Posterior Fossa AVMs; Endovascular Management Challenges

M Aziz, H Eldawoody

Citation

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Abstract

Objective: Arteriovenous malformations (AVMs) of the posterior fossa are complex neurovascular lesions that are much more likely to present with hemorrhage. The incidence of hemorrhagic presentation for posterior fossa AVMs was found to range between 75-92%. AVMs are still considered challenging lesions to treat and the treatment itself poses significant risks. Available therapeutic options include observation, microsurgical resection, radiosurgery, endovascular embolization, or combinations of two or more of these modalities.

Aim: To present our initial experience with multimodality management of 20 posterior fossa AVMs, with an emphasis on endovascular treatment challenges and outcomes in Egypt.

Patients and Methods: This retrospective study involved 20 patients that underwent procedural interventions for treatment of posterior fossa AVMs. Early and late neurological outcomes were assessed via the Glasgow outcome score (GOS). Radiological outcome was assessed by digital subtraction angiogram (DSA). Outcome was categorized into: Complete obliteration, presence of residual and recurrence after obliteration. In the endovascular cases the percentage of the residual AVM nidal size was assessed for the need of further management. Technical difficulties encountered during endovascular management were all recorded. Complications related to the type of intervention were all recorded.

Results: 20 patients were included in the study; 10 males and 10 females. The mean age at the presentation was 36.76 years old. The most common initial presentation was hemorrhage. The mean GCS at presentation was 11.8. 16 cases (80%) underwent endovascular intervention as a standalone or as an adjuvant treatment modality meanwhile 4 cases underwent direct surgical excision. Surgical excision was done in 4 cases. GNRS was considered in 4 cases with incomplete obliteration of the AVM nidus after endovascular treatment. Early clinical evaluation for our cases showed a GOS of 5 for 10 (50%) patients. At 6-12 months follow-up we attained a favorable outcome in 18 (90%) patients. We had two (10%) deaths in our case series. Six AVMs (37.5%) of those treated with embolization exhibited ≥ 90% obliteration rate, 8 (50%) cases exhibited 50-89% obliteration rate, while 2 (12.5%) cases showed only < 50% obliteration rate.

Conclusion: Safe multimodality approach treating AVMs gives the patient the best chance by using all tools and one should not be dogmatic trying to treat posterior fossa AVMs merely through neuroendovascular root. Endovascular management of posterior fossa AVMs might show some technical difficulties that can be overcome after gaining experience.

INTRODUCTION:

Arteriovenous malformations (AVMs) of the posterior fossa are complex neurovascular lesions that are considered relatively uncommon as they account only for 5-18% of all brain AVMs.1-4 Infratentorial lesions can involve the cerebellum, the brainstem, or a combination of both locations.2 AVMs that involve the cerebellum, either vermis or hemisphere, comprise 60-75% of all infratentorial AVMs.2,5,6

Unlike the supratentorial located AVMs, posterior fossa AVMs are much more likely to present with hemorrhage and rarely present with seizures.7 Accumulating data within the last decades have found the incidence of hemorrhagic presentation for posterior fossa AVMs to range between 75-92%.7-9 In addition, infratentorial AVMs were found to have the highest overall annual rupture rate of 8.4% per year and that of 9.6% in the first 5 years after primary hemorrhagic presentation.10 On the other hand, progressive

neurological deficits (either due to mass effect, ischemia or hydrocephalic changes) have been found to constitute the second most common presentation mode for the posterior fossa AVMs reaching up to 28% of cases.2,11

Despite the marked advancement in the microsurgical techniques posterior fossa AVMs are still considered challenging lesions to treat and the treatment itself poses significant risks. Available therapeutic options include observation, microsurgical resection, radiosurgery, endovascular embolization, or combinations of two or more of these modalities. Treatment is dependent on the clinical presentation, patient age, AVM location and size, pattern of venous drainage, and the presence of flow-related intranidal aneurysms. Till now only few large study series have been reported concerning the treatment of posterior fossa AVMs.2,3,11-16

AIM

In this study the authors present their initial experience with multimodality management of 20 posterior fossa AVMs that were managed between January 2012 and August 2015, with an emphasis on endovascular treatment challenges and outcomes in Egypt.

