Usefulness of silicone elastomer drains in endoscopic treatment of arachnoid cysts – preliminary report

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Abstract

Introduction: *Endoscopic technique is gaining importance in treatment of arachnoid cysts (AC). Recommended procedures include cystocisternostomy and cystoventriculostomy. Long-term patency and functional efficacy of such connections remain a topic of discussion.*

Aim: *To present early and long-term outcome after endoscopic cystocisternostomy and cystoventriculostomy, in which functional efficacy was supported with a silicone elastomer catheter.*

Material and methods: *The study included 13 adults with symptomatic AC treated during an 8-year period. In 7 cases of cysts of the lateral cerebral fissure, cystocisternostomy with optic chiasm cistern, carotid artery cistern or prepontine cistern was performed. Six arachnoid cysts located on the brain convexity were opened to the lateral ventricle by cystoventriculostomy. Because of the anatomical situation, in none of the cases was the communication wide enough to warrant long-term patency, which was secured by use of a silicone elastomer catheter or a set of catheters. Results of the treatment were assessed based on predefined clinical and radiological criteria. The follow-up period ranged from 2.5 to 6 years.*

Results: *Clinical condition improved in 11 patients (84.6%). In 12 patients (92.3%) the size of the cyst decreased. Significant changes occurred 6-12 months after the procedure. No improvement was noted in half of patients with epilepsy, and a small radiological improvement was noted in cysts of the lateral cerebral fissure. Two patients required prolonged observation because of onset of asymptomatic subdural haematoma.*

Conclusions: *Regarding safety, replicability, efficacy and low complication rate, use of a silicone elastomer catheter is a promising solution in the endoscopic treatment of selected patients with AC.*

Key words: *neuroendoscopy, arachnoid cysts, outcome.*

Introduction

Arachnoid cysts (AC) are collections of liquid biochemically resembling cerebrospinal fluid within the arachnoid membrane, usually of congenital origin. They derive from cleft or doubling of the arachnoid meninx [1, 2] and arise in locations similar to natural arachnoid cisterns [1-5]. From five to fifty per cent of AC are asymptomatic and are discovered only accidentally [5]. Some of them can manifest with symptoms of brain compression, which appear after cessation of skull growth or result in hypoplasia of neighbouring neural structures [6]. Haemorrhages to the AC lumen have been described as well as cases of spontaneous cyst resolution [7, 8]. Increasing accessibility of neuroimaging studies results in much more frequent diagnosis of AC than in previous decades. Since the first description of the cyst by

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Bright, their treatment has been a source of controversy regarding indications for surgery and choice of treatment method [6, 9-15]. Among recommended surgical procedures are endoscopic cystocisternostomy and cystoventriculostomy [13, 16-21]. Long-term patency of such a stoma and its functional effectiveness are debatable.

Aim

The aim of the study is to present early and long-term results of endoscopic cystocisternostomy and cystoventriculostomy with their functional effectiveness secured with a silicone elastomer drain. This method has never been a topic of a separate publication.

Material and methods

Thirteen patients with AC were treated with endoscopy and implant in the last 8 years. There were 7 women and 6 men, aged 21-45 years (mean 29.6 years). In all patients diagnosis was made with ambulatory computed tomography (CT) or magnetic resonance imaging (MRI) of the head. Symptoms found on admission are shown in Table I. Duration of the symptoms varied from 6 months to 8 years and 2 patients could not define when their symptoms had started. In 7 patients the cyst was located in a lateral fissure of the brain and in 6 on the convexity of the brain. The majority of the lateral fissure cysts fitted into the 2nd and 3rd group of Galassi classification [22].

Qualification for surgery was based on meticulous analysis of clinical symptoms and radiological pictures. Patients scheduled for surgery suffered from symptoms of increased intracranial pressure or from epilepsy resistant to standard pharmacological treatment. Other symptoms were at first ambulatory-observed to make sure they were not cyst-independent. A small increase in the size of a cyst was found in only one patient.

