

Microsurgical Fenestration of Middle Cranial Fossa Arachnoid Cyst

In-Soo Kim, M.D., Dong-Won Kim, M.D.

Department of Neurosurgery, Dongsan Medical Center, Keimyung University School of Medicine, Daegu, Korea

Objective : The optimal surgical treatment for symptomatic middle cranial fossa arachnoid cysts is controversial. Therapeutic options include endoscopic fenestration, excision, cyst shunting, and craniotomy for fenestration of basal cistern. We reviewed the results of surgically treated middle cranial fossa arachnoid cysts.

Methods : We performed a retrospective study in 18 cases of middle cranial fossa arachnoid cysts who had been treated with microsurgical fenestration between 1995 to 2003. The analysis was based on the results of the patients' age, sex distribution, developed area, clinical symptoms, treatment method, and complications.

Results : Eighteen surgically treated middle cranial fossa arachnoid cysts patients were evaluated. The age range of cyst development was between 2 years and 44 years with the average of 16.4 years. The follow-up periods averaged 31.48 months. There were 15 male and 3 female patients, with significantly more cyst development in males than females. The most common clinical symptom was headache, followed by seizure. In the entire series, 77.8% of patients demonstrated a decrease in cyst size in serial imaging studies. Of them, 67.3% demonstrated a complete cyst effacement. Overall, 100% of patients with Grade I cysts, 81.8% of patients with Grade II cysts, 60% of patients with Grade III cysts exhibited evidence of decrease in cyst size during long-term monitoring. Complications included headache, meningitis, and hydrocephalus.

Conclusion : Patients who were treated with microsurgical fenestration showed good outcome with acceptable complications. We concluded that microsurgical fenestration is a safe and effective surgical method for middle cranial fossa arachnoid cysts.

KEY WORDS : Middle cranial fossa · Arachnoid cyst · Microsurgical fenestration.

Introduction

Arachnoid cyst develop in any areas along the cerebrospinal axis, although it has been usually reported to occur in the Sylvian fissure¹⁹. Moreover, arachnoid cyst has been detected incidentally in many asymptomatic cases. Generally, careful monitoring has been regarded as the established rationale in asymptomatic cases. However, surgery is also indicated in cases in which the cyst is gradually enlarged, local neurological symptoms or epileptic seizure are present or the intracranial pressure is elevated by hydrocephalus or subdural hematoma²⁰.

Several surgical methods have already been proposed to manage the middle cranial fossa arachnoid cyst, which is the most common intracranial arachnoid cyst^{3,21}. These include the excision of the cyst, endoscopic fenestration, cysto-peritoneal shunt and fenestration. However, each method has its own

advantage and disadvantages. In the excision of the cyst, the complete removal of the cyst is difficult and the recurrence rate reaches approximately 25%. In cysto-peritoneal shunt, many complications are noted¹³. In the endoscopic fenestration, control of bleeding can be difficult, usually requiring copious amounts of irrigation for long periods. Endoscopic procedure are also limited by number of working and viewing channels. Under the background described above, while avoiding cysto-peritoneal shunt, we performed the excision of the cyst as well as fenestration of basal cisterns to lower the recurrence rate. Here, we report our surgical results with a review of literature.

Materials and Methods

We retrospectively reviewed the medical records of 18 patients who were treated at the department of neurosurgery

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• Address for reprints : Dong-Won Kim, M.D., Department of Neurosurgery, Dongsan Medical Center, Keimyung University School of Medicine, 194 Dongsan-dong, Jung-gu, Daegu 700-712, Korea Tel : +82-53-250-7333, FAX : +82-53-250-7356, E-mail : dongwon@dsmc.or.kr

of our hospital between 1995 and 2003. These patients were diagnosed with middle cranial fossa arachnoid cyst on plain skull radiography, brain CT and MRI scans. The cysts seen in the Sylvian fissure were classified as Type I, II and III^{6,7)}. This is based on the classification system of Galassi. In cases of Type I cysts, the small-sized, spindle-shaped cyst is located anterior to the middle cranial fossa. In these cases, no ventricular compression, midline shift and cranial deformity are noted.

