Meningioangiomatosis (MA) is a rare congenital tumor that occurs mostly in 5-15 year old children. There have been only 5 cases previously reported that described the cystic nature within these tumors. We present a case of a MA accompanied by a separate macrocyst. A normally developed 2 year-old female patient presented with partial and generalized seizures. The brain computerized tomogram and magnetic resonance imaging revealed the presence of a calcified mass accompanied by a cyst in the right parietal area, surrounded by low density and high attenuation edema and hemorrhage. Upon right parietal craniotomy, a 1.6 cm × 1.2 cm × 0.5 cm sized plate-like, gray-white, slightly hard mass was seen and it was completely excised. Approximately 1 cm from the mass in the anterior lateral direction, a cyst was found and subsequent biopsy of the cyst wall revealed no tumor tissue, and therefore the cyst was not removed. Pathologic report demonstrated the meningioangiomatosis. Follow up examination 2 years later showed no recurrence of the tumor, and there was no evidence of neurological deficits. Authors suggest that cysts that arise in the surrounding tissues of tumors may not be tumor cysts, and do not require surgical removal.

KEY WORDS: Brain tumor • Cyst • Epilepsy • Infant • Neurofibromatosis.
nance imaging (MRI) showed that there was a discrete cystic lesion in the right peritrigonal portion (Fig. 1B-D). The mass in the T2-weighted image showed a central low signal intensity and peripheral iso-signal in the lesion, suggesting central calcification with peripheral subacute stage hemorrhage, and a low intensity signal on T1-weighted images and high intensity signal on T2-weighted images, indicating moderate peritumoral edema (Fig. 1F, G). After enhancement there was no evidence of cyst enhancement, but the mass adjacent to the cyst demonstrated dense enhancement (Fig. 1G, H). Therefore, the patient was initially diagnosed with a low-grade cystic glioma or vascular anomaly with cystic change from old hemorrhage.

A right parietal craniotomy was performed with a dural incision. The exposed brain was seen as normally colored, and subsequently localization was accomplished employing a neuronavigator (Fig. 2A). A cortical incision followed by dissection to a depth of 1.5 cm revealed a slight gray discoloration and a longish appearing 1.6 cm × 1.2 cm × 0.5 cm sized, plate-like, gray-white, slightly hard mass which was completely resected (Fig. 2B-H). After removal of the mass, a 1.8 cm × 1.5 cm × 1.5 cm sized, separate cyst was found about 1 cm anterolateral from the mass lesion (Fig. 2I). As multiple frozen biopsies of the cyst wall failed to detect any tumor tissues, and the cyst was close to the motor cortex and fibers, the cyst was not removed. The dural incision was tightly closed, the skull bone flap fixed, and the scalp was finally closed. The course of the procedure was uneventful and the final pathology report was a MA (Fig. 3). The patient was discharged 1 week after the procedure without any neurological complications. Follow up examination 2 year later demonstrated no recurrence of the tumor, and no
other problems or neurological deficits were observed.

**DISCUSSION**

Since the first description of MA in 1915, there have been approximately 100 cases reported to date worldwide. Sixteen cases have been reported as NF2-associated MA, and these patients were characterized by predominant incidence among adults and no reports of a case in children less than 5 years of age\(^\text{[16]}\). To date, 84 cases of sporadic MA have been reported mainly in children and young adults, and among them 9 cases have been reported in children under 5 years of age\(^\text{[16]}\). Therefore, sporadic MA is very rare in children under 3 years of age, and to date only 5 cases have been described in the literature, thus making our case the sixth (Table 1)\(^\text{1,2,15,22]}\). Sporadic MA has been reported mainly in the temporal lobe (33% of 84 cases), followed by the frontal lobe (25%), and the parietal and occipital lobes, in decreasing frequency, but MA accompanied by NF has been shown to occur mostly in the frontal lobe\(^\text{[16]}\). Multiple MA lesions accompanied by NF occur in 35% of patients, but the incidence of sporadic MA is only 13%.

