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Original Research Paper

Neurosurgery

AN INSTITUTIONAL EXPERIENCES – ARTERIO VENOUS MALFORMATION (AVM) SURGERY

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ABSTRACT

Objective- To evaluate the outcomes of surgical treatment for brain AVM at a single institution **Methods-** This retrospective single-center case series enrolled the patients who underwent surgical treatment of AVM at the Neuro Care Hospital Jaipur, between 2013 and 2022. Data were collected on patients demographic, clinical presentation, AVM characteristics, SM grading and post operative outcome. **Results-** Fifty six patients were enrolled. The majority of AVMs were of Spetzler-Martin grade II (57.14%), localized supratentorialy (n = 46; 86%). A total resection was performed in 56 patients (100 %), and the 6-month outcome was good in 43 patients (77%), moderate disability was present in 10 patients (18%), and death occurred of 3 patient (5%) **Conclusion-** AVM are difficult to treat and treatment decision should be individualized. Microsurgery is the best method to treat the majority of AVMs (S-M grade I to III) with a low mortality and morbidity, when precisely planned and performed by an expert.

KEYWORDS :

INTRODUCTION

Cerebral arteriovenous malformations (AVMs) are congenital abnormalities of cerebral vessels, forming a nidus which directly shunts arterial blood to the venous system. The symptoms including as intracerebral hemorrhage or subarachnoid hemorrhage, seizures, headache or focal neurological deficit (1). Rupture of AVMs is associated with a high morbidity (80%), and the mortality rate is 10%-30% (2). Permanent neurological deficit may be present in up to 42% of patients, while only 33% of patients survive bleeding without neurological deficit (3). The annual risk of AVM rupture is 2%-4% in the case of intact AVMs, and in the case of ruptured AVMs, the risk of re-rupture increases to 6%-8% during the first year and then slowly decreases (4, 5).

Pathology

Macroscopically, there are three segments which forming arteriovenous malformation: (1) arterial feeders, (2) nidus and (3) draining veins. Nidus is the main part of AVM which connected directly feeder arteries and draining vein without formed capillary network. (6).

Microscopically AVM is composed of clusterized and abnormally muscularized arterial feeders which may have duplications or destructions of elastic laminae, veins of different diameter and wall thickness, blood vessels of indeterminate characteristics which can be formed only of fibrous tissue or may have characteristics of both arteries and veins and glial tissue which is located between blood vessels (7)

During angiogenesis primitive artery forms lateral sprouts which separate from the artery and then join together into a blood vessel which shall become a vein. It is postulated that defect in complete separation of the sprout from artery leads to formation of pathological communications of artery and vein which later grows into AVM.

EPIDEMIOLOGY

The incidence of AVMs is around 1/100 000 persons per year (8) AVMs can be divided into three groups based on angioarchitecture, symptoms, prognosis and treatment(6)

(1) SUBPIAL AVM- is the most common variety. They are localized under meninges, and size of nidus can range from several milimeters to several centimeters.

(2) SURFACE PIAL AVM- is the another variety and most common in paediatric population and is composed of almost direct shunt. Flow is extremely strong with consequent venous dilatation. These are extremely rare lesions with great haemorrhagic potential.

(3) DURAL AVMS OR DURAL AV FISTULAS - are lesions which also include nidus localized in dural sinus. They represent about 10-15% of AVMs. Lesions of this type are most often acquired, and etiological factors are of wide spectrum including dural phlebitis, trauma, infection of paraendocranial structures (e.g.mastoiditis). Primary cause of dural AVMs is venous hypertension.

Presentation

Arteriovenous malformation scan be divided into hemorrhagic and non-hemorrhagic based on symptoms and There is also a group of those accidentally detected.

