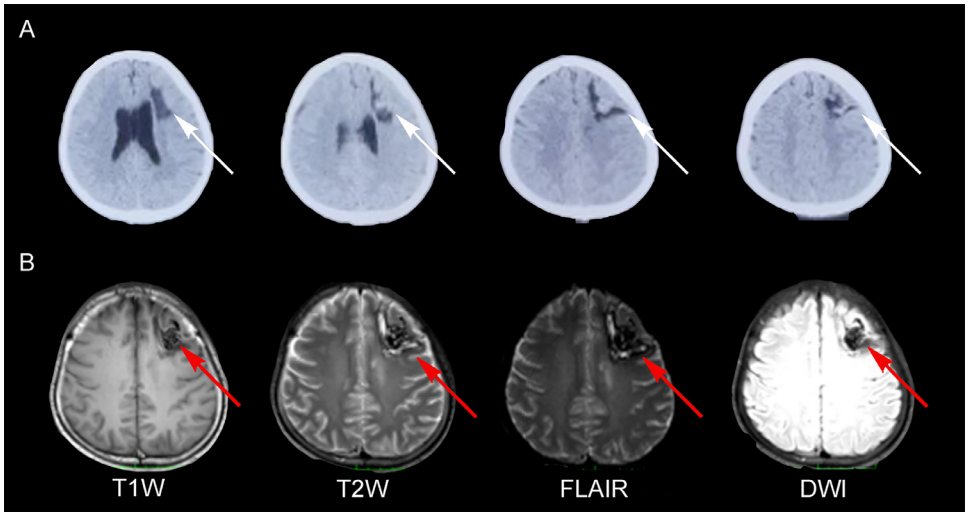

Fig. 1 – Initial imaging of the patient consists of (A) a serial CT scan showing a hyperdense lesion in the left parietal lobe accompanied by a hypodense lesion surrounding perifocal edema (white arrow), which suggested an AVM with differential diagnosis of brain tumor and (B) an MRI showing multiple flow voids with ischemic components and left frontal lobe hemorrhage (red arrow) due to AVM. AVM, arteriovenous malformation; CT, computed tomography; DWI, diffusion-weighted imaging; FLAIR, fluid-attenuated inversion recovery; MRI, magnetic resonance imaging; T1W, T1-weighted; T2W, T2-weighted.

the cortical-subcortical regions of the left frontal lobe, measuring approximately 1.7 × 2.6 × 1.5 cm, fed by the left middle cerebral artery (MCA) M3 segment, and draining into the superior sagittal sinus, classified as SM grade I (Figs. 2A and B). The patient was subsequently referred for further management.

Given the patient's young age, the symptomatic presentation, and the anatomical characteristics of the AVM, embolization was considered. Despite the low SM grade suggesting a preference for microsurgical resection in such cases, the patient expressed a strong aversion to open surgery, attributed to cultural beliefs and personal fears. Respecting the patient's preferences and considering the potential for a minimally invasive approach to provide a safe and effective alternative, the decision to proceed with endovascular embolization was made. Given the diagnosis of SM grade I AVM, embolization was recommended as the optimal treatment approach, respecting the patient's preference against open surgery due to cultural beliefs.

The procedure for the embolization involved the patient undergoing digital subtraction angiography (DSA) (Philips Azurion system, Philips Healthcare, Netherlands) to detail the AVM's architecture and confirm its suitability for embolization (Fig. 2C). Under local anesthesia and sedation, a femoral artery approach was utilized to introduce a 5 French guiding catheter into the cerebral vasculature. The catheter was navigated to the feeding arteries of the AVM under fluoroscopic guidance. Once in position, 2.7 French Marathon microcatheter (Medtronic, United States), was advanced through the guiding catheter into the nidus of the AVM. Ethylene-vinyl alcohol copolymer, a liquid embolic agent, was then carefully injected through the microcatheter to occlude the AVM nidus. The procedure was meticulously performed by an experienced interventional neuroradiologist, ensuring precise delivery of the embolic material to avoid non-target embolization and to minimize the risk of complications.