Table I. Clinical symptoms in 13 patients with arachnoid cyst

Symptoms	No. of patients
Intracranial hypertension	10
Cognitive function impairment	7
Pyramidal symptoms	5
Epilepsy	4
Vision impairment	4
Balance disturbances	3
Paraesthesia	1

The goal of the endoscopic procedure was to join the AC lumen with one of the natural cisterns of cerebrospinal fluid by the shortest route possible. Surgical access was planned with the cistern aimed at on a single line with the trepanation bore. This line was also intended as an endoscope track. In two cases of convexity cysts, a TatraMed stereotactic frame was applied to ensure precise aim localization. All patients were operated on in the supine position with appropriate head rotation. To stabilize the head during the whole procedure, it was fixed in a Mayfield clamp. The procedures were performed with rigid GAAB, FRAZEE and CHAVANTES-ZAMORANO Karl Storz Endoscope instruments. Major differences as to the size of working channel and instrumental equipment exist between different endoscope models. Due to its length, the CHAVANTES-ZAMORANO endoscope was used for procedures with a stereotactic frame. Visualization of the operative field was secured with a digital camera and high-definition monitor integrated with a visual track. The endoscope was inserted into the skull via a 10-15 mm trepanation bore, the location of which was first planned in detail. After incision of the dura mater the external wall of the cyst was coagulated and cut. The endoscope was introduced into the cyst and its inside was inspected 'freehand'. This stage was accomplished with exchangeable 30 and 70° angular optics. The field was continually rinsed with warm Ringer solution to secure clear sight. This procedure also prevented excessive loss of cerebrospinal fluid, which prevented a collapse of the cyst walls. Final location of the cyst and natural cerebrospinal cistern stoma was chosen after endoscopic exploration. The AC of the lateral fissure of the brain was drained into the cistern of the optical chiasma, the carotid artery cistern or the prepontine cistern with cystocisternostomy. Cystoventriculostomy of AC located on the convexity of the brain was performed with the lateral ventricle. Basic endoscopic tools were used. The cyst wall was blunt-punctured and the fenestration was widened with a Fogarty no. 3 balloon catheter. When the wall was too thick, it was cut with scissors after coagulation of small superficial vessels. In neither of the cases did anatomical limitations allow for formation of a stoma wide enough to secure long-term effective patency. Hence, it was secured with a silicone elastomer Integra NeuroSciences umbrella drain. The umbrella not only prevented obturation of the opening, but stabilized the position of the drain within fluid collections as well. The drain was introduced via the working channel of the endoscope or outside the endoscope (next to it) under visual guidance. In patients with a lateral fissure cyst the umbrella tip of the drain was implanted into an arachnoid cistern and the free tip floated inside the cyst. In brain convexity cysts, two connected drains were placed in such a manner that one umbrella remained inside the cyst while the other was set inside the lateral ventricle (Figure 1). Thorough flushing of blood clots off the surgical field finished the procedure. Dura mater hole was filled with TachoComb. Meticulous suture of soft tissues covering the skull prevented cerebrospinal fluid collection below the periosteum immediately after the surgery.

Results were assessed both clinically and radiologically. Neurological examination was conducted according to the protocol of the department. Radiological studies included CT or MRI of the head and were assessed by the same team. The first control examination was performed 48 h after surgery, then a month, 3 months, 6 months and a year after the procedure and annually later on. This scheme could be tailored to the clinical situation and was not always strictly adhered to. Resolution of increased intracranial pressure symptoms and remission or reduction of previously seen symptoms were considered significant clinical improvement. Patients with minimal improvement had a small clinical benefit when compared to the pre-operative period. Reduction of AC size by 20% was a radiological criterion of successful surgery. The measurement used was the sum of the largest dimensions obtained in 3 different planes. Ambulatory follow-up was 2.5-6 years (mean 34 months).