- HEMORRHAGE. Intracranial hemorrhage is the most common presentation of AVM seen in 30 to 82% of cases. Blood can be found in subarachnoidspace (30%), parenchyma (23%), intraventricular (16%) or in multiple sites. (7, 9). The risk of bleeding in previously non-ruptured AVM is 2-4% per year, but in complex lesions the risks are higher.(6,10,11).
- Aneurysm is most common anomalies which is associated with increase chance of hemorrhage. Aneurysms combined with AVM appear in large series in 7-23% of cases. (12) It is due to aneurysms represent a weak point in angio architecture of AVM (7, 13) and most of studies suggested that existence of aneurysms increases the risk of hemorrhage (4).
- NIDUS SIZE - nidus size is also a risk factor for bleeding, but there is a controversy regarding nidus size. Significant number of studies show that hemorrhagic complications are more common with small niduses than with bigger ones (14).there are two theories which favor that small niduses are more prone to rupture. Firstly, bigger AVMs more often give non-hemorrhagic symptoms and are being detected this way, so the share of hemorrhagic presentations with big AVMs is significantly

smaller than small AVMs (6) Secondly, blood pressure in small AVMs is significantly higher than in big ones (4,15).

- VENOUS DRAINAGE and VENOUS STASIS - risk of bleeding in cases of deep venous drainage is higher than those with surface drainage (16, 17). similar Reduction in diameter of draining veins results in increase of pressure in proximal vascular bed of AVM causing higher risk of rupture (18)

Non-hemorrhagic-manifestations EPILEPSY- This is the second most common symptom of AVM. Most often it is the consequence of cortically located AVMs in temporal zones in middle aged patients (18).

HEADACHE - Headache is an initial symptom in 7-48% of cases, which is non specific (19).

FOCAL NEUROLOGICAL DEFICIT- Focal neurological deficit are due to blood stealing phenomenon, venous hypertension and mass effect.

Accidental Findings-

some time patients referred to imaging for others reason and imaging suggestive of AVM. This is accidental finding and can be asymptomatic or the symptoms were not recognized. Such lesions account for about 25% (6).

PATIENTS AND METHODS-

This is retrospective, single-center case series involved 56 patients who underwent surgical treatment for cerebral AVM at the Neuro Care Hospital Jaipur, Rajasthan between 2013 and 2022. The diagnosis of AVMs was based on CT angiography and MRI angiography, which was repeated approximately one week after surgery to confirm the effect of surgical treatment. The following parameters were evaluated: clinical symptoms, localization and lateralization of AVM, S-M grade, outcome at the time of discharge and at 6 month based on Glasgow Outcome Score (Good – GOS 5; Moderate – GOS 4, Severe – GOS 3).

RESULTS-

Demographic 56 patients enrolled in our study, in which 36 males and 20 females. The youngest patient was 17 year male and, the oldest 76 years old male. Thirty four (60.71%) patients (22 males and 12 females) were younger than 40 and 22 (39.29%) patients (14 males and 8 females) were older than 40 years.

Table 1 AGE and SEX of patients

Variables	Number (percentage)
Sex	
Male	36 (64.28%)
Female	20(35.71%)
Mean age (in years)	42
Less than 40 years	34(60.71%)
40 or >40 years	22(39.29%)

Lateralization And Location-

The majority of AVMs (86%) were localized in the supratentorial region. Supratentorial AVMs were most frequent in the frontoparietal and temporo parietal lobes (Table 2). infratentorial AVMs (14%) were localized in the cerebellum.

Lateralization of AVMs 64 % AVM localized in the right hemisphere and 36 % AVM in the left hemisphere (table 2)

Table 2

Location	Number (percentage)
Supratentorial	46 (86%)
Fronto parietal	18 (32.14%)
Parietal	6(10.71%)
Temporoparietal	12(21.42%)
temporal	4(7.14%)
Frontal	4(7.14%)
Occipital	2(3.57%)
Infratentorial	8 (14%)
Cerebellum	8(14%)
Lateralization	
Right hemisphere	36(64%)
Left hemisphere	20(36%)

Symptomatology -

The most frequent symptom was bleeding, which was present in 28 (50%) of patients Followed by seizure, which was present in 12(34%) and focal neurological deficit in 12 (34%) of patients. headache also common symptom which was present in 8% patients and 8% of AVMs were diagnosed accidentally. bleeding is more common in male and younger patients compare to female and older patients.