Post-embolization, imaging confirmed the successful reduction of the AVM nidus (Fig. 2D), highlighting the efficacy of the intervention. The patient was observed for a short period post-procedure in the neurointensive care unit and reported no immediate postoperative seizures or other complications. He was discharged with instructions to continue anticonvulsant therapy and scheduled for follow-up evaluations.

Three months postadmission, the patient reported a marked improvement in his symptoms, with no recurrence of seizures or headaches. Follow-up serial CT-scan imaging demonstrated no evidence of residual AVM or new hemorrhage, confirming the stability of the embolization outcome (Fig. 3). This outcome highlights the importance of considering patient preferences and cultural factors in the management of brain AVM. In this case, the patient's fear of open surgery and the cultural context significantly influenced the treatment decision-making process, underscoring the necessity of a personalized approach to care.

Discussion

In addressing the management of low-grade brain AVM, our case underscores the importance of a patient-centered approach, balancing traditional treatment paradigms with individual patient preferences and cultural considerations. This discussion draws upon a comprehensive review of the literature, emphasizing the evolving role of endovascular therapy and the imperative of respecting patient autonomy in treatment decisions.

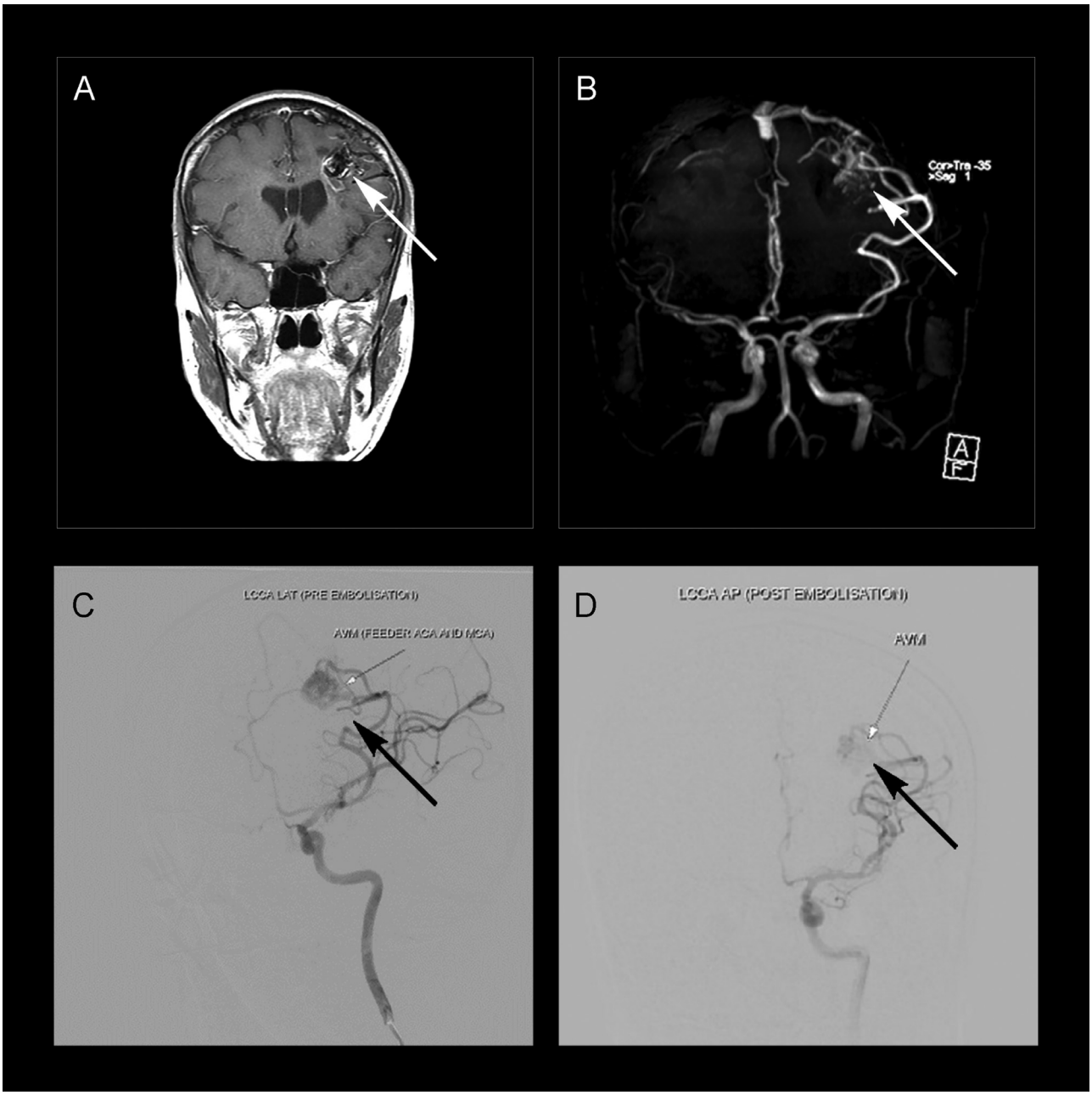

