SURGICAL MANAGEMENT OF CEREBRAL CAVERNOUS MALFORMATIONS (CAVERNOMAS) CAUSING SEIZURES IN CHILDREN: THE CHEO EXPERIENCE.

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ABSTRAC

Purpose: *To review seizure outcome after surgery for cerebral cavernous malformation (CCM) in children presenting with seizures as the main symptom.*
Material and Method: *We retrospectively reviewed the cases of 10 patients with cerebral cavernous malformations presenting with seizures as the main symptom. These 10 patients were treated surgically between 1988 and 2004, at our institution. There were 5 males and 5 females, age range from 1yr 8 months to15 yrs (mean 8 yrs).The clinical histories, and radiological findings, pathology and operative reports were reviewed. Imaging studies were done as follows: CT + Angiogram in 4 patients, CT + MRI + MRA in 3 patients, CT + MRI in 2 patients.*
The cavernomas were located as follows: temporal lobe: 5 cases; parietal lobe: 3 cases (2 in sensory- motor strip); and frontal lobe: 2 cases. All patients had diagnostic EEG, and nine (90 %) were on antiepileptic drugs. Five patients had partial complex seizures and five generalized tonic- clonic seizures. Seven (70%) patients underwent tailored complete lesionectomy and epileptic focus resection as determined by the use of intraoperative electrocorticography(ECOG). One patient (10%) underwent complete lesionectomy and partial focus resection. Two patients (20%) with lesions in the sensory motor cortex underwent complete lesionectomy only. Mean follow up time was 5 yrs (range 3 months - 20 yrs).
Results: *All patients tolerated surgery well without morbidity or mortality. All patients are seizure free. Seven (100%) patients who underwent tailored complete lesionectomy and epileptic focus resection are seizure free with no antiepileptic medication. One patient who underwent lesionectomy and partial focus resection is seizure free on medication. The two patients who underwent lesionectomy only, are both seizure free, one patient still requiring antiepileptic medication.*
Copnclusion: *For cerebral cavernous malformations presenting with seizures in this age group, complete microsurgical excision is the treatment of choice. Surgery should be preceded by careful electroclinical, neuroimaging, anatomical and functional evaluation. The good seizure outcome results (100%) after surgical intervention in our patients are probably related to both the lesionectomy and the excision of the epileptogenic focus in non eloquent areas (80%). Nevertheless, the two patients with lesions located in eloquent cortex that underwent complete lesionectomy alone (20%), are also seizure free. Based on these findings it would appear that complete lesionectomy is the main variable in determining seizure outcome after surgery for CCMs presenting with seizures. Larger series will be required to statistically support this assumption.*
Key words: cavernous angiomas - lesionectomy - seizures

INTRODUCTION

Cerebral Cavernous Malformations (CCM) are angiographically occult vascular lesions with a reported prevalence of about 0.4%-0.5% in the general population[1,2]. Cerebral cavernous malformations clinically manifest as hemorrhage, seizures or neurological deficits. Seizures are the presenting symptom in 23% - 36% of the patients with CCM[3,4,5,6].

In series of pediatric patients with cerebral cavernous malformations, seizures have been reported to be the main symptom in 29%-36 %[7,8,9]. Seizure morbidity from CCM alone is significant, and children are more likely to have disability from seizures than adult patients[10].

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Considering the long life expectancy of children, even medically controlled seizures present the dilemma of lifetime costs and the side effects of antiepileptic medication. Treatment modalities of these lesions should therefore take into account the seizure related outcome. We therefore retrospectively reviewed seizure outcome after surgery for cerebral cavernous malformations in children presenting with seizures as the only symptom, treated at our institution for the last 16 years.

MATERIALS AND METHODS

We retrospectively reviewed the cases of 10 patients with cerebral cavernous malformations presenting with seizures as the main symptom, treated surgically between 1988 and 2004. The clinical histories, seizure type, radiological finding, electrophysiological tests, pathology and operative reports were reviewed. There were 5 males and 5 females, age range was 1yr 8 months to 15 yrs (mean 8 yrs). Nine patients were on antiepileptic medication, with break through seizures at a frequency of 1 seizure per month to 240 seizures per month (mean 15/month). Duration of seizures before surgical treatment was 4 months to 5 years (mean 2 years). One patient with seizure frequency of one per month, with duration of 4 months was not on antiepileptic medication. Imaging studies were performed as follows: CT + Angiogram in 4 patients, CT + MRI + MRA in 4 patients, CT + MRI in 2 patients.

The lesions were located as follows: temporal lobe: 5 cases; one of the patients had multiple CCMs but the one located in the temporal lobe was causing the epileptogenic focus as confirmed by Ictal EEG video telemetry and Intraoperative electrocorticography (EcoG); parietal lobe: 3 cases (2 in the sensory- motor strip); and frontal lobe: 2 cases (Table 1). The Wada test was performed on three right handed patients harbouring lesions on the left temporal lobe.

Table 1. Lesion Location

	Left Hemisphere	Right Hemisfere	Total number of cases
Frontal	0	2	2 (20%)
Temporal	3	2	5 (50%)
Parietal	2	1	3 (30%)
Occipital	0	0	0 (0%)

Clinical seizure type and location

Five patients had complex partial seizures and five patients had simple partial seizures with generalization. Table 2 shows clinical seizure type and lesion location.