Type II cysts are slightly larger than Type I cysts in size. In most cases, Type II cysts assume a triangular or quadrangular shape along the insular floor. Among the type II cysts, about 50% showed a mild mass effect. In some cases, cranial deformity is accompanied. Type III cysts are the largest in size, and assume an oval or round shape. Type III cysts occupy mostly within the middle cranial fossa. A severe mass effect and the cranial deformity are accompanied in these cases. The patients who were diagnosed on the basis of radiologic findings, underwent microsurgical fenestration. We perform the craniotomy as small as possible. This is used to create a craniotomy of 2 × 2cm, and the operating microscope is brought into the field and cyst membrane was punctured to removal of cystic fluid. The arachnoid membrane attached to brain parenchyma was removed as much as possible, and then arachnoid membrane was fenestrated to the basal cistern. The ipsilateral optic nerve and carotid artery are identified. The dissection then proceeds to the deeper membranes. Arachnoid membrane adhering to the internal carotid artery and optic nerve is incised. The posterior communicating artery and Cranial Nerve III are identified and sharply freed of arachnoid membrane. The membrane of Liliequist is also completely opened. CSF pulsations, demonstrating free communication of the deep cisterns, confirmed successful completion of the procedure. This maneuver results in communication of the deep basal cisterns.

The mean follow-up period was 31.48 months(range 3~103 months, standard deviation=26.65). In these patients, we analyzed such factors as age, sex, clinical symptoms, the size of cyst, treatment outcomes and complications

Results

Age and sex

In our series, arachnoid cyst was noted between 2 and 44 years of age. The mean age was 16.4 years (standard deviation =12.98). Five patients were at preschool age (<6 years); four patients were at prepubertal age (7~10 years); three patients were at adolescent age (11~19 years); and six patients were at adult age (>20 years). To put this in another way, of the total patients, approximately 66.7% (12/18) were at infantile and adolescent age (<19 years).

The sex distribution was 15 males and 3 females, with a male predominance.

The affected sites and morphological classification

The ratio of the affected left- and right-hemisphere was 10:8, with a predominance of left-hemisphere.

According to Galassi classification, Type I was 11.1%(2/18), Type II was 61.1%(11/18) and Type III was 27.8%(5/18).

Clinical symptoms

All eighteen patients were symptomatic. Of the two cases of type I cysts, one patient presented with a headache and one patient with a seizure, and of the eleven cases of type II cysts, seven patients presented with a headache and four patients with a seizure. And of the five patients of type III cysts, two patients presented with a headache and three patients with a seizure.

Headache was the most prevalent clinical symptom and epileptic seizure was seen in eight patients (Table 1).

The surgical outcomes based on the shape of arachnoid cyst

Following fenestration, the size of cyst decreased by more than 50% in 77.8%(14/18), of which the cyst completely disappeared in 67.3%(9/14).

According to the classification system of Galassi, the size of cyst decreased in 100%(2/2) of Type I patients (Fig. 1); 81.8%(9/11) of Type II patients (Fig. 2); and 60%(3/5) of Type III patient (Fig. 3).

The symptoms were alleviated.

Postoperative complications

Postoperatively, headache developed in two cases, meningitis

Table 1. Case summary of arachnoid cysts

Age/sex	Chief complaint	Site	Type	F/U	Complication	Result
1 15/M	Headache	Right	II	16Ms	none	Improved
2 11/M	Seizure	Right	II	103Ms	none	Improved
3 9/M	Headache	Right	II	13Ms	none	Improved
4 28/M	Seizure	Left	III	84Ms	Meningitis Hydrocephalus	Improved
5 2/M	Seizure	Left	II	59Ms	none	Improved
6 33/F	Seizure	Right	III	16Ms	Headache	Improved
7 25/M	Seizure	Left	II	15Ms	none	Improved
8 36/M	Headache	Left	I	21Ms	none	Improved
9 35/M	Headache	Right	II	40Ms	none	Improved
10 10/M	Headache	Left	III	20Ms	none	Improved
11 6/F	Headache	Right	II	13Ms	none	Improved
12 6/M	Headache	Left	II	13Ms	none	Improved
13 4/M	Headache	Left	II	9Ms	none	Improved
14 7/M	Seizure	Right	I	20Ms	none	Improved
15 2/M	Headache	Right	III	14Ms	Headache	Improved
16 44/F	Seizure	Left	III	20Ms	none	No change
17 12/M	Seizure	Left	II	18Ms	none	No change
18 10/M	Headache	Left	II	3Ms	none	No change

