Endoscopic fenestration of intraventricular cerebrospinal fluid cysts: the contralateral approach

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OBJECTIVE The endoscopic fenestration of intraventricular CSF cysts has evolved into a well-accepted treatment modality. However, definition of the optimal trajectory for endoscopic fenestration may be difficult. Distorted ventricular anatomy and poor visibility within the cyst due to its contents can make endoscopic fenestration challenging if approached from the ipsilateral side. In addition, transcortical approaches can theoretically cause injury to eloquent cortex, particularly in patients with dominant-sided lesions. The aim of this study was to examine the value of the contralateral transcortical transventricular approach in patients with dominant-sided ventricular cysts.

METHODS During a 5-year period between 2007 and 2011, 31 patients with intraventricular CSF cysts underwent surgery by the senior author (R.R.). Fourteen of these patients had cysts located on the dominant side. An image-guided endoscopic cyst fenestration via the contralateral transcortical transventricular approach was performed in 11 patients. A retrospective chart review was performed in all these patients to extract data on clinical presentation, operative technique, and surgical outcome.

RESULTS The most common presenting symptom was headache, followed by memory deficits and cognitive deterioration. In all cases CSF cysts were space occupying, with associated obstructive hydrocephalus in 8 patients. Image-guided endoscopic fenestration was successfully performed in all cases, with septum pellucidotomy necessary in 6 cases, and endoscopic third ventriculostomy in 1 case for additional aqueductal occlusion. Postoperative clinical outcome was excellent, with no associated permanent neurological or neuropsychological morbidity. No recurrent cysts were observed over a mean follow-up period of 2 years and 3 months.

CONCLUSIONS The contralateral approach to ventricular cysts can achieve excellent surgical outcomes while minimizing approach-related trauma to the dominant hemisphere. Careful case selection is essential to ensure that the contralateral endoscopic trajectory is the best possible exposure for sufficient cyst fenestration and restoration of CSF circulation.

<http://thejns.org/doi/abs/10.3171/2015.4.JNS142157>

KEY WORDS endoscopy; intraventricular; CSF; cyst; surgical technique

NEUROENDOSCOPY is widely accepted as a safe and effective treatment modality for intraventricular cystic lesions in modern neurosurgery.^{2,6,8,9,14,15,17–20,23} In cases of suspected malignancy the indications for neuroendoscopy are still contentious, although there may be a role in tumor biopsy, cytoreduction, and the management of secondary hydrocephalus.^{2,6,8,9,14,18,20,23} In benign disease such as CSF cysts, however, neuroendoscopic approaches may be curative.^{2,8,9,15,17,19}

Although usually termed CSF or arachnoid cysts, they can contain CSF-like fluid, and the cells lining their walls may derive from the arachnoid, ependyma, or choroid plexus; most are believed to be congenital, reflecting some

degree of aberrant brain development.¹ Regardless of their origin, large CSF cysts become clinically symptomatic through their space-occupying effect, or as a result of associated obstructive hydrocephalus. Several treatment options for intraventricular CSF cysts have been described in the literature, including open microsurgical aspiration, excision, or marsupialization, as well as cystoperitoneal shunting procedures. Fenestration of CSF cysts using a purely endoscopic technique has also been increasingly reported.^{2,8,19} In most cases, endoscopic fenestrations are performed via an ipsilateral transcortical transventricular approach offering the shortest trajectory to the cyst. However, anatomical orientation upon entering a ventricle

SUBMITTED September 15, 2014. ACCEPTED April 2, 2015.

INCLUDE WHEN CITING Published online October 2, 2015; DOI: 10.3171/2015.4.JNS142157.

that is occupied by a large cyst is often challenging, and visualization may be obscured as a result of the proteinaceous cyst contents. Furthermore, in patients with CSF cysts located in the dominant hemisphere, a conventional ipsilateral approach can cause approach-related injury to eloquent cortex and is theoretically associated with an increased risk of neurological deficits.

In this study, we retrospectively review a series of patients with intraventricular CSF cysts located on the dominant hemisphere that underwent image-guided endoscopic fenestration via a novel contralateral approach to improve intraventricular orientation and visualization, as well as reduce the risk of approach-related morbidity to the dominant hemisphere.

Methods

Retrospective Analysis

During a 5-year period between 2007 and 2011, 31 patients with intraventricular CSF cysts underwent surgery by the senior author (R.R.). All patients underwent preoperative general neuropsychological examinations if possible. Brain dominance was established based on these neuropsychological examinations and handedness. In all, 14 patients had intraventricular cysts located in the dominant hemisphere.