MATERIALS AND METHODS:

Patient Population:

This retrospective study involved 20 patients that underwent procedural interventions, between January 2012 and August 2015, for treatment of posterior fossa AVMs with standard indications. Demographic data including patients' age and sex were all collected and recorded.

Preprocedural assessment:

All our patients were subjected to thorough clinical assessment by general and neurological examination, in addition to laboratory and radiological assessment. Computerized Tomography (CT) scanning and Magnetic Resonance Imaging (MRI) were routinely done to diagnose hemorrhage if present and raise the suspect of the presence of an infratentorial AVM. The diagnosis of posterior fossa AVM was confirmed by digital subtraction angiography (DSA) for all patients. DSA was used as the radiologic investigation of choice to characterize and collect AVM angioarcetectural data, planning treatment and evaluation of treatment outcome. Detailed information were collected from diagnostic DSA as regard: nidus location, size, number of arterial feeders, pattern of venous drainage, dural supply, associated vascular pathologic conditions as arterial aneurysms, venous varices or ectasias, venous stenosis, as well as the anatomical access and its feasibility.

AVM data:

As regard AVM data, the cerebral AVMs involved in our study were categorized according to site into cerebellar, brain stem, or combined in both. Other parameters that were determined as regard the AVMs data included: number of feeding arteries, pattern of venous drainage (Deep, Superficial or both), nidal size and configuration, presence of flow related perinidal aneurysm and Spetzler-Martin Grade (S-M grade).17

Treatment Options:

Treatment decision and plan was carried out in a multidisciplinary approach. Assessment of the patient and designing a plan to accomplish the goals of treatment was done after a good understanding of the pretreatment angiographic studies, clinical picture and apparent influence of the angioarchitecture on the natural history of each individual arteriovenous malformation. A preliminary assessment of the technical possibilities and difficulties was done. In addition a formulation of the reasonable risks, expectations and results was done as an initial therapeutic plan.

Discussion of the details of the procedure, including its risks, goal and alternative modes of treatment with the patient and/or his or her family was done; the objective of the procedure and the possibility of additional treatment were discussed in advance.

Procedural data collection:

The data of the procedures done were recorded including the modality(ies) selected for management, technical difficulties, number of embolization sessions, materials used in embolization, percentage of postembolization size reduction in cases that underwent preoperative and preradisurgical embolization and finally procedure related complications.

Postprocedural assessment:

Clinical outcome:

Early postinterventional neuro-logical status (after recovery) was assessed and the early Glasgow outcome score (GOS) was recorded for each patient.

Final clinical outcome was assessed during follow up visits. Delayed GOS is recorded for the patients at 6 months duration from the intervention. Outcomes were analyzed in terms of change between preoperative and final postoperative GOS (Table 1).18 Results were evaluated in terms of deterioration following treatment. Schematically these 5 groups can be considered in a simpler fashion in 2 categories: 1) favorable outcome (improvement and no or minor deterioration) for 4 and 5 GOS, 2) unfavorable outcome (moderate deterioration, major deterioration and death) for 1, 2 and 3 GOS.

Table 1

Glasgow outcome scale [18]

Score	Condition	Description
1	Death	Severe injury or death without recovery of consciousness
2	Persistent vegetative status	Severe damage with prolonged state of unresponsiveness and a lack of higher mental functions
3	Severe disability	Severe injury with permanent need for help with daily living
4	Moderate disability	No need for assistance in everyday life, employment is possible but may require special equipment.
5	Mild disability	Light damage with minor neurological and psychological deficits.

Clinical symptom outcome was assessed in terms of the control of the presenting symptom (hemorrhage, headache, ataxia and neurological deficit).

Radiological outcome:

Radiological outcome was assessed angiographically in the patients who underwent surgery and endovascular intervention. In the surgical cases a postoperative DSA was done as early as possible after surgery and the results were assessed in terms of either totally obliterated lesion or a residual was detected. In the endovascular cases the percentage of nidal obliteration was detected and recorded through control angiogram at the end of endovascular treatment session.