Results

Immediate and long-term results of AC according to adopted assessment criteria are show in Tables II and III. Clinical improvement was observed in 11 patients (84.6%) and reduction of cyst size in 12 patients (92.3%). Signs of increased intracranial pressure, blurred vision and balance disturbances resolved in all patients. Six patients showed improvement of intellectual function. Pyramidal

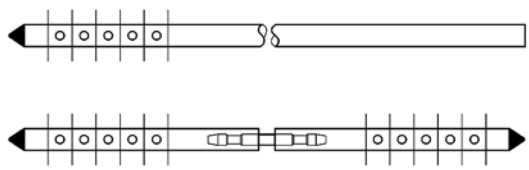

Figure 1. A drain with an umbrella and two connected drains used for cystocisternostomy and cystoventriculostomy

symptoms resolved in 3 patients and decreased in the remaining patients. In 3 epilepsy patients symptoms receded in the immediate post-op period until month 16, when one of these patients had a relapse without any sign of radiological deterioration. In 2 patients headache returned, but different in character and without any signs of the cyst rebuilding in CT. Hence, headache of other than AC origin was diagnosed. A significant radiological improvement was noted in all younger patients with a cyst on the convexity, and a lesser one with lateral fissure cysts. No deterioration of neurological status, infectious complications, drain migration or death was seen. Peri-cerebral haematoma with shrinking of the cyst was seen in 2 patients with lateral fissure AC treated with cystocisternostomy and drain implantation. Both were asymptomatic and no surgery was necessary. Their resorption was monitored with CT. One patient suffered from cerebrospinal fluid collection below the epicranial aponeurosis early post surgery, yet it resolved spontaneously within a few weeks (Figures 2A-C, 3A-B).

Table II. Results of treatment of 13 patients with arachnoid cyst – clinical improvement

Result	Improvement	Small improvement (no change)
Immediate	8 (61.5%)	5 (38.5%)
Long-term	11 (84.6%)	2 (15.4%)

Table III. Treatment results of 13 patients with arachnoid cyst – radiological picture

Result	Shrinking of the cyst	No change in cyst size
Immediate	7 (53.8%)	6 (46.2%)
Long term	12 (92.3%)	1 (7.7%)

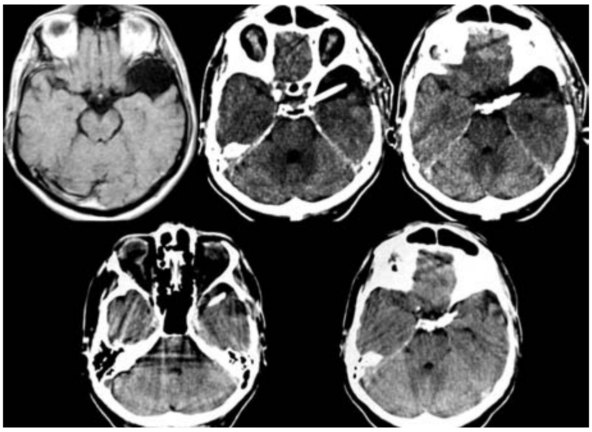

Figure 2A. CT of the head. Implanted drain connecting arachnoid cyst of the lateral fissure with peripontine cistern. Studies prior to surgery, a few days and 12 months after surgery

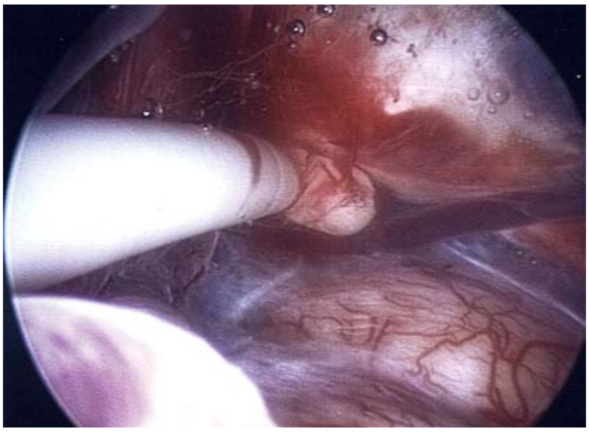

Figure 2B. Same case, endoscopic picture. Introduction of the drain into the peripontine cistern