Fig. 2 – (A) MRI and (B) MRA confirmed the presence of an Spetzler-Martin grade I arteriovenous malformation involving the cortical-subcortical regions of the left frontal lobe (white arrow). DSA shows reduction of AVM nidus between (C) pre-embolization and (D) post-embolization (black arrow). AVM, arteriovenous malformation; DSA, digital subtraction angiography; MRA, magnetic resonance angiography; MRI, magnetic resonance imaging.

The indication for endovascular therapy in AVM management, particularly for low-grade (SM I–II) AVM, has gained traction as a primary therapeutic option or as an adjunct to microsurgery and radiosurgery. This shift is supported by the literature, which acknowledges the high cure rates and relatively low complication rates associated with microsurgical resection, while also recognizing the potential of endovascular treatment to offer a less invasive yet effective alternative for nidus obliteration [4,7]. Studies by Ikedo et al. (2023) and Lawton & Lang (2019) further illustrate the tailored approach to multimodal treatment, suggesting that personalized strategies, incorporating endovascular intervention, are both safe and effective for managing unruptured AVM [8,9].

The patient's autonomy and cultural preferences were taken into account while choosing endovascular therapy over more conventional surgical methods, which is crucial to our case. A Randomized trial of Unruptured Brain Arteriovenous malformations ARUBA trial emphasizes the intricate process