The most common symptoms are seizures and headaches. Seizures occur in 85% of sporadic MA patients, and comprise of complex partial (47%), simple partial (34%), and general tonic clonic seizures (11%)\(^\text{[25]}\). Seizures are characteristically intractable in many cases, and there has been report of a sudden unexplainable death in one patient\(^\text{[26]}\). As the mechanisms involved in the development of MA is not clear, immunohistochemistry is of little value. Pathologically, meningiovascular proliferation, perivascular cuffs of spindle cells proliferation, and perivascular connective tissue proliferation may be seen, but without malignant features. Neurofibrillary tangles seen during degeneration is observed in 1/5-5/6 of patients, there is almost no growth of the tumor prior to surgery, and there are no recurrences after surgical removal. These characteristics suggest that MA is more related to a malformation or hamartoma, rather than a true neoplasm\(^\text{[5,11,23]}\). Consi-

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**Table 1. Summary for meningioangiomatosis developed in infants and toddlers less than 3 years of age. No case was associated with neurofibromatosis**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Age/Sex</th>
<th>Symptoms and signs</th>
<th>Radiologic findings</th>
<th>Operation</th>
<th>Postoperative results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aizpuru et al.(^\text{[1]})</td>
<td>2.5 yrs / M</td>
<td>Seizures</td>
<td>Dense calcification lesion with dense enhancement on the right parietal lobe</td>
<td>Biopsy</td>
<td>NA</td>
</tr>
<tr>
<td>Oka et al.(^\text{[15]})</td>
<td>16 mos / F</td>
<td>Seizures</td>
<td>Densely enhanced lesion in the left temporoparietal area</td>
<td>Total removal</td>
<td>No deficit; no seizure nor recurrence for 3 yrs and 5 mos</td>
</tr>
<tr>
<td>Tien et al.(^\text{[22]})</td>
<td>20 mos / F</td>
<td>Seizures</td>
<td>Low signal intensity on T1- and high signal intensity on T2-weighted MRI in the right occipital lobe</td>
<td>Partial resection</td>
<td>No deficit</td>
</tr>
<tr>
<td>Blumenthal et al.(^\text{[2]})</td>
<td>11 mos / M</td>
<td>First seizure attack</td>
<td>Focal calcified enhanced mass in right frontal lobe</td>
<td>Total removal</td>
<td>No deficit</td>
</tr>
<tr>
<td>Authors’ case</td>
<td>2 yrs / F</td>
<td>First seizure attack</td>
<td>Focal calcified mass with separated cyst in right parietal lobe</td>
<td>Total removal of calcified mass except cyst</td>
<td>No deficit; no seizure for 2 yrs</td>
</tr>
</tbody>
</table>

mos : months, NA : non-available, yrs : years
dering the fact that growth is present in NF2-associated MA, mutation of the somatic or germline NF2 gene is suspected in sporadic MA. Even though Stemmer-Rachamimov et al. confirmed that there were no NF2 gene mutations among 12 sporadic MA patients, a recent study reported 1 case of NF2 gene deletion, and therefore this needs to be further elucidated by future studies.

MA may be accompanied by other tumors such as astrocytomas, ependymomas, oligodendrogliomas, primitive neuroectodermal tumors, schwannomas, and hamartomas. Other accompanying vascular lesions are anterior cerebral aneurysms, venous angiomas, and vascular malformations, and occasionally encephaloceles. The most common lesion reported are meningiomas, which was seen in 16 of MA patients. Although these meningiomas are not histologically malignant, the presence of brain invasion makes it essential to differentiate from a malignant meningioma. Consequently, MA lesions have been shown to improve symptoms, but still total removal seems to be more effective. If post-operative seizure control is not successful, then extension of the epileptic foci was seen to develop with time.