MRI was performed as a standard practice for planning of the procedure. The contralateral transcortical transventricular approach was only planned if: 1) the right lateral ventricle still offered sufficient space to maneuver the neuroendoscope, 2) the midline could be crossed safely, 3) the planned approach offered an optimal trajectory for the fenestration, and 4) it allowed sufficient restoration of the CSF circulation. The possibility of supplemental procedures such as septum pellucidotomy or third ventriculostomy was also explored. In 3 patients with an intraventricular cyst in the dominant hemisphere, a suitable trajectory could not be identified, and a conventional ipsilateral transcortical approach to the cyst was used. In the remaining 11 patients, an image-guided endoscopic cyst fenestration via a contralateral transcortical transventricular approach was performed. Hospital charts and operative notes were reviewed in all patients to extract data on clinical presentation, operative technique, and surgical outcome.

A number of tools were used intraoperatively to aid surgical performance (see illustrative case below). Neuronavigation systems were used in all cases to exactly define the transcortical transventricular trajectory. Endoscopy provided excellent intraventricular visualization through illumination, magnification, and a wide viewing angle. Moreover, the use of specially designed instruments through working channels allowed adequate dissection.

Postoperatively, patients were routinely monitored on an intensive care unit. Early MRI or a CT scan was performed within 24 hours to exclude operative complications such as hemorrhage or acute hydrocephalus. In addition, all patients underwent MRI 3 months following their operation, with subsequent follow-up imaging arranged as necessary. Antiepileptic drugs were not used perioperatively. Finally, all patients also had a postoperative general neuropsychological reevaluation.

Operative Technique (Illustrative Case)

An 81-year-old woman was admitted to an acute geriatric ward with progressive loss of consciousness and right-sided hemiparesis. An MR image revealed a large space-occupying cyst of the left lateral ventricle with associated midline shift and early cerebral herniation (Fig. 1). After careful evaluation, the case was considered suitable for a contralateral frontal approach.

A neuronavigation system (BrainLAB AG) was used to define the optimal position for a bur hole trephination, and to plan the transcortical approach to the ventricle (Fig. 2). A rigid endoscope with a 6.0-mm outer diameter, 2.8-mm optic channel, 2.2-mm working channel, 1.4-mm irrigation channel, and 1.4-mm overflow channel was used for intraventricular visualization (MINOP Ventriculoscope, Aesculap AG). The overflow channel was also used as a secondary working pathway, thus allowing bimanual tissue dissection.

After penetration of the right lateral ventricle with the rigid endoscope, the septum pellucidum was exposed and fenestrated with the aid of a bipolar electrode, as well as grasping and cutting instruments. Upon entering the contralateral ventricle, the wall of the cyst was shrunk with coagulation, and then opened with sharp scissors. The ventricular chamber on both sides was then visualized, confirming the unhindered CSF flow into the third ventricle (Fig. 3). After removing the endoscope, the bur hole was closed with a titanium plate, and the wound approximated with sutures.

The postoperative course was uneventful and the patient showed rapid regression of all preoperative clinical symptoms. Three months after surgery, neuropsychological examination revealed satisfactory age-related performance, and postoperative MRI confirmed a collapsed cyst with resumption of normal CSF flow (Fig. 4).

Results

Radiological Features and Clinical Presentation

Eleven right-handed patients with space-occupying intraventricular cysts on their dominant left side underwent detailed preoperative neuroradiological studies, including triplanar MRI. Cysts were located in the occipital horn in 6 cases, the atrium in 3 cases, and the frontal horn in 2 cases. Compression of the opposite ventricle was observed in all patients, and associated obstructive hydrocephalus was observed in 8 patients.

The most common presenting symptom was headache (8/11), followed by memory deficits (5/11). One patient suffered from herniation of the dominant hemisphere resulting in severe neurological deficits (see illustrative case above). The diagnosis was made incidentally in 3 cases.

In 10 patients a detailed preoperative neuropsychological examination was performed, revealing signs of cognitive deficits in 8 cases. These deficits mainly consisted of mental slowing, loss of attention span, and impaired short-term memory.

Image guidance was routinely used and the right lateral ventricle was successfully tapped on the first attempt in every case. In 6 cases, a septum pellucidotomy was performed to gain access to the contralateral side; in the re-

FIG. 1. Preoperative T2-weighted axial (A–D) and contrast-enhanced T1-weighted coronal (E–H) MR images showing a large intraventricular CSF cyst with space-occupying effect and herniation of the dominant hemisphere. The right ventricle is compressed, but there remains sufficient space for an endoscopic approach. Note the displaced septum and the medial wall of the cyst (arrow) in panel C.

maintaining 5 cases, no septum was present. Endoscopic cyst fenestration achieved cystoventricular communication and restored CSF flow in all cases; in 1 case, endoscopic third ventriculostomy was also performed because of additional aqueductal compression.

Surgical Outcome

There were no permanent postoperative complications in the series. One patient had a minor transient memory deficit, with complete resolution of symptoms within 5 days. Postoperative imaging did not show structural damage to the fornix in any case. A small parenchymal hemor-

rhage around the cortical trajectory was found on postoperative CT in 1 case; this was, however, in the absence of clinical symptoms and signs, and without significant associated mass effect.