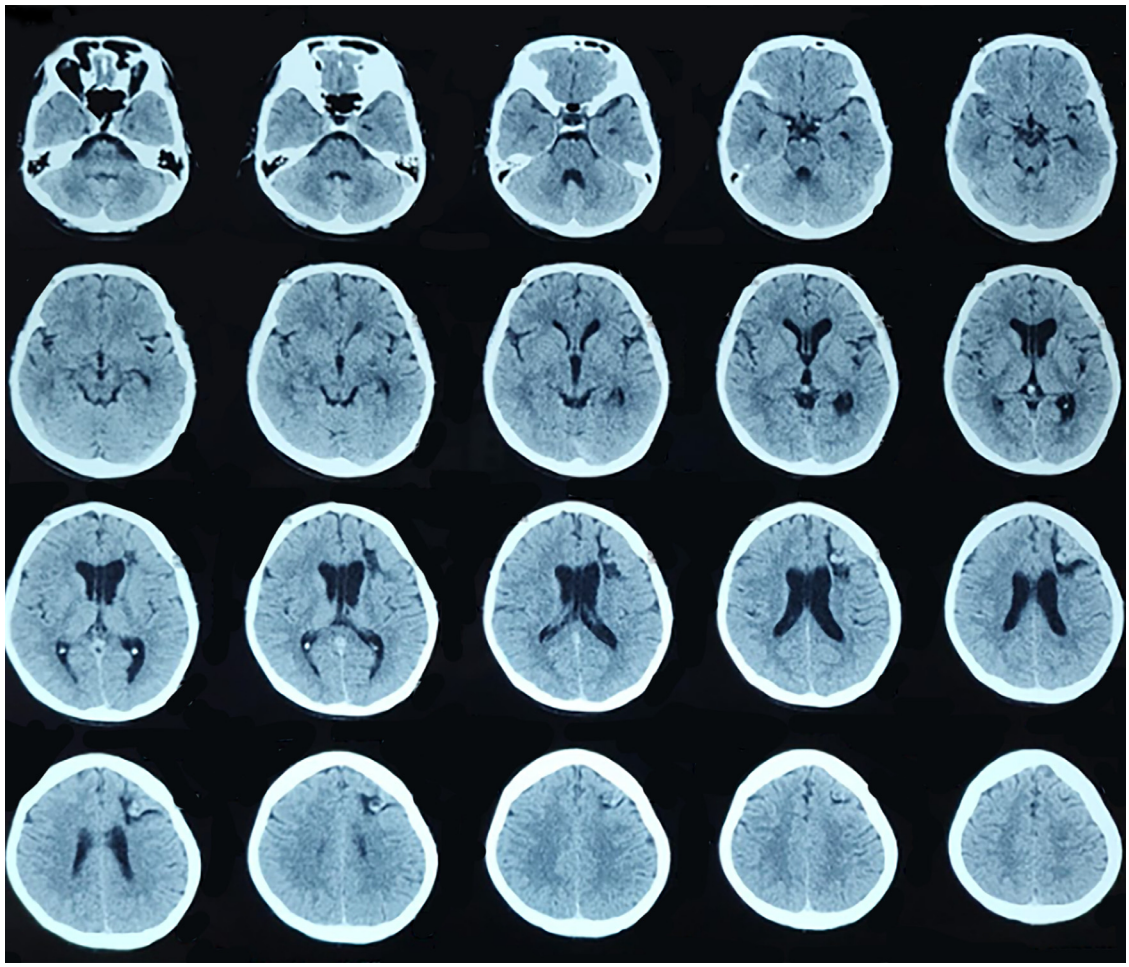

Fig. 3 – Follow-up serial CT-scan imaging demonstrated no evidence of residual AVM or new hemorrhage. AVM, arteriovenous malformation; CT, computed tomography.

of decision-making in the treatment of AVM, emphasizing the importance of aligning therapeutic options with patient values and socio-cultural contexts [8,9]. The increasing preference for percutaneous procedures in treating peripheral AVM, as demonstrated in a study conducted in England National Health Service [10], along with the potential of embolization as a primary therapy for small cerebral AVM [11], highlights the transition towards minimally invasive treatment options that are favored by patients.

Endovascular therapy, while less invasive, is not without its complications when compared to surgical therapy. Endovascular treatment may involve risks such as hemorrhagic complications, recanalization, or incomplete obliteration of the AVM, potentially requiring additional interventions [4]. Conversely, surgical resection, particularly for low-grade AVM, has a high success rate for complete nidus obliteration but comes with risks associated with open brain surgery, including infection, bleeding, and neurological deficits depending on the AVM's location [8]. The choice between these modalities requires careful consideration of these potential complications in the context of the AVM's characteristics and the patient's overall health and preferences.

Combining these viewpoints, our study highlights for an adaptable, patient-centered approach to AVM management. It emphasizes the significance of taking into account not only the clinical and structural factors of the AVM, but also the patient's personal preferences, fears, and cultural views during the treatment planning phase. This strategy is demonstrated in our specific situation, where the choice to pursue endovascular embolization was greatly impacted by the patient's preference, motivated by the fear of invasive surgery and cultural factors. This emphasizes the need for clinicians to engage in shared decision-making processes with their patients, ensuring that treatment strategies are not only evidence-based but also aligned with patient values, preferences, and cultural contexts.

The limitation of our case is its singular focus, which may not capture the full spectrum of outcomes and experiences of all patients undergoing endovascular treatment for low-grade AVM. While this case provides valuable insights into the efficacy and patient satisfaction associated with endovascular embolization, especially in the context of patient autonomy and cultural preferences, it is important to acknowledge that individual results may vary. Furthermore, the long-term out-

comes and potential for AVM recurrence following embolization require ongoing study to fully understand the durability of this treatment approach.

Conclusion

In conclusion, our case and the supporting literature collectively advocate for a patient-centered approach to the management of brain AVM, highlighting the evolving paradigms of patient-centered care in neurosurgery and interventional neuroradiology. This approach not only ensures optimal clinical outcomes but also respects the individuality of patient values and preferences in the complex landscape of AVM treatment.