Abbreviations : M : male, F : female, F/U : follow-up, Ms : months

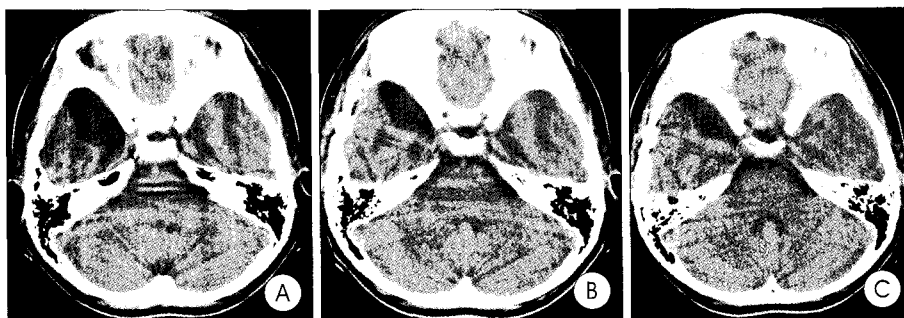


Fig. 1. Preoperative computed tomography of seven-year-old male patient with seizure showing Galassi type I arachnoid cyst on right temporal lobe(A). Computed tomographies at postoperative 2 months(B) and 11 months(C) reveal reduced size of cyst.

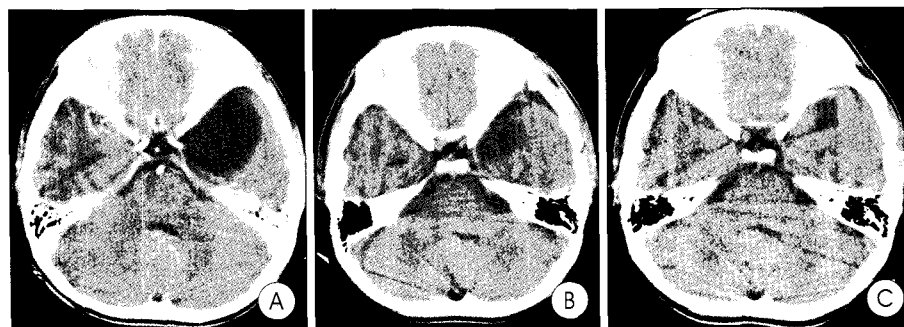


Fig. 2. Preoperative computed tomography of five-year-old male patient with seizure showing Galassi type II arachnoid cyst on left temporal lobe(A). Computed tomographies at 1 months(B) and 13 months(C) reveal reduced size of cyst.

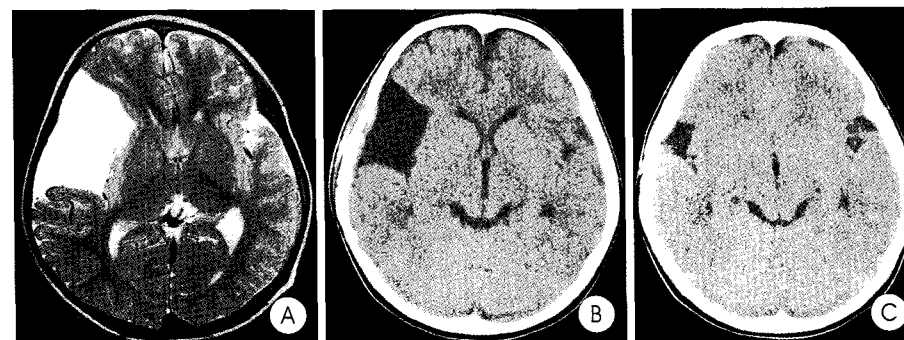


Fig. 3. Preoperative magnetic resonance imaging of thirty three-year-old female patient with seizure showing Galassi type III arachnoid cyst on right temporal lobe(A). Computed tomographies at 1 month(B) and 14 months(C) reveal reduced size of cyst.

in one case and hydrocephalus in one case. There was no mortality cases. Hydrocephalus was found nine months following surgery. Ventriculo-peritoneal shunt was performed for the corresponding case.