There have been 6 cases (including the present case) of MA accompanied by cysts which have all been reported to be located within or attached to the MA lesion (Table 2). In 2 cases the cyst was microcystic and which was visible only on microscopic examination, 2 cases were sufficiently large to be detected by MRI, while 1 case was a large cystic mass comprising of multiple cysts. However, there have no reports of a large macro-cyst that was completely separate from the main tumor, as in our case. It has been suggested that the formation of this cyst is due to collection of trapped CSF by the tumor as in cystic meningiomas, but communication between the cyst and the subarachnoid space was not confirmed. In our patient, pathologic examination demonstrated no tumor tissue present in the

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<th>Operation</th>
<th>Postoperative results</th>
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</thead>
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<tr>
<td>Park et al.</td>
<td>47/F</td>
<td>Headache and generalized seizures for 5 years</td>
<td>2 × 1 × 1 cm and 0.2 × 0.1 × 0.1 cm round calcified masses and ecchondritic cysts with edema in the left frontoparietal and right parietal lobes</td>
<td>Eccentric cyst within left lesion</td>
<td>Total removal of only left lesion</td>
<td>Free of seizures and headaches for the 15 months since surgery</td>
</tr>
<tr>
<td>53/M</td>
<td>Headache and generalized seizures for 2 years</td>
<td>Dense round calcified lesions with eccentric cysts in the left frontal and parietal lobes</td>
<td>Multiple macrocysts with meningioma in the right frontobasal hemisphere</td>
<td>Total removal of both frontal and parietal lesions</td>
<td>Free of seizures and headaches for the 7 months since surgery</td>
<td></td>
</tr>
<tr>
<td>Kuchelmeister et al.</td>
<td>58/M</td>
<td>Headache, forgetfulness for 10 years</td>
<td>Multicystic with meningioma in the right frontobasal hemisphere</td>
<td>Septated large multiple cysts</td>
<td>Total removal</td>
<td>Forgetfulness, no recurrence for the 2 years since surgery</td>
</tr>
<tr>
<td>Kobayashi et al.</td>
<td>14/M</td>
<td>Intractable seizure (complex partial and generalized tonic-clonic) for 3 years</td>
<td>2.3 cm mass of hypointensity on $T_1$ and isointensity on $T_2$ in the left frontoparietal lobe with small cyst</td>
<td>Small cyst in the periphery of the lesion</td>
<td>Total removal</td>
<td>Seizure controlled with two antiepileptic drugs for 10 months</td>
</tr>
<tr>
<td>Wang et al.</td>
<td>12/M</td>
<td>Intractable seizure (complex partial) for 7 years</td>
<td>4 × 3 × 2 cm cystic lesion in the left frontoparietal lobe</td>
<td>Large cyst within lesion</td>
<td>Lesionectomy</td>
<td>Seizure controlled with antiepileptic drug for 10 month</td>
</tr>
<tr>
<td>Authors’ case</td>
<td>2/F</td>
<td>First partial and general seizure attack</td>
<td>Plate-like, gray-white, slightly hard calcified 1.6 cm x 1.2 cm x 0.5 cm mass</td>
<td>Separated 1.8 cm x 1.5 cm x 1.5 cm cyst</td>
<td>Total removal of calcified mass except cyst</td>
<td>No recurrence for the 2 years since surgery</td>
</tr>
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cyst wall. The cyst was separated from the MA, completely separated within the parenchyma and with no communication between the cyst and subarachnoid space. The above findings suggest that this cyst was not formed by the tumor or a portion of the tumor trapping the CSF. Therefore, considering the above findings, we propose that MA is a developmental anomaly rather than a neoplasm, and that the formation of the cyst is also an accompanying developmental anomaly. If this is true, then the cyst forming around the tumor would not be a true tumor, and removal of the cyst may not be essential, especially if it is located in the eloquent area, and also if there are no demonstrable tumor cells in the cyst wall biopsies.

CONCLUSION

Although rare in infants and toddlers, MA should be considered as a differential diagnosis, and as accompanying cysts in the eloquent area surrounding the tumor may not be a tumor, careful consideration should be given with respect to removal of the cyst.

• Acknowledgements
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References