Final angioarchitectural outcome was assessed via a followup DSA that was done at 6 months in surgical and endovascular cases and at 24 months and again at 36 months in radiosurgical cases. Outcome was classified after comparison with the baseline preprocedural DSA: Complete obliteration, presence of residual and recurrence after obliteration. In the endovascular cases the percentage of the residual AVM nidal size was assessed for the need of further management.

Procedure related complications

Technical complications and complications related to the type of intervention were recorded.

RESULTS

Patients' demographics:

In the current study, we retrospectively reviewed the patients that presented with posterior fossa AVM between January 2012 and August 2015. Twenty patients were included in the study. There was no gender predominance with equal male to female ratio; 10 males and 10 females. The mean age at the presentation was 36.76 years old (range; 1.5-65 years) for all cases, but it was higher in males 42.7 years old and lower for females 30.8 years old (Table 2).

Clinical presentations:

The majority of patients with posterior fossa AVM involved in the study presented with hemorrhage at initial presentation. Thirteen (65%) cases had different types of hemorrhagic incidents. Intraventricular hemorrhage was found in 8 patients, cerebellar parenchymal bleeding in 6 patients, one patient had subarachnoid hemorrhage and another with brainstem hemorrhage. Ten out of twenty cases (50 %) were presented with disturbed level of consciousness [GCS <15] and the other ten cases were fully conscious on initial presentation. The mean GCS at presentation was 11.8. Other clinical presentations/radiological signs included headache (9 patients; 45%), followed by ataxia/ cerebellar signs (8 patients; 40%), hydrocephalus (3 patients; 15%) and trigeminal neuralgia (2 patients; 10%). One child presented with macrocrania and venous hypertension and another patient was incidentally discovered (Table 2).

Table 2

Patients' demographics and clinical data

Demographic data	Patients
Age in years (mean)	37.76
Sex	
Males	10(50%)
Females	10(50%)
Presentations	
Hemorrhage	13(65%)
IVH	8(40%)
Cerebellar hemorrhage	6(30%)
SAH	1(5%)
Brainstem hemorrhage	1(5%)
Headache	9(45%)
Ataxia/cerebellar signs	8(40%)
Dizziness/vertigo	3(15%)
Hydrocephalus	3(15%)
Trigeminal neuralgia	2(10%)
Macrocrania	1(5%)
Incidental	1(5%)

Two female patients were presented by cerebellar hemorrhage during pregnancy (10 % of all cases included in the study and 20 % of female cases).

AVM Data:

Locations of the AVM in our study included the cerebellar hemisphere in 14 patients (70%), cerebellar vermis in 5 (25%), brainstem in 2 (10%) and cerebellopontine angle

(CPA) in another 2 (10%) cases. Three posterior fossa AVMs in the study extended to more than one allocation. Thirteen (65%) AVMs had a nidal size that ranged between 3 and 6 cms while the other 7 (35%) AVMs nidal size less than 3 cms. As described by Spetzler-Martin17, eloquent areas in the posterior fossa were considered as the brainstem, cerebellar nuclei and cerebellar peduncles. The S-M grade was found to be I in 3 cases (15%), II in 9 (45%), III in 5 (25%) and IV in 2 (10%). One patient had a S-M grade V AVM. Eight AVMs had single arterial supply, 7 (35%) supplied by superior cerebellar artery (SCA) and one (5%) by posterior inferior cerebellar artery (PICA). Twelve AVMs on the other hand sustained multiple arterial supplies; two of which showed bilateral supply (Table 3). Two cases with posterior fossa AVM presented with VA-PICA flow related aneurysms, one was the source of IVH and treated accordingly with coiling and the other was small and unruptured and the AVM was treated by surgical excision. Six AVMs had superficial drainage whereas the other 14 AVMs were deeply drained.