Discussion

To date, several hypotheses have been proposed to explain the etiology of middle cranial fossa arachnoid cyst¹⁹. First, in the theory of abnormal splitting of meninges, the arachnoid membrane splits and duplicates during the development of endomeninx. Second, according to Robinson, the pouch of arachnoid cyst is developed within the space due to

the agenesis of temporal lobe. Third, according to Starkman et al., the temporal lobe undergoes the agenesis while the cyst is gradually enlarged. However, Robinson's hypothesis did not explain the mechanism by which the temporal lobe was re-expanded postoperatively. And based on some clues, the theory of abnormal splitting of meninges has been recently accepted²². These clues were : (1) Postoperatively, there was no significant difference in the volume between left and right hemisphere; and (2) Some studies have shown that the temporal lobe was the only structure associated with arachnoid cyst that underwent agenesis. In our series, the undeveloped structures adjacent to the cyst were re-expanded after the cyst size decreased postoperatively. Based on these results, it can be inferred that the cyst compressed its adjacent structures and then inhibited their normal development.

According to Rengachary and Watanabe¹⁴, of the total intracranial arachnoid cysts, 49% were seen in the Sylvian fissure, 11% were seen in the cerebellopontine angle, 10% were seen in the supracollicular area, 9% were seen in the vermis, 9% were seen in the sellar and suprasellar area, 5% were seen in the interhemispheric fissure, 4% were seen in the cerebral convexity and 3% were seen in the clival area^{15,21}. Regarding the ratio of left-to-right hemisphere, Galassi et al. and Yamakawa et al. have reported that the left-hemisphere predominance was seen in cases of arachnoid cyst^{6,7}. In our series, the left-hemisphere predominance was also noted with a ratio of left-to-right hemisphere of 10 : 8. Moreover, some studies have shown that a male-to-female ratio was 3:1, indicating the male predominance was present in this series. Of the total cases, 60~80% were noted in patients aged less than 16 years. These tendencies were also found in our patients; a male-to-female ratio was 15:3, showing the male predominance was present, and 66% of total patients were less than 19 years of age.

In association with the sites of cyst development, various

clinical symptoms are noted. Generally, these clinical symptoms include cranial malformation, headache, vomiting, local neurological deficits and seizures⁴. In cases of the cyst within the Sylvian fissure, headache and seizures are commonly noted. In our patients, headache and seizures were also two major clinical symptoms.

There is a controversy as to whether the surgery is indicated in cases of intracranial arachnoid cyst. According to Pascual et al.¹¹, the conservative therapy will be given to asymptomatic cases in which increased intracranial pressure and local neurological deficits are absent. By contrast, Auer et al.¹¹ maintained that the surgery would be indicated even in the above cases because hemorrhage might occur within the arachnoid cyst after mild head injury particularly in child or infants. Some cases might be indicated in the surgery, which include those in which the signs and symptoms due to the cyst are present; those in which a mass effect is identified on brain CT and MRI scans; those in which the cyst is enlarged during the follow-up period; and those in which the intracranial hemorrhage due to the cyst occurs¹⁰. We think that all sylvian cysts exerting detectable mass effects call for surgical treatment even if clinically silent⁷.

Although still controversial, two types of surgical method are recommended : the direct and indirect method². The direct method refers to the removal of cyst membrane directly; and indirect counterpart does the shunt operation between cyst and peritonium and those between cyst and vein. The cyst is excised based on the postulate that the arachnoid cyst is spontaneously enlarged via a certain mechanism. To explain this mechanism, several hypotheses have been proposed^{14,16}. First, the cerebrospinal fluid(CSF) is spontaneously released from the inner layer of arachnoid cyst. Second, the cerebrospinal fluid is influxed into the cyst via the ball-and-valve mechanism. Third, the continuous communication is achieved between the cyst and cerebrospinal route. Finally, the osmotic or filtrative effect are present in the arachnoid granules of cyst, which is involved in CSF absorption. However, the total removal of cyst wall is technically difficult because the cyst wall is attached to brain tissue. For this reason, the postoperative recurrence might be complicated by the secondary occlusion of fenestrated part, the incomplete removal of cyst wall and the insufficient CSF absorption into the subarachnoid space. Besides, the recurrence rate was reported to be 25%^{5,13,16}. The endoscopic fenestration is a less invasive regimen, but it is disadvantageous because the bleeding control and surgical technique are difficult^{9,12}.