Table 2. Clinical seizure type and lesion location

Frontal	Temporal	Parietal	Occipital	Total cases
Complex partial				
1	3	1	0	5 (50%)
Simple partial with generalization				
1	2	2	0	5 (50%)

Electrophysiological tests

Interictal scalp EEG recordings were done in all 10 patients. Nine patients had strictly unilateral EEG abnormality. Lateralization of the EEG abnormality correlated/localized to the side of lesion in four patients. One patient with a right parietal lesion showed bilateral EEG abnormality, due to spread of spikes to the left parietal region (Table 3).

Three patients had Ictal EEG video telemetry. One patient had multiple CCM, one had bilateral EEG abnormality in interctal EEG (table 4).

Surgical treatment

Intraoperative electrocorticography (EcoG) was performed in nine patients and the EcoG epileptoform activity correlated well with the location of the lesion. In one patient the EcoG abnormality was found within the lesion and not extending 1cm beyond the periphery of the lesion. In six patients the abnormal EcoG activity extended beyond 2 cm of the periphery but contiguous to the lesion. One patient had remote abnormal EcoG activity, non contiguous as demonstrated by contra lateral activity on scalp ictal EEG. Intra operative electrocorticography was not performed on one patient only with a lesion located in the motor sensory strip.

Seven patients had tailored complete lesionectomy and epileptic focus excision as determined by the EcoG. The patient with a non contiguous epileptogenic focus underwent complete lesionectomy and partial focus resection. The two patients with lesions (CCM) located in the motor sensory strip underwent complete lesionectomy only.

Table 3.Interictal EEG and lesion location

	Frontal	Temporal	Parietal	Occipital	Total of cases
Unilateral	2	5	2	0	9 (90%)
Bilateral	0	0	1	0	1 (10%)
Localized	0	3	1	0	4 (40%)

Table 4.Ictal EEG telemetry

	Frontal	Temporal	Parietal	Occipital	Total of cases
Unilateral	1	1	0	0	2 (66,66%)
Bilateral	0	0	1	0	1 (33,33%)

Follow up time ranged from 3 months to 16 years (mean 5 years).

Intraoperative electrocorticograph: Number of patients: Frontal, 2; Temporal, 5; Parietal 2 and Occipital, 0.

RESULTS

Surgery was well tolerated and there was no mortality or morbidity encountered . All patients were seizure free at the last follow up. Eight patients were seizure free with no antiepileptic medications. Two patients had not been weaned from medication, but no breaks through seizures were documented.

All seven patients who underwent tailored complete lesionectomies and epileptic focus excision as determined by EcoG where seizures free with no medication. The patient who underwent lesionectomy with partial epileptic focus resection was seizure free but on medication. The two patients who underwent lesionectomy only were both seizure free , one patient still requiring antiepileptic medication.

In these small series, tailored complete lesionectomy and epileptic focus resection as determined by radiological and EcoG findings (7 patients) in non eloquent areas gave 100% seizure free outcome with no antiepileptic medication. Lesionectomy alone or with partial focus resection resulted in good seizure control: 1 patient was seizure free with no medication (33.3%) and 2 patients were seizure free but on medication (66.7%). Factors that are reported[15,16] to influence seizure outcome after surgery, such as duration of seizures before surgical treatment, seizure frequency, anatomical location of the lesion and gender were not of statistical significance in our small series and therefore were not analyzed.

DISCUSSION

In addition to hemorrhage, cerebral seizures are a significant contributor to the morbidity associated with cavernous malformations[10]. The detrimental effects of persistent epileptic activity on brain development are well recognized[11]. Various studies have shown that surgical treatment is highly effective in patients with epilepsy secondary to cerebral cavernomas. Surgical intervention leads to a favorable seizure outcome, particularly in patients with concordant electroclinical data and neuroimaging [2,12,13,14,15]. Nevertheless, there is no agreement concerning the best surgical strategy to treat cerebral cavernous malformations associated with epilepsy. That is, pure lesionectomy versus lesionectomy and epileptic focus resection.

Some authors have reported good immediate seizure outcome (65-70% seizure free) following pure lesionectomy with late seizure recurrence[12,13,14,15]. Other series have reported 80-90% seizure free outcomes with tailored resection of both the cavernoma and the epileptogenic focus[2].The same rate of success has been reported after tailored resection of the lesion and the epileptogenic focus for the surgical treatment of epilepsy

secondary to other structural lesions[16,17,18,19].

Very few reports in the literature discuss the surgical management of CCMs and seizure outcomes , in the pediatric population[2,20]. Buckingham and colleagues[2] reported a pediatric series of 6 patients with CCM s, with only 4 patients presenting with seizures as the main symptom. I n these series, EcoG was used in 4 patients with epileptogenic focus resection in 3 patients. All 4 patients were reported to be seizure free, 2 patients still on medication.

CONCLUSIONS

For cerebral cavernous malformations presenting with seizures in this age group, complete microsurgical excision is the treatment of choice. Surgery should be preceded by careful electro clinical, neuroimaging, anatomical and functional evaluation. The good seizure outcome results (100%) after surgical intervention in our patients are probably related to both the lesionectomy and the excision of the epileptogenic focus in non eloquent areas (80%). Nevertheless, the two patients with lesions located in eloquent cortex that underwent complete lesionectomy alone (20%), are also seizure free. Based on these findings complete lesionectomy appears as the main variable in determining seizure outcome after surgery for CCMs presenting with seizures. Larger series will be required to statistically analyze the impact of both surgical strategies (complete lesionectomy with and without epileptogenic focus resection) on seizure outcome

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