Table 3

AVM data

AVM Data	Patients' Number
Location	
Right Cerebellar Hemisphere	8(40%)
Left Cerebellar Hemisphere	6(30%)
Vermis	5(25%)
Brain Stem	2(10%)
Cerebellopontine angle (CPA)	2(10%)
Size	
<3cm	7 (35%)
>3cm	13 (65%)
S-M grade	
S-M grade 1	3(15%)
S-M grade 2	9(45%)
S-M grade 3	5(25%)
S-M grade 4	2(10%)
S-M grade 5	1(5%)
Arterial Supply	
SCA	7
SCA and AICA	1
SCA and AICA and PICA	7
SCA and PICA	5
AICA and PICA	1
PICA	1
Venous Drainage	
Superficial	6
Deep	14
Superficial drainage means, superficial cortical drainage	
Deep drainage means, drainage to the transverse/sigmoid sinuses or any of perimesencephalic veins, petrosal veins.	

Management:

Out of the 20 cases diagnosed to have posterior fossa AVM in our study, 16 cases (80%) experienced endovascular intervention as a standalone or as an adjuvant treatment modality meanwhile 4 cases (20 %) underwent direct surgical excision alone via a suboccipital approach.

Out of the 16 endovascular treated cases only 7 (35%) cases required a solo endovascular treatment (one aneurysm coiling and the other six AVMs onyx embolization). Three cases underwent emergency hematoma evacuation followed by onyx embolization. Four cases experienced endovascular embolization of the AVM [3 by onyx and one by N-butyl-cyano-acrylate (NBCA)] followed by Gamma knife Radiosurgery (GKRS). GNRS was considered in cases with incomplete obliteration of the AVM nidus. Two cases had onyx embolization followed by surgical excision. One case underwent onyx embolization and later developed hydrocephalus secondary to IVH and required a ventriculoperitoneal shunt insertion (Table 4).

Table 4

Posterior fossa treatment modalities

Treatment Modality	No (%age)
Endovascular embolization	7(35%)
Endovascular embolization + GKRS	4(20%)
Endovascular embolization + Surgery	2(10%)
Surgery	4(20%)
ICH evacuation + Endovascular embolization	3(15%)

Endovascular difficulties encountered during posterior fossa AVM embolization, and troubleshooting to overcome these difficulties:

Among our study group of 20 patient treated for posterior fossa AVM, 16 cases had the chance to receive endovascular root treatment either as a solo treatment or as a part from multidisciplinary multimodality approach. Endovascular management for posterior fossa AVM usually carries lots of technical challenges and here we report the points of difficulties we met in our study and their troubleshooting management techniques commonly used in our cases. 1) Difficulty in accessing, together with instability, of the guiding catheter within the proximal vertebral artery due to arch tortuousity from the femoral approach in case number one. We succeeded to overcome that problem through using a smaller diameter guiding catheter 5F through a direct trans-brachial approach to the right vertebral artery. 2) Difficulty in advancing the microcatheter into the proximal part of AICA due to acute angle of the AICA origin (case 8). That problem was solved by shaping the microcatheter together with using alternative and sequential microwires (0.008 & 0.007) through the same microcatheter. 3) Microcatheter was stuck in the distal feeder portion of the AVM nidus (cases 6 and 10). That trouble was overcome in the successive cases by usage of detachable tip microcatheter with variable tip length according to the AVM angioarchitecture and proper control of the liquid embolic agents' back flow around the microcatheter to be not more than half a centimeter in case of using nondetachable tip microcatheter and beyond the third marker when using detachable tip microcatheters. 4) Improper visualization of

the liquid embolic agent (LEA) flow on the screen during injection. That problem possibly could be overcome through adequate shaking of the onyx [liquid embolic agent (LEA)] before usage and also by using blank map during injection together with high definition large screens of flat panel angio-machines. 5) The proximal reflux distance allowed for the liquid embolic agent on the proximal feeder (cases 3, 4). Generally not well defined, during AVM embolization through a PICA territory branch the reflux should not be allowed back to the second loop, the catheter position should be as distal as possible. 6) LEA extravasations (cases 4, 6). Extravasation is considered an avoidable complication that should be early detected and subsequently stopping injection whenever a high pressure is felt on syringe during injection. Early detection could be aided by noticing the formation of abnormal flakes or drops that could not be attributed to the pre-embolized nidus angioarchitecture specially if the AVM nidus is close to the forth ventricle. Using high definition large screens of flat panel angio-machines could also be a beneficial tool that helps to detect any LEA extravasation as early as possible.