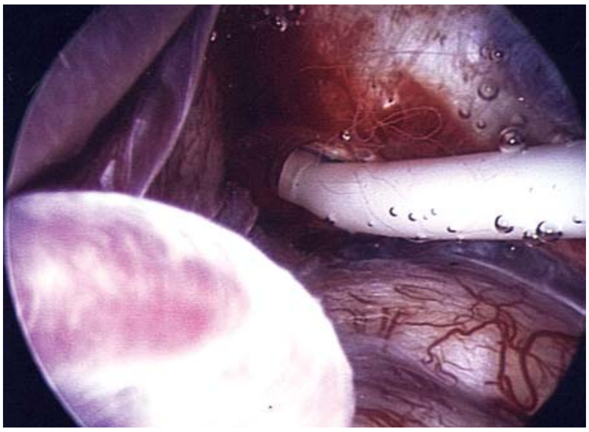

Figure 2C. Same case, endoscopic picture. Drain in position permanently securing patency of cystocisternostomy

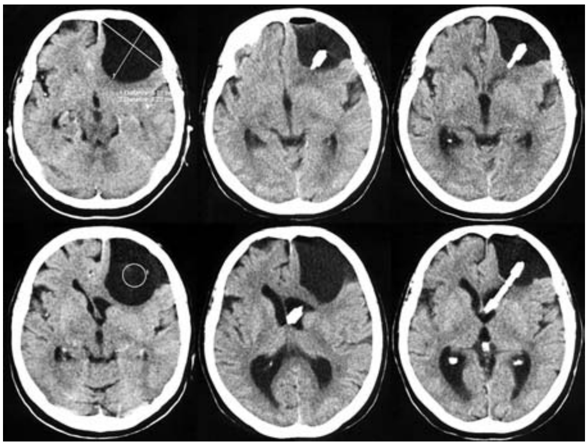

Figure 3A. CT of the head. Large arachnoid cyst at the brain convexity in the frontal region causing dislocation of the midline structures and compression of the lateral ventricle. Study after cystoventriculostomy and implantation of drains to connect the cyst with the lateral ventricle. Three months after surgery: dimensions of the cyst decreased and compression of the lateral ventricle subsided

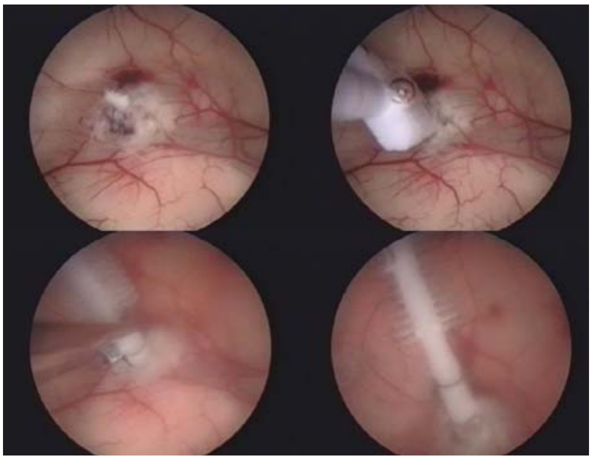

Figure 3B. Same case, endoscopic picture. Securing patency of cystoventriculostomy with a set of drains

Discussion

Patients with diagnosed AC are not uncommon in neurological clinics, yet the literature lacks clear-cut qualification criteria for surgical treatment of this condition. In the presented, highly-selected group of patients these seemed obvious. Gaab *et al.* suggest surgical treatment of all symptomatic and asymptomatic cysts in young patients with mass effect on CT or MRI. When no correlation of clinical and radiological picture can be found, they propose observation and intracranial pressure monitoring [23]. Beltramello and Mazza broaden the spectrum of indications for symptomatic cysts with increased intracranial pressure, regardless of existing communication of the cyst with a natural cerebrospinal fluid cistern [8]. No consensus of management of asymptomatic AC has been worked out so far. A chance to improve intellectual performance speaks in favour of surgical treatment, especially in younger patients [16]. Glassi thinks grade 2 and 3 (according to his own classification) asymptomatic lateral fissure cysts should only be treated with surgery after lack of their communication with arachnoid cisterns has been confirmed [22]. Risk of complications exceeding the potential risk of cyst growth and cases of spontaneous cyst resolution should also be considered when evaluating indications for surgery [8].