Ethics approval and consent to participate

The University of Indonesia Institutional Review Board, approved the report protocols, with protocol number KET-9/UN2.F1/ETIK/PPM.00.02/2023, in January 2024. Informed consent for participation was obtained from all subjects involved in the study.

Availability of data and materials

All data generated or analyzed during the study are included in this published article.

Patient consent

Informed consent for publication was obtained from all subjects involved in the study.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2024.03.078.

CRediT authorship contribution statement

Al Rasyid: Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. **Nita Widjaya:** Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Salim Harris:** Validation, Resources, Writing – review & editing. **Mohammad Kurniawan:** Validation, Resources, Writing – review & editing. **Taufik Mesiano:** Validation, Resources, Writing – review & editing. **Rakhmad Hidayat:** Validation, Resources, Writing – review & editing. **Adrian Ridski Harsono:** Validation, Resources, Writing – review & editing. **Setyo Widi Nugroho:** Validation, Resources, Writing – review & editing. **Reyhan Eddy Yunus:** Validation, Resources, Writing – review & editing. **Elvan Wiyarta:** Methodology, Software, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration.

REFERENCE

[1] Shaligram SS, Winkler E, Cooke D, Su H. Risk factors for hemorrhage of brain arteriovenous malformation. CNS Neurosci Ther 2019;25(10):1085–95.

[2] Bazarde HA, Wenz F, Hänggi D, Etminan N. Radiosurgery of brain arteriovenous and cavernous malformations. In: Wenz F, editor. Radiation oncology. Cham: Springer International Publishing; 2019. p. 1–19.

[3] Derdeyn CP, Zipfel GJ, Albuquerque FC, Cooke DL, Feldmann E, Sheehan JP, et al. Management of brain arteriovenous malformations: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2017;48(8):e200–ee24.

[4] Baharvahdat H, Blanc R, Fahed R, Smajda S, Ciccio G, Desilles JP, et al. Endovascular treatment for low-grade (Spetzler-Martin I-II) brain arteriovenous malformations. AJNR Am J Neuroradiol 2019;40(4):668–72.

[5] Alfter M, Albiña-Palmarola P, Cimpoca A, Díaz-Peregrino R, Jans P, Ganslandt O, et al. Multi-stage treatment for spetzler-martin grades iii, iv, and v arteriovenous malformations: preoperative embolization and microsurgical resection in a consecutive series of 250 patients. J Clin Med 2023;12(18):59–90.

[6] Morel BC, Wittenberg B, Hoffman JE, Case DE, Folzenlogen Z, Roark C, et al. Untangling the modern treatment paradigm for unruptured brain arteriovenous malformations. J Pers Med 2022;12(6):904.

[7] Razavi SAS, Mirbolouk MH, Gorji R, Ebrahimnia F, Sasannejad P, Zabihyan S, et al. Endovascular treatment as the first-line approach for cure of low-grade brain arteriovenous malformation. Neurosurg Focus 2022;53(1):E8.

[8] Ikedo T, Yamamoto EH, Mori H, Niwa A, Ozaki S, Kushi Y, et al. Impact of tailored multimodal treatment for unruptured brain arteriovenous malformation: comparison with a randomized trial of unruptured brain arteriovenous malformations. Acta Neurochir (Wien) 2023;165(12):3779–85.

[9] Lawton MT, Lang MJ. The future of open vascular neurosurgery: perspectives on cavernous malformations, AVM, and bypasses for complex aneurysms. J Neurosurg 2019;130(5):1409–25.

[10] Arasakumar D, Brookes J, Hamilton G, Tsui J, Lim CS. The trend of percutaneous and open surgical procedures for peripheral arteriovenous malformations in the National Health Service England. Ann R Coll Surg Engl 2022;104(9):661–6.

[11] Kocur D, Przybyłko N, Hofman M, Jamróz T, Ignatowicz A, Baron J, et al. Endovascular treatment of small cerebral arteriovenous malformations as a primary therapy. Pol J Radiol 2018;83:e143–ee50.