Immediate and delayed post-procedural outcome:

Early clinical evaluation for our cases showed a GOS of 5 for 10 (50%) patients. Eight (40%) patients had an early GOS of 3. Three patients developed immediate post procedural ataxia that improved by time and one patient that complained of early right hemihypothesia that also improved at followup. We had two (10%) deaths in our case series; one had a cerebellar hemorrhage and died after onyx embolization and the other had subarachnoid hemorrhage and died after surgical ventriculostomy and excision. At 6-12 months followup we attained a favouable outome in 18 (90%) patients; where 13 patients had a GOS of 5 (65%) and 5 patients to have a GOS of 4 (table 5).

Table 5

Early and follow up GOS for our cases

	GOS	
Score	immediate	Delayed (6-12 months)
5	10	13
4	-	5
3	8	-
2	-	-
1	2	2

Obliteration rate immediate post-procedure and at follow up:

The immediate obliteration rate results for our cases showed that the 4 cases that underwent surgical excision exhibited a total removal with no residual nidal tissue. Six AVMs (37.5%) of those treated with embolization exhibited ≥ 90% obliteration rate, 8 (50%) cases exhibited 50-89% obliteration rate, while 2 (12.5%) cases showed only < 50% obliteration rate.

Over the next year of treatment, 4 cases did not show for followup and one case that immediately showed subtotal occlusion exhibit recanalization and sent for GNRS.

Complications related to endovascular procedures:

Out of 16 patients with posterior fossa AVM treated through endovascular root either as solo treatment or as a part from multidisciplinary approach five cases showed post procedure complications, one died on the second day from massive pulmonary embolism (PE) (case 7), one has minor iatrogenic SAH that resolved completely with no sequelae and one has aggravation of her cerebellar signs with no obvious infarction after the treatment that improved over the follow up time, and two have SCA territory infarction after treatment with persistent cerebellar ataxia partially improved overtime.

Table 6

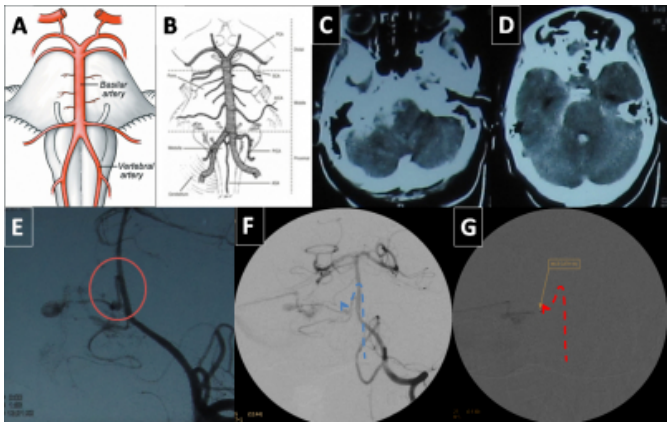
Procedural complications

Complications	Number of cases
Transient	
Iatrogenic SAH	1
Cerebellar signs with no definite procedure related infarction	1
Permanent	
PE	1
SCA territory infarction	2