By contrast, the shunt operation is a non-invasive, simple and safe regimen compared to the direct removal of cyst wall¹⁸. According to Punzo et al.¹³, the shunt operation must be considered in the following cases : cases of the non-communicative

arachnoid cyst accompanying hydrocephalus in which the basal cisterns are obstructed; those in which neither mass effect nor hydrocephalus was confirmed on radiography; and in which the long time surgery enhances the risk. However, the shunt operation had several disadvantages. This disadvantage was that the arachnoid membrane is left to perform the secretory and filtrating function; the surgical vision is limited; and fatal slit ventricle syndrome due to infection, obstruction, and CSF overdrainage. Moreover, the postoperative outcomes are complicated by subdural hemorrhage and headache. For these reasons, the shunt operation has been rarely done in recent years^{13,15}.

In consideration of the advantages and complications of these two surgical techniques, while avoiding cysto-peritoneal shunt, to lower the high recurrence of cyst wall excision, we performed the excision of the cyst as well as fenestration of basal cisterns. High recurrence rate was the most serious problem in patients who underwent the direct cyst wall removal. Because high recurrence rate was reported when incomplete removal of cyst wall and insufficient CSF absorption into the subarachnoid space was seen, we excised the subarachnoid membrane cells on the cyst wall as much as possible and widely opened the basal cisterns⁸ to lower the recurrence rate. Therefore, we attempted to render CSF from the remnants of subarachnoid membrane cells on the unexcised cyst wall to be absorbed via a normal CSF route. Finally, we noted that the surgical technique described above was effective in reducing the size of cyst after the surgery. Moreover, the postoperative outcomes were not complicated. At a more than 3-month follow-up, no recurred cases were noted except for one case. Based on these results, although complications of fenestration procedure such as meningitis, hemiparesis, new seizure, subdural hematoma have been reported¹⁷, we assume that the surgical technique described above is effective in treating patients with middle cranial fossa arachnoid cyst.

Conclusion

In conclusion, our results indicate that not only the direct cyst removal but also the fenestration of basal cisterns is a safe and effective treatment of middle fossa arachnoid cyst.

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Commentary

In this article, authors documented clearly that microsurgical fenestration of middle fossa arachnoid cyst is an effective

treatment to control clinical symptoms and to decrease a size of cyst. Currently, the issues of management of intracranial arachnoid cyst are surgical indication and best treatment modality. As far as symptomatic arachnoid cyst is concerned, neurosurgeons make sure how symptoms are related with pre-existing arachnoid cyst. A patient who presents with headache or seizure should be scrutinized in terms of cause of headache or seizure and effect of surgery of arachnoid cyst. If there is little evidence of relevance between presenting symptoms and cyst, surgical management will be unnecessary or preventive procedure. In my practice, seizure is rarely provoked by middle fossa arachnoid cyst itself despite thorough investigation including video EEG monitoring. Also arachnoid cysts are not infrequently found on the neuroimaging study when seizure is investigated as like as head injury. In this circumstance we should carefully weigh risk and benefit of surgery for arachnoid cyst.

With regard to best surgical method for arachnoid cyst, microsurgical excision and fenestration has been a standard procedure over two decades. I would congratulate authors that microsurgical fenestration resulted in good outcome with few complications. Fewer complications in this report might be indebted to smaller craniotomy than standard craniotomy. However, nowadays minimally invasive endoscopic surgery is replacing standard microsurgery in the management of arachnoid cyst and its surgical outcome is comparable to microsurgical fenestration with less complication. As endoscopic fenestration has been a standard treatment modality for suprasellar and posterior fossa arachnoid cyst for many years, middle fossa arachnoid cyst can be managed with endoscopic fenestration alone. A bleeding during endoscopic fenestration is not as common as written in this article if well-experienced neurosurgeons perform endoscopic procedure.

Young Shin Ra, M.D.

Department of Neurosurgery,
University of Ulsan, Asan Medical Center