SM GRADING- The Spetzler-Martin (SM) grading scale, most commonly used classification system, uses 3 anatomic factors (nidus size, nidus location relative to eloquent brain, and pattern of venous drainage) to enumerate AVM grades. The SM grading scale uses the following point system to assign AVM grade: nidus size (<3 cm=1point; 3–6 cm=2 points; and >6 cm=3 points), nidus location (noneloquent=0 points; eloquent=1 point), and pattern of venous drainage (superficial only=0 points; deep=1 point).

The SM grading scale is a well-validated tool for estimating the risks of surgical resection using baseline imaging data. According to the S-M scale, overall the majority of AVMs were grade II (57.14%), followed by grade I (19.64%) and grade III (17.85%). In males, majority of AVM were grade II, grade III and grade 1 and in females, majority of AVM were grade II, grade I and grade III. (Table 3)

Table 3

Spetzler-Martin grading	No of patients	Males	Females
Grade I	11 (19.64%)	8 (14.28%)	3 (5.35%)
Grade II	32 (57.14%)	17 (30.35%)	15 (26.78%)
Grade III	10 (17.85%)	9 (16.07%)	1 (1.7%)
Grade IV	3 (5.3%)	2 (3.5%)	1 (1.7%)
Grade V	0	0	0
Total	56	36	20

Management-

All patients of AVM underwent CT brain with angiography, MRI brain and routine investigation before surgery. After establishments of diagnosis, complete excision was performed in all patients (100%)(FIGURE 1). Fifty four patients (96.42%) had a newly diagnosed AVM, and the surgical treatment in our department was the first intervention, while two patients (3.58%) had taken treatment of AVM by gamma knife radiosurgery, which was not fully successful. Rebleeding was reported in one case and no response to radiosurgery in another case. These two patients underwent total resection in our centre and achieved good outcome . suzita clip was used for obliteration of vessles and large feeder.

Outcome-

4 patients developed hemiparesis to opposite side of surgery which was not present before surgery and in two patients, postop ICH was developed, resurgery done, suction and evacuation of ICH done.

The 6-month outcome was good in 43 patients (77%), moderate disability was present in 10 patients (18%), and death occurred of 3 patients (5%). S-M grade I AVMs had a good outcome in 88% of the cases and moderate outcome in 12%.

S-M grade II AVMs had a good outcome in 82% of the cases

and moderate outcome in 18%. S-M grade III AVMs had a good outcome in 73% of the cases, moderate outcome in 20% Cases and death occurred in 7% cases.

S-M grade iv AVMs had a moderate outcome in 33% of the cases and death occurred in 66% In summary, the mortality rate was 5.35 %. (TABLE 4)

TABLE 4

Spetzler-Martin grading	No of patients	GOS outcome score		
		Good (5)	Moderate (4)	Death (1)
Grade 1	11	9	2	0
Grade 2	32	28	4	0
Grade 3	10	6	3	1
Grade 4	3	0	1	2
Grade 5	0	0	0	0
Total	56	43 (77%)	10 (18%)	3 (5%)

DISCUSSION

AVMs are congenital pathologies, which are most often diagnosed in the fourth decade of life (20). Our findings are almost consistent with these observations – the mean age of our patients was 42 years. AVMs do not have gender predilection (20) but In our study, there were more common in males. The most frequent clinical presentation of AVM was bleeding (50%) in our study, which is similar with the usually reported range of 45%-65% (21, 22). The dominant locations of AVMs in our study were supratentorial (86%) and S-M grade II (54%). A total resection was performed in 100 % and a good outcome was achieved in 77% of patients. The overall morbidity rate was 10.71 %(4 patients developed hemiparesis and 2 patients ICH). And the mortality rate was 5.35%, which was explained by selection of higher S M grading patients for surgery . These results are similar to previous reports, supporting the general opinion that microsurgery may be used to treat the majority of small-nidus AVMs AND SM grade I AND II with a low mortality and morbidity, when precisely planned and performed by an expert vascular team (2, 5, 23).