ILLUSTRATIVE CASES

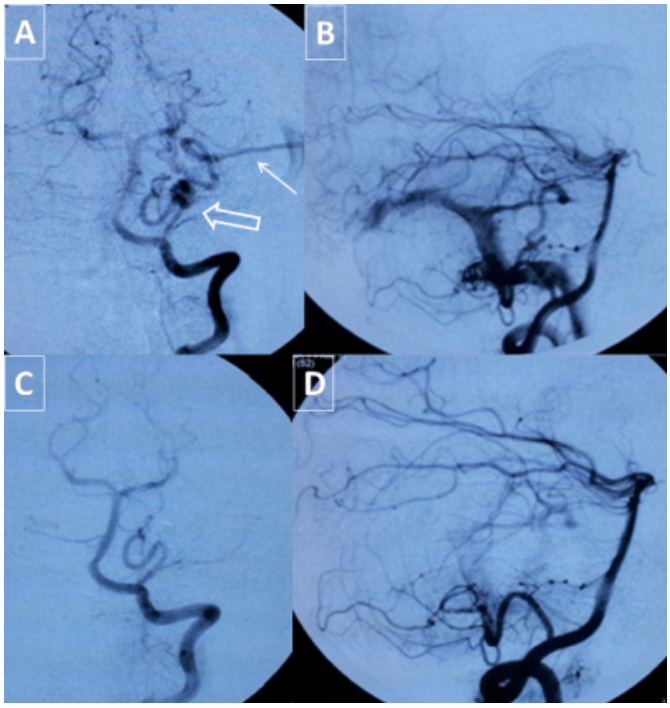
Case 1

54 years old female presented with acute onset headache. A&B: Anatomical diagram of arterial supply of posterior fossa, note the direct right angle origin of AICA in picture A (childhood) and more curved origin (adulthood) in B. C&D: CT brain of the patient showed right CPA haemorrhage. E,F&G: DSA showing right CPA small AVM supplied by the right AICA with venous aneurysm, draining deeply into petrosal vein to the sigmoid sinus, note the acute angle of the right AICA origin from the basilar artery (red circle in E). Endovascular embolization was performed using onyx and eventually we could achieve access to the right AICA by shaping of the microcatheter and using microwires of size 0.008, 0.007 inches sequentially and alternatively (the sharp angle was shown as dotted blue and red coloured arrowed in F&G).



Case 2

28 years female patient presented during the second month of pregnancy with acute left hemiataxia. CT brain showed Left cerebellar hematoma, Posterior fossa decompression was performed. A&B: DSA showed Lt hemispheric cerebellar AVM (open arrow) supplied by hemispheric branches of PICA and small branch from the SCA, drained deeply into petrosal vein to the sigmoid sinus (small white arrow). C&D: Endovascular embolization was performed using onyx and nBCA in 2 sessions and eventual near complete obliteration was achieved.



DISCUSSION

Infratentorial AVMs are complex neurovascular lesions that carry a marked therapeutic challenge and a possible severe clinical course. The difficulty in management of such lesions can be attributed to the confined location within the narrow posterior fossa, proximity to highly eloquent and vital structures, in addition to the complexity of the vascular structures within that area. The first posterior fossa AVM excision was successfully performed in 1932 and since then many authors have published small case series discussing posterior fossa AVM managment.19 Posterior fossa AVMs usually pose a much higher risk of hemorrhagic presentation when compared to their counterpart supratentorial ones.2,8,11,20 In our study, 65% of our patients with posterior fossa AVMs presented with hemorrhagic incidents. These results coincide with those published by Yang et al21 where 63.9% of posterior fossa AVMs presented with hemorrhage, and are also slightly lower than data published in literature with a proportion of hemorrhagic presentation

ranging between 72-92%.2,3,11,22,23 15.4% of AVMs (case 1,14) that presented with hemorrhage in our study where found to have flow related aneurysms which is consistent with the Toronto Study Group24 data that demonstrated that the presence of associated aneurysm can be an independent risk factor for hemorrhagic event. In our experience we had 50 % of our patients that presented with disturbed level of consciousness. The mean GCS at presentation was 11.8. Other clinical presentations that we recorded in our series included headache (45%), ataxia (40%), hydrocephalus (15%), trigeminal neuralgia (10%), venous hypertension (5%) and incidental discovery (5%).