The problem of endoscopic AC treatment in adults is not extensively discussed in the literature. Thorough planning of operative access and drainage point of the cyst into the natural cerebrospinal fluid cistern is a key to successful surgery. The possibility of such stoma formation from anatomical and technical points of view ought to be analyzed, regarding aberrant, as a result of cyst, intracranial anatomy. Complete MRI allows for three dimensional assessment of the cyst, its wall thickness, content and relations to arachnoid cisterns and the ventricular system. The adopted method of localizing the trepanation bore and the cistern aimed at on the same line perpendicular to the bore, extracerebral access and minimization of intervention into the brain structure confirmed its usefulness in all cases. Application of the stereotactic frame was necessary for finding optimal access to a narrow lateral ventricle. However, due to disfigurement of anatomical structures from the cyst, various neuronavigation systems ought to be used [24, 25].

Rigid neuroendoscopes seem superior in surgical application to flexible ones. They have a better optical system, allow easier orientation in the operative field, and more instruments can be used with them [16, 18, 20, 21, 23, 26].

The intra-operative situation is always decisive for the point of AC wall fenestration into a natural cerebrospinal fluid cistern. Proper orientation in the operative field is crucial for this stage of surgery. Identification of the frontal lobe, temporal lobe, lesser wing of sphenoid bone, petrosphenoid fold, veins of the lateral fissure and middle cerebral artery make it easier in the case of a lateral fissure cyst. Thickening and cloudiness of the cyst wall from previous bleedings can make orientation much more difficult [7, 26]. Our experience shows that a basic endoscopic tool set is sufficient for performing fenestration [27]. Edges of the opening can be coagulated to make them contract. This is especially recommended when a valve mechanism is seen in the cyst wall [3, 16]. Adequate size of fenestration, guaranteeing its long-term functionality, ought to be 10-15 mm. It can rarely be done with lateral fissure cysts. Hence, whenever there is a risk of obstruction of the stoma, a few smaller holes to adjacent natural cerebrospinal fluid cisterns can be formed [20, 21, 26]. Bleeding from bridging veins within the cyst during surgery or iatrogenic injury to blood vessels can also affect fenestration patency [7, 16]. Post-haemorrhagic fluid contains more cells and proteins, which potentially promote adhesions of the arachnoid, resulting in closure of a created stoma. Continual rinsing with warm Ringer solution and bipolar coagulation usually allow effective control of minor bleeding.

The authors secured functional effectiveness of cystocisternostomy and cystoventriculostomy with silicone elastomer drainage. Such a procedure was recommended by Schroeder *et al*. [20, 23]. Regardless of location of the AC, its additional benefit is prevention of closure of the fenestration due to decrease of pressure within the cyst and receding of the cyst walls. In the case of cystoventriculostomy, the distance from the cyst of the brain convexity and lateral ventricle is significant and drainage placement ensures communication. Introduction of the drain is not always possible and safe because of the proximity of important neurovascular structures and should never be forced. Kim and Paladino *et al*. adopted a similar treatment scheme, observing satisfactory results, although in only a few patients and without approaching cysts of the brain convexity [21, 28].

Cases of patients who had only minor improvement after surgery or no improvement at all suggest another undiagnosed reason, unrelated to the presence of the AC. According to Bidziński, neurological symptoms and epilepsy in cysts are caused by two factors: compression on the brain structures and gliosis in the immediate proximity, which can explain treatment failures [29].

No radiological improvement with neurological betterment comes from lesser elasticity of the brain in adult patients and from aforementioned gliosis [7, 20, 30]. Greenfield *et al*. believe that in lateral fissure cysts remission of symptoms is more likely than reduction of the cyst size [3]. Improvement of clinical status in such cases can be explained by equalization of pressure on both sides of the fenestration. Schroeder *et al*. point to this phenomenon in cysts with a valve mechanism in the wall [31]. However, according to Roszkowski, the pressure gradient across fluid compartments is unpredictable, considering pulse-dependent phases of intracranial pressure fluctuation and the resultant direction of cerebrospinal fluid flow [18].

Due to its safety, repeatability, effectiveness and small number of complications, application of a silicone elastomer drain seems a promising option in endoscopic treatment of selected arachnoid cyst cases.

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