Outcome of Microsurgical Resection of Cerebral Arteriovenous Malformations (AVMs) of 15 cases

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ABSTRACT

INTRODUCTION: Cerebral arteriovenous malformations (AVMs) are one-seventh as common as cerebral aneurysms. 50% of death of patients with cerebral AVMs are due to intracranial hemorrhage. There are different modalities of treatment of cerebral AVMs which include microsurgery, radiosurgery and embolisation. In experienced hands best treatment option is microsurgical resection that usually makes the patient disease free immediately and prevents future bleeding. Aim of this study is to discuss the outcome of microsurgical resection of cerebral AVMs in our institute.

METHODS: Over a period of nearly three years, between November 2009 and July 2012, we performed microsurgical excision of cerebral AVMs on 15 patients under general anaesthesia at Department of Neurosurgery, NAMS, Bir Hospital. Follow up period ranged from 6 months to 3 years and surgical outcome was measured by GOS (Glasgow Outcome score).

RESULTS: The male female ratio was 1:0.26 and mean age was 30. Twelve patients were presented with intracerebral hematoma (ICH) and 3 patients with seizure disorder. On cerebral angiogram 9 patients had Spetzler – Martin grade II, 5 had grade III and 1 had grade IV. Favorable outcome after surgical excision was achieved in 13 (86.7%), 2 (13.3%) were severely disabled and there was no mortality. This is most probably largest series of intracerebral AVMs surgery produced in Nepal till date.

CONCLUSION: Surgical excision is the best treatment option for cerebral AVMs except giant AVMs which requires multimodality treatment approaches.

KEY WORDS: cerebral arteriovenous malformation, cerebral AVMs, CT angiogram, microsurgical resection, outcome.

INTRODUCTION

Cerebral arteriovenous malformations (AVMs) are tangled fistulous connection between feeding arteries and draining veins centered on nidus, a vascular mass replacing the capillary bed where shunting occurs. Cerebral AVMs are one-seventh as common as cerebral aneurysms. The exact incidence of cerebral AVMs is unknown. The large autopsy series estimate the frequency of AVMs detection to be 1.4% to 4.3%.

The incidence rate in general population is about 1/100000 people/year. It accounts about 2% of all strokes and 38% of all intracerebral hemorrhage in patients between 15 to 45 years of age. The prevalence has been estimated to be 0.2 to 0.8%.

Supratentorial AVMs are more common than posterior fossa AVMs. Multiple AVMs exist in about 1% of patients and may be associated with Osler Weber Rendu disease (Hereditary Hemorrhagic Telangectasia). The annual risk of hemorrhage of unruptured AVMs is about 2-4% and annual risk of ICH of ruptured AVMs is...
18%. 50-70% of death of patients with AVMs are due to hemorrhage. The annual case fatality is 1.5% \(^1\).

The goal of treating AVMs is to eliminate the risk for hemorrhage and to preserve or improve functional neurological status which can be either achieved by surgery, radiosurgery and embolisation or combination of them.

First surgical exposure of AVM was performed by Giordano in 1890 \(^4\). Fedor Krause, a German neurosurgeon, attempted to surgically eliminate a cerebral AVM by ligating its feeding arteries in 1908 \(^5\). Olivecrona appears to have been the first to actually completely excise a cerebral AVM in 1932 and later a cerebellar AVM in 1938 \(^6\). Invention of cerebral angiography by Egas Moniz in 1930 made diagnosis of cerebral AVM straight forward and its total surgical excision became feasible. MG Yasargil played a critical role in the introduction of operating microscope and microinstruments for cerebrovascular surgery and in addition, he was one of the first individual to propose the use of presurgical embolisation of AVMs \(^7\).

**METHODS**

This is a retrospective study of prospectively collected data of 15 patients who underwent microsurgical excision of intracranial AVMs between November 2009 and July 2012 at department of Neurosurgery, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal. There are no intraoperative facilities of Transcranial Doppler, ICG angiography and Neurophysiological monitoring in our institute. Diagnosis was either made by CT angiography or Digital Subtraction Angiography (DSA). Outcome was measured by GOS. Prior to discharge postoperative cerebral CT angiography was carried out in all cases. Followed up period was ranged from 6 months to 3 years.

**RESULTS**

Male and female ratio was 1: 0.26 and mean age was 30. On admission 12 patients were presented with intracerebral hematomas and out of them 7 had contralateral hemiparesis. 3 patients had seizure disorders; two with focal seizures followed by secondary generalization and one with visual sensory seizures. Initially all patients were advised for cranial CT which showed ICH in 12 patients and calcified lesions in 2 patients. Final diagnosis were made either by CT angiogram ( Fig 1 & 3 ) or DSA. On angiogram 9 patients had Spetzler-Martin grade II, 5 had grade III and 1 with grade IV AVMs (Table. 1).

<table>
<thead>
<tr>
<th>Spetzler – Martin grade</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>9</td>
</tr>
<tr>
<td>III</td>
<td>5</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
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<tr>
<td>V</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
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![Fig. 1. Preoperative CT angiogram of 24 year old right handed gentleman showing Spetzler and Martin grade III cerebral AVMS in right parietal lobe fed by branches of middle cerebral artery and drained into superior sagittal sinus.](image)
Location wise, 14 AVMs were located supratentorially and 1 infratentorially. AVMs associated aneurysms were present in two patients, one was intranidal and other one was unrelated. Postoperative complication rate, in our series, was 20% (3); one patient had developed cavity haematoma and two patients suffered from new onset of hemiparesis. Favorable outcome was achieved in 86.7% (13) and two patients were severely disabled. There was no mortality in our series (Table 2). Post operative angiograms of all patients showed no residual AVMs (Fig. 2 and 4).