Multimodality management for posterior fossa AVMs has been recently advocated where the treatment is tailored case by case according to presentation, AVM angioarchitecture, availability of the settings and surgeon's experience. Introduction of multimodal management for cerebral AVMs in general and infratentorial ones in particular has much contributed in improving the management outcomes.10,24-26 Twenty percent of patients involved in our study had direct surgical excision, whereas 80% experienced endovascular intervention either as a solo or adjuvant treatment modality. Four cases experienced endovascular embolization followed by GKRS and two cases had onyx embolization followed by surgical excision. The technical difficulties encountered during endovascular management were found to be scarcely if not being discussed before in literature. We tried in our study to record and highlight all the technical difficulties that we met in our setting. We also tried to present some troubleshooting for some problems. These troubles included 1) difficulties in accessing the proximal vertebral artery due to arch tortuosity from the femoral approach in case number one. We used a smaller diameter guiding catheter through a trans-brachial direct approach. 2) Difficulty in accessing the proximal part of AICA due to acute angle of the AICA origin. Shaping the microcatheter and using alternative microwires through the same microcatheter aided in overcoming that problem. 3) Stucking of the microcatheter in the distal feeder portion of the AVM nidus that could be overcome by using a detachable tip microcatheter with variable tip length according to the AVM angioarchitecture and proper control of the liquid embolic agents' back flow around the microcatheter. 4) Improper visualization of the liquid embolic agent flow on the screen during injection. Adequate shaking of the onyx before usage was found to be mandatory to overcome that problem. 5) The proximal reflux distance allowed for the liquid embolic agent on the proximal feeder. Generally not well defined, during AVM embolization through a PICA territory branch the reflux should not allowed back to the second loop, the catheter position should be as distal as possible. 6) Embolizate extravasations. Early detection could be aided by noticing the formation of abnormal flakes or drops that could not be explained to the pre-embolized nidus angioarchitecture specially if the AVM nidus is close to the forth ventricle. Using high definition large screens of flat panel angio-machines available in the market could also be a benifitial tool that helps to detect any embolizate as early as possible.

It is now evident from literature that total AVM obliteration is essential to prevent prospective bleeding. Reported obliteration rates range between 52-100% according to the treatment modality used and lesion complexity degree. In their series discussing surgical outcomes in the treatment of posterior fossa AVMs, Drake et al reported a 92% obliteration rate.3 Batjer et al2 reported a total obliteration rate (100%) while Kelly et al10 attained only 52% angiographic obliteration rate in treated S-M grades III–V posterior fossa AVMs. In our study, 100% obliteration was achieved in the 4 cases treated surgically with no residual nidal tissue. In the patients that received endovascular embolization 37.5% exhibited ≥ 90% obliteration rate, 50% exhibited 50-89% obliteration rate and 12.5% of our cases showed only < 50% obliteration rate.

There are multiple surgical series in literature on posterior fossa AVMs that evaluate functional outcomes with no well-described systematic reviews that deal with management results. Excellent and good clinical results were reported in up to 67– 81 % of treated patients for earlier clinical series.2,3,10,21,24 Relying on GOS for evaluation, our results revealed a good outcome in 65% (GOS 5) of cases and an accepted outcome (GOS 4) in 25%. da Costa et al reported "good" mRS outcomes in 67% of cases whereas 28% of the patients suffered from "poor" outcomes.24 Drake et al reported a 71% of patients having an "excellent to good outcome" (3).3 Batjer and Samson attained "excellent to good" outcomes in 80% of their 30 cases with posterior fossa AVMs.2 Kelly et al have also described their experience with treating AVMs located in the posterior fossa, although the analysis included only the 48 lesions that were Spetzler-Martin grades III–V, where 81% of patients had "excellent to good" outcomes.10 Yang et al had 43 patients (70.5%) achieved good functional outcomes at the last follow-up.21

