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Profile of Cerebral Arteriovenous Malformations at Dr. Saiful Anwar Hospital Malang: A Multi-Modality Epidemiologic Study

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ABSTRACT

Introduction: Brain arteriovenous malformations (AVMs) are congenital abnormalities in which direct connections form between arteries and veins, bypassing the capillary network and resulting in significant hemodynamic disturbances. This abnormal vascular architecture increases the risk of life-threatening intracranial hemorrhage. The diagnosis and management of brain AVMs are challenging due to their variability in size, location, and vascular supply. Accurate assessment requires advanced imaging modalities such as CT, MRI, and DSA, combined with the Spetzler-Martin (S-M) classification for risk stratification. Epidemiological studies are important for guiding clinical decisions. This study aims to describe the demographic, clinical characteristics, and imaging findings of brain AVMs patients at Dr. Saiful Anwar Hospital, Malang.

Material and Methods: A retrospective descriptive study using radiology records from September 2020 to August 2024, including all patients diagnosed with brain AVMs who underwent CT, MRI, or DSA imaging.

Results: The majority of patients were male (69.6%), and the largest age group was ≥50 years (36.9%). The most common presenting symptom was neurological deficit (47.8%), followed by headache (30.4%) and seizure (21.8%). S-M grading varied by imaging modality, CT most frequently detected grade III, MRI identified grades III–V, while DSA most often revealed grade I.

Conclusion: Cerebral AVMs are more commonly treated in males and individuals aged ≥50 years. The main symptoms are neurological deficits, headaches, and seizures. A multimodal approach is essential for diagnosis and management.

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INTRODUCTION

Cerebral arteriovenous malformations (AVMs) are congenital vascular disorders characterized by an abnormal collection of arteries and veins in the brain that are interconnected in the absence of capillary tissue between them, thus forming a high-flow, low-resistance channel between the arterial and venous systems. In addition to changes in the structure of blood vessels, this condition also causes significant hemodynamic disorders, such as venous backflow, venous hypertension, and hypoperfusion of the brain area around the lesion. Although cerebral AVMs can vary in the size and structure of their blood vessels, cases of multiple cerebral AVMs in a single patient are very rare. When compared to other brain vascular disorders, such as aneurysms, AVMs have a lower incidence rate, which is about 1.12-1.34 per 100,000 people per year. AVMs usually present with symptoms of intracranial bleeding (30–70%), seizures (10–30%), or headaches; alternatively, they may be found incidentally (0–15%). If left untreated, the annual risk of rupture is 1–3% [1–4].

The Spetzler-Martin (S-M) classification is used to assess AVMs based on size, involvement of important brain areas (eloquent), and type of venous drainage. AVM sizes are rated 1, 2, or 3 points for <3 cm, 3-6 cm, or >6 cm diameters; eloquent area engagement gets 1 point; and drainage through the deep vein system also

gets 1 point. This classification plays an important role in determining management. In ruptured AVMs, hemodynamic stabilization is a priority before definitive treatment such as microsurgery, embolization, or radiosurgery. According to the S-M classification, AVMs with grades I-II usually require only one treatment modality, whereas grade III AVMs require a multimodal approach. Grades IV-V AVMs are generally managed conservatively [2,5].

The diagnosis and management of AVMs is particularly challenging due to the anatomical complexity and angioarchitectural variations of each case, which involve the location, size, supply of arteries, as well as venous drainage patterns [6–10]. Thus, epidemiological studies are needed to provide empirical data that will strengthen the diagnostic process and support the development of management strategies and more effective AVM therapies in the future.

MATERIAL AND METHODS

This retrospective descriptive study analysed patient medical records at Dr. Saiful Anwar Hospital's radiology department in Malang between September 2020 and August 2024. The population included all patients suspected of having cerebral vascular malformations who had undergone CT scans, MRIs or DSAs. A total non-probability sample was taken, with patients diagnosed with cerebral AVM included and those with non-AVM cerebral vascular malformations excluded. Data were collected through a review of medical records to identify demographic characteristics, clinical symptoms, and imaging findings. Descriptive analysis was performed to map the case profile and gradation stratification using the S-M classification.