### Table 2. Outcome (Glasgow Outcome Score)

<table>
<thead>
<tr>
<th>Score</th>
<th>No. of patients</th>
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<tbody>
<tr>
<td>Good recovery</td>
<td>11 (73.4%)</td>
</tr>
<tr>
<td>Moderately disabled</td>
<td>2 (13.3%)</td>
</tr>
<tr>
<td>Severely disabled</td>
<td>2 (13.3%)</td>
</tr>
<tr>
<td>Vegetative</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Dead</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>15 (100%)</td>
</tr>
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**DISCUSSION**

The cause of Cerebral AVMs are not precisely known. AVMs are thought to be true congenital abnormalities. The annual incidence of AVM is 1 per 100,000 people per year and prevalence is 18 per 100,000 per year. It is more common in children and young adults and both gender are equally affected. In our series of 15 cases there were significantly more male than female (male:female ratio - 1:0.26).

Literature review reveals that 60% of cerebral AVMs present with ICH, 20% with seizure disorder and 15% are asymptomatic. 5% may have rare presentations like headache, pulsatile tinnitus, focal deficit and cognitive dysfunction and these last two symptoms might be attributed to ‘steal’ phenomenon. Presentations of our cases have also shown similar trend, that is, 12 patients presented with ICH and three with epilepsy.

Preliminary choice of imaging is CT or MRI of brain to detect intracranial hemorrhage and calcified vascular...
lesions. Final confirmation of cerebral AVMs are made by either DSA and CT angiography. Cerebral angiography does not only show architecture of AVM but also helps to reveal other associated vascular pathology like aneurysms which can be present in 10 – 20% of cerebral AVMs. AVM associated aneurysm was present in 2 (13.3%) patients in this series; one was intranidal and other one unrelated.

Based on cerebral angiography there are many complex grading system, but Spetzler – Martin grading system, which was proposed in 1986, is simple and widely used by neurosurgeons and neuroradiologists. This is useful grading system for communication of information regarding cerebral AVMs and it dictates the modalities of treatment and their outcome. This grading system is based on three variables i.e size of the nidus, eloquency of brain and draining veins. This grading system has minimum score 1 and maximum score 5, thus, graded as I to V. The risk associated with surgery have been attributed to grade of AVMs, greater the grade of AVM poorer the surgical outcome.

In this series, 9 patients had Spetzler- Martin grade II, 5 had grade III and 1 had grade IV and no patient had grade V. Thus, all patients had been decided to have undergo microsurgical excision.

The goal of treatment of AVM is to eliminate the risk of hemorrhage by obliterating it which requires single or multimodality approaches. Available treatment options are microsurgery, radiosurgery and embolisation alone or in combination.

Radiotherapy has been used for the management of AVMs for nearly as long as surgery has. Radiotherapy is only suitable for AVMs of less than 3cm in size and obliteration rate is about 70-80% in three years after radiotherapy. Serious complication like radio necrosis can occur in 3 – 6% and bleeding rate after radiation is about 5% for first few years which is similar to bleeding rate of unruptured AVMs.

Complete cure of AVMs with embolisation alone is very difficult to achieve. Embolisation is commonly used as a preoperative measure to reduce blood loss, or prior to radiotherapy to reduce the nidus size. It can be used as a stand – alone treatment modality in small AVMs but provides low cure rate of about 20% with present technology.

Treatment of AVMs remains among the most difficult lesion to treat and a challenge for neurosurgeons. Giant AVMs (grade V) represent a small but difficult group of AVMs to treat that often have higher treatment morbidity and mortality rates than do smaller one. During past decade, however, neurosurgeons have developed surgical approaches to these giant AVMs that allow treatment to be administered with an acceptance level of risk for many patients with these lesions. The use of microinstruments and operative microscope, along with neurophysiological monitoring, preoperative embolisation and staged surgery, has enabled neurosurgeons to resect some of these lesions safely.

Microsurgical resection is the best treatment option for cerebral AVMs which has got cure rate of more than 95% for grade I to III. Risk of surgery have been observed to relate to the size of nidus, deep venous drainage, and location in or adjacent to critical brain regions. Outcome of surgical resection of grade I to III cerebral AVMs are excellent with low morbidity and no mortality. Morbidity of 17% and mortality of 3% have been observed in previous series of large and giant AVMs. In Hero’s series of 91 patients there was no postoperative complication and surgery related death. In Sisti’s series of 67 cases one patient developed focal deficit but no fatality. In Hamilton and Spetzler’s series of 71 patients there was no morbidity and mortality. Piku’s case series showed no mortality but 6 patients had developed postoperative complications. In our series of 15 patients 3 patients (20%) suffered postoperative complications; one had cavity hematoma which required second surgery and other two developed new focal deficits. Favorable outcome was achieved in 86.7% and 13.3% were severely disabled.

On postoperative angiogram total obliteration was achieved in more than 95% and 4% residual or recurrent AVMs have been reported in previous literature. In Heros and Hamilton’s series AVMs obliteration was 100%. In Sisti and Piku’s series obliteration rates were 94% and 98.6% respectively. Postoperative cerebral angiography of our series showed 100% obliteration rate. These results are favorably comparable with previous series of AVM surgery.
CONCLUSION

The best treatment option for intracranial AVM is microsurgical excision. Radiosurgery and embolisation alone or in combination are other modalities of treatment where surgery alone is not feasible or not indicated.

REFERENCES