Despite successful treatment results in most cases, utmost

attention has to be drawn to those patients, suffering from severe treatment complications. Major treatment related complications causing permanent and severe neurological disability or death occurred in 5 patients (25 %); among these, we had two (10%) mortality (one post endovascular embolization and the other post surgical intervention), two cases with ischemic insult and one with cerebellar manifestations that resolved at follow up. Although the rate of treatment complications in literature is comparable to our results, ranging between 17 and 20 %,2,10,11,15 this issue must be stressed in particular, since data of the ARUBA trial have been recently published.27 There are multiple surgical series published on posterior fossa AVMs that evaluate outcome and complication rate. In 1986 Drake et al 3 published their surgical experience in the treatment of 66 posterior fossa AVMs. In this series 14% had a poor result, and 15% died. The majority of surgery-related morbidity was due to massive postoperative hemorrhage, possibly from inadequate hemostasis. Surgical therapy was found to be least effective for brainstem AVMs. In the study by Solomon and Stein,15 which included 12 brainstem AVMs, 9 patients underwent resection. Four patients were neurologically stable, 3 had transient deficits, and 2 had permanent postoperative deficits. None of the patients died. Batjer and Samson2 published their experience treating 30 patients with posterior fossa AVMs. Two patients (7%) died in the perioperative period and 4 (13%) significantly worsened following surgery, whereas the remaining 24 (80%) had good to excellent outcomes. These authors reported an overall mortality and morbidity rate of 20%. Similarly, Symon et al.11 reported the results of their series of 28 patients in which 4 (14.3%) sustained significant neurological deterioration after surgery, and 1 (3.6%) died in the perioperative period.

AVM and pregnancy:

Two female patients were presented by cerebellar hemorrhage during pregnancy. Both females presented with cerebellar hemorrhage. One patient had a left cerebellar S-M grade II AVM and had multiple feeders. She underwent hematoma evaluation followed by single session onyx embolization that lead to 100% nidal obliteration. The other female had a vermian S-M grade IV AVM with multiple feeders. She underwent hematoma evacuation followed by 2 sessions of onyx embolization that resulted in 90% nidal obliteration. Both patients had a favorable clinical outcome on discharge. In a review conducted by Lv et al regarding the management of AVM in pregnant females 54 cases (83.1%) of AVMs that ruptured during pregnancy and postpartum. In this review, ruptured AVMs were treated before delivery, irrespective of the stage of pregnancy, and the method of treatment were decided primarily on neurosurgical grounds. Unfavorable maternal clinical outcome (modified Rankin Scale (mRS)≥2) was identified in 20 cases (30.8%) and abortion occurred in 10 cases (15.4%). There were three maternal deaths, yielding a case mortality rate of 4.6%.28

The limitation of this study is the small sample size, which could be attributed to the rarity of the pathology and difficulty of management. We were not able to find statistical relations between different parameters within the study. The small sample size hampered finding relation between hemorrhagic presentation, S-M grade, AVM location on one hand and the clinical and radiological outcome on the other. However we succeeded in achieving our aim, which was to present our humble experience in management of posterior fossa AVM which is first discussed in our country and to highlight the technical obstacles that might be met with during endovascular management and to present some points of trouble shooting for these problems.

CONCLUSION

Although the task for endovascular embolization of the posterior fossa AVM is difficult but is not mission impossible. We have to carefully study of angiogram & use the best working angle and choose the best & easy access main feeder first. Precise controlled intra-nidal injection with the usage of detachable tip microcatheter should be strongly considered. The controllability and diffusability of the liquid embolic agents differ. This study showed 25% complication rate with immediate total or near total occlusion of 50% that are comparable to others' results. Multiple sessions on intervals are generally better in multifeeder AVMs. Safe multidisciplinary approach treating AVMs gives the patient the best chance by using all tools and should not be dogmatic trying to treat posterior fossa AVMs merely through neuroendovascular root.

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Author Information

Mohamed Mostafa Aziz, MD
Lecturer of Neurosurgery, Department of Neurosurgery, Ain Shams University
Cairo, Egypt

Hany A. Fikry Eldawoody, MD
Lecturer of Neurosurgery, Department of Neurosurgery, Mansoura University, Mansoura, Egypt; Consultant of Neurosurgery, Department of Neurosurgery, Prince Mohamed Bin Abdul-Aziz Hospital
Riyadh, Saudi Arabia