RESULTS

The study included 46 patients, with data collected from September 2020 to August 2024 at Dr. Saiful Anwar Hospital in Malang. Patient details, clinical symptoms, and imaging results from head CT, MRI, and cerebral DSA were recorded. As shown in Table 1, the research subjects were predominantly male (69.6%) compared to female (30.4%). The minimum age range included patients aged ≤19 years (13.1%) and 40–49 years (13.1%), while the majority were ≥50 years old (36.9%).

The clinical symptoms observed in the study subjects included headaches, seizures, and neurological deficits, specifically limb weakness (paresis) and altered consciousness. According to Table 2, neurological deficits were the most prevalent clinical symptom, affecting 22 patients (47.8%). Of these patients, 12 (54%) had paresis and 10 (45.5%) had decreased consciousness. Headaches were reported by 14 patients (30.4%), while seizures occurred in 10 patients (21.8%).

Table 1. Demographic Characteristics of Research Subjects by Gender and Age (n=46)

Variabel		Frequency	Total (%)
Gender	Male	32	69.6
	Female	14	30.4
Age (Years)	≤ 19	6	13.1
	20-29	7	15.2
	30-39	10	21.7
	40-49	6	13.1
	≥ 50	17	36.9

Table 2. Clinical Symptoms of Study Subjects (n=46)

Clinical Symptoms	Frequency	Total (%)
Headache	14	30.4
Stiff	10	21.8
Neurological Deficit	22	47.8
– Palsy	12	54.5
– Decreased consciousness	10	45.5

The degree of AVM in patients was determined using the S-M classification, based on radiological examinations. The S-M scale ranges from grades I to V. Radiological examinations were divided into three modalities: CT scan, MRI, and DSA. CT scans included head CT with contrast and CT angiography of the head. MRI included head MRI with contrast and MRI angiography of the head. DSA in this study referred specifically to brain DSA. A total of 55 radiological examinations were performed: 31 CT scans, 18 MRIs, and 6 DSA procedures. Some patients underwent examinations using two different modalities: three patients had both CT and MRI, four had both CT and DSA, and two had both MRI and DSA.

Table 3 shows that CT scan results revealed AVM grade I in 9.7% (3 cases), grade II in 35.5% (11 cases), and grade III in 54.4% (17 cases). No cases of grade IV or V were observed. MRI results showed AVM grade I in 16.7% (3 cases), grade II in 33.4% (6 cases), grade III in 38.9% (7 cases), grade IV in 5.5% (1 case), and grade V in 5.5% (1 case). Meanwhile, the DSA examination revealed an AVM of grade I in 66.6% (4 cases), grade II in 16.7% (1 case) and grade IV in 16.7% (1 case). There were no cases of grade III or V.

DISCUSSION

The profile of cerebral AVM cases at Dr. Saiful Anwar Hospital in Malang from September 2020 to August 2024 shows a dominance of males, with 32 cases

Table 3. Grading AVM according to S-M Classification based on Radiological Examination Modality

Klasifikasi Spetzler-Martin	Modalities					
	CT scan		MRI		DSA	
	(frequency and amount in %)					
Grade I	3	9.7	3	16.7	4	66.6
Grade II	11	35.5	6	33.4	1	16.7
Grade III	17	54.8	7	38.9	0	0
Grade IV	0	0	1	5.5	1	16.7
Grade V	0	0	1	5.5	0	0

(69.6%) compared to 14 cases (30.4%) in females (Table 1). These findings are in line with a study by Darlan et al. (2021) at the National Brain Center Hospital, which noted a higher prevalence of AVM in males (62.5%) during 2015–2016 [2]. Similar results were also reported by Tong et al. (2016) in a study at Beijing Tiantan Hospital in China, on 3,299 AVM patients during 1980–2015, which showed a higher prevalence in males (64.4%) than females (35.6%) [11]. This suggests that cerebral AVMs tend to be more common in males in different populations [12–14]

The findings of this study indicated that the highest incidence of cerebra longl AVMs was observed in the ≥50 age group (36.9%). This finding is in contrast to the results of earlier studies by Darlan et al. (2021) and Tong et al. (2016), which reported the highest prevalence in the 20–29 age group [2,11]. In their meta-analysis, Gross and Du (2013) stated that, although AVMs can manifest from a young age, the timing of the first bleed can vary significantly and does not always occur in the early decades of life. This observation suggests that a significant proportion of AVMs may remain undiagnosed until adulthood or old age, particularly in cases where they do not manifest noticeable symptoms [15].