A critical step in management of AVMs is the selection of treatment option among multiple modalities such as Surgery ,Endovascular embolization, Radiosurgery and combination of the above. This is always individualized according to the patient's overall status and AVM characteristics. The characteristics of AVM, which have to be taken into account when selecting treatment modality, are S-M grade, blood flow through AVM, AVM-related aneurysms, intracerebral hematoma, and hydrocephalus. Other crucial factors include the number and accessibility of arterial feeders, number of draining veins and their location (deep or superficial), and the density and compactness of the nidus. In this study author choose surgery because Surgery provides Complete excision of the brain AVM nidus, causing a reduction in case fatality and in the subsequent occurrence or recurrence of ICH, provides the highest cure rates, mostly Single stage surgery and Cost effective. Surgery is more risky and have pre and post operative complication but using special precaution we can reduced complication. Surgery has following complications.

Direct lesion of eloquent areas produces neurological deficits, Postoperative bleeding due to the presence of a residual that has not been removed during surgery and Postoperative hyperemia. These complication can be avoided /reduced by Careful selection of the patient (patient with eloquent AVM to Gamma Knife treatment), Meticulous coagulation of deep medullary feeders, Check any residual of the AVM during surgery, Keep the patient under controlled blood pressure during postoperative period

Although Gamma knife Radiosurgery is a less invasive than surgery, but the effects are slow and it usually takes at least two to three years for an AVM obliteration. In this period, This leaves people exposed to the risk of haemorrhage before occlusion and this is limited to brain AVMs with a compact nidus of 3 cm diameter or less.

Endovascular embolization is also less invasive than surgery but Complications arising after embolization are not negligible. endovascular embolization provide incomplete obliteration of the AVM so need multiple intervention siting, Multiple time GA exposure and Risk of reflux of embolic agents into vessels supplying eloquent areas of the brain causing FND.

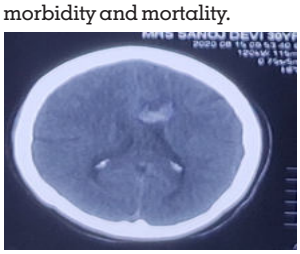
The critical step of AVM resection is an identification of feeders, both superficial and deep, and identification of draining veins, which must stay intact in the initial phase. Proximal control of arterial feeders by help of temporary clips or coagulation precedes their resection. After the resection of arterial feeders, nidus resection is performed. The final step of AVM resection is coagulation and an interruption of draining veins. Meticulous hemostasis is essential because a problem with hemostasis may signalize residual AVM left behind. In the postoperative phase, normotension and normovolemia therapy is used. Analgesia, sedation, and antiepileptic drug are used individually

Microsurgery is a first-line treatment for S-M grade I-II AVMs and also used for the treatment of S-M grade III AVMs, with combination of other treatment modalities. Preoperative planning is a crucial part of surgery. Basic characteristics of AVM, including localization, character of the nidus, its filling, arterial feeders, draining veins, and relation to eloquent areas, are assessed based on DSA and MRI imaging.

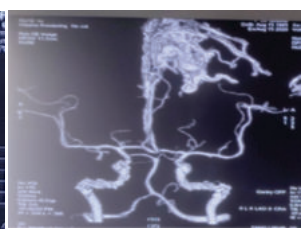
The limitation of our study is that we did not have DSA imaging which may provide additional information compared with CT angiography.

CONCLUSION-

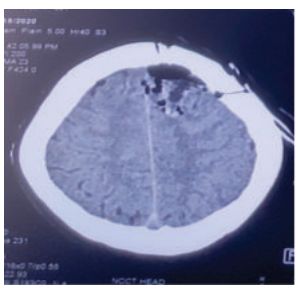
Microsurgery is an appropriate method of treatment for S-M grade I-III pial AVMs. A meticulous selection of patients for surgical treatment is crucial. Careful preoperative planning and individual approach are required. Precise technique, meticulous hemostasis, and accurate postoperative intensive care are essential for successful treatment. If all criteria are fulfilled, surgical treatment of S-M grade I-III AVMs is a safe and efficient modality, which is associated with a low morbidity and mortality.



A



B Pre Operative



C

D Post Operative

Figure1. case of arteriovenous malformations (AVM. Computed tomography (CT) and CTangiogram revealed left

fronto parietal intracerebral hematoma caused by the AVM, (**A & B**). AVM excision done microsurgically post operative CT scan and CT angio showed total removal of AVM (C& D) .

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