In this study, neurological deficits were the most prevalent clinical symptom in cerebral AVM patients, documented in 22 cases (47.8%), manifesting as paresis (54% of deficits) and decreased consciousness (45.5%). Headaches followed, reported by 14 patients (30.4%), while seizures occurred in 10 patients (21.8%). These findings align with Toader et al. (2024), who identified neurological deficits, headaches, and seizures as hallmark AVM symptoms [16]. Headaches are frequently attributed to elevated intracranial pressure or mass effects of AVMs. Seizures, conversely, may be precipitated by cortical irritation or local ischaemia, which is triggered by the phenomenon of vascular steal [16–18].

The utilisation of multimodalities in this study, encompassing CT scan, MRI, and DSA, demonstrates a comprehensive diagnostic approach. A CT scan is a widely utilised diagnostic tool for initial screening, with a focus on detecting acute bleeding. An MRI is renowned for its ability to effectively visualise soft tissues and the anatomical structures surrounding the nidus. On the other hand, DSA is regarded as the gold standard for conducting a detailed characterisation of AVMs and for planning interventions in treatment. The combination of these modalities is of significant importance due to the fact that each possesses specific advantages. MRI is highly sensitive to the identification of small lesions and their relationship to functional brain tissue, while DSA allows for real-time and highly detailed vascular mapping, which is crucial for determining management strategies and evaluating the risk of bleeding. This evidence-based multimodal approach is now a key recommendation in the management of cerebral arteriovenous malformations (AVMs). This approach ensures the accuracy of diagnostic assessments and the efficacy of therapeutic interventions, enhancing patient safety [7,19,20].

The distribution of AVM grading based on imaging modalities at Dr. Saiful Anwar General Hospital in Malang is varied. CT scans identify the majority of AVMs as grade II and III. CT scans have limitations in detecting AVMs with high complexity, especially those involving eloquent areas or deep venous drainage. Research by Lin et al. (2016) confirms that CT sensitivity in detecting AVMs is lower than MRI, especially for small lesions or those located in areas that are difficult to visualize optimally [21]. Instead, MRI detects all grades of AVM, including detection in grades IV and V. This aligns with the findings of Vella et al. (2020), who reported that MRI has a sensitivity of 80% and specificity of 94.4% in detecting AVMs, making it an effective screening modality prior to confirmation with DSA [22].

DSA as the gold standard in vascular evaluation of AVMs shows the dominance of grade I AVMs of 66.6%, followed by grades II and IV, without the discovery of grade III or V. The advantage of DSA comes from its high spatial resolution and real-time visualization of vascular anatomy, including arterial supply and venous drainage patterns, which are crucial for grading and planning interventional therapy. However, the absence of a grade V in DSA in this study may be due to the characteristics of the sample A multimodal imaging

approach that combines the rapid detection of bleeding provided by CT scans, the soft tissue detail of MRI, and the vascular accuracy of DSA is highly recommended for the comprehensive diagnosis and management of AVMs, in order to minimize the risk of complications and improve patient clinical outcomes [23–25].

CONCLUSION

The case profile of cerebral AVMs at Dr. Saiful Anwar General Hospital in Malang from September 2020 to August 2024 shows that AVMs are more commonly found in male patients and those aged ≥50 years. The most dominant clinical symptoms are neurological deficits, followed by headaches and seizures. A multimodal approach utilizing CT scans, MRI, and DSA plays a role in diagnosis and grading of AVMs, with DSA remaining the gold standard for detailed evaluation of vascular anatomy. These findings emphasize the importance of combining imaging modalities in the management of cerebral AVMs to ensure accurate diagnosis and optimal therapeutic planning.

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CONFLICT OF INTEREST

The authors declare there is no conflict of interest for this research.

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