Routine clinical follow-up 3 months after surgery revealed no neurological deficits. Headache, the most common symptom upon first presentation, improved significantly in 6/8 patients; the remaining 2 patients suffered from unchanged migraine. All 8 patients with preoperative neuropsychological deficits showed improvement on detailed postoperative examination. None of the patients developed epileptic seizures. Postoperative MRI confirmed

FIG. 2. Intraoperative use of a rigid ventriculoscope. Navigation is mandatory for planning the optimum trajectory to enter the ventricular chamber. Note bimanual dissection through the working and overflow channels (left).

FIG. 3. Intraoperative photographs showing steps of the procedure. After entering the right frontal horn, the septum is fenestrated with coagulating, grasping, and cutting devices (**A**). Through the fenestrated septum, the contralateral ventricle is approached and the cyst membrane opened (**B**). Note the left caudate nucleus (*star*), thalamostriate vein (*arrow*), and white surface of the thalamus. After sufficient cyst fenestration, the extremely enlarged occipital horn is exposed (**C**). Note the tentorium (*star*), straight sinus (*arrow*), and the falx (*double star*) by partial aplasia of the occipital lobe. The endoscope is moved back into the right frontal horn (**D**), confirming normal CSF flow through the foramen of Monro (*arrow*). Note bilateral exposure after septal fenestration.

free flow of CSF in the fenestrated cysts in all cases and, over a mean follow-up period of 2 years and 3 months, no recurrence of symptoms or regrowth of cysts were observed.

Discussion

Anatomical orientation can be challenging when entering a ventricular space occupied by a large CSF cyst. In many cases, recognition of anatomical landmarks is further impaired by poor visibility through the proteinaceous contents of the cyst. The contralateral approach to such intraventricular space-occupying cysts may improve surgical orientation and visualization.

The traditional neurosurgical view of a rigid brain organization with fixed areas of eloquence has been challenged by recent conceptual and methodological advances in neuroscience.⁴ This implicitly contests the classic concept of taking the most direct approach to access cerebral lesions, especially in minimally invasive and endoscopic neurosurgery, where in most cases functional cortical mapping is not possible. The risk of significant injury to eloquent cortex in endoscopic transcortical approaches is comparatively low, as evidenced by the favorable outcomes in existing case series.^{8,19} Nonetheless, complications such as hemorrhage do still occur, and their impact is likely to be greater in dominant-hemisphere approaches.

In this study we report on the application of image-guided endoscopic fenestrations of dominant-sided CSF cysts via a contralateral transcortical transventricular approach. The concept of a contralateral approach to address lesions of the dominant side is well accepted in cranial

FIG. 4. Postoperative T2-weighted axial (**A–D**) and contrast-enhanced T1-weighted coronal (**E–H**) MR images showing successful cyst fenestration and normal CSF flow within the ventricular chamber. The cyst is collapsed, the septum is in the midline, and the gyral surface demonstrates effective decompression of the dominant hemisphere. Note placement of the septal fenestration (*arrows*) in panels **B** and **E**.

microneurosurgery, allowing an optimal surgical exposure while avoiding approach-related damage to important neurovasculature of the dominant hemisphere.

Several authors have reported the use of contralateral approaches for the microsurgical management of intracranial aneurysms.^{3,5,11,12,21} The contralateral supraorbital keyhole approach has also been described by the pupils of Perneczky in detail.^{10,22} Novak et al. reported a case of a recurrent posterior fossa craniopharyngioma approached through the cistern magna from the contralateral side with an excellent outcome.¹⁶ Spetzler's group reported a series of 32 patients with lesions located laterally in or adjacent to the lateral ventricle, of whom 29 patients had lesions in the dominant hemisphere; a contralateral interhemispheric transcallosal approach was used, achieving excellent surgical outcomes.¹³ However, none of the aforementioned studies emphasized the importance of a contralateral approach for the treatment of intraventricular lesions.

The use of endoscopes for the treatment of cystic intracranial lesions has gained broader acceptance in modern neurosurgery.^{2,6,8,9,14,15,17–20,23} Although available neuroendoscopic equipment is rapidly advancing, the use of rigid instruments through narrow working channels is entirely coaxial, and most neurosurgical approaches leave little room for maneuvering, making tissue manipulation challenging. CSF cysts may therefore be considered as prime candidates for endoscopic fenestration because the operation does not involve extensive tissue resection, and cysts and ventricles offer sufficient CSF space to maneuver the endoscope. Talamonti et al. reported a high rate of clinical improvement in symptomatic patients (40/44; 91%) and reduction of cyst size (37/50; 74%) with no deaths and no permanent morbidity in endoscopically treated patients with developmental intraventricular cysts.¹⁹ In their publication, however, the choice of the optimal approach is not elaborated in detail.

Gangemi et al. reviewed their experience with 22 patients with intraventricular (n = 13) and paraventricular (n = 9) CSF cysts, operated on using endoscopic techniques.⁸ In their series, all midline lesions (6/22) were approached through right-sided transcortical access according to the principle of entry through the nondominant hemisphere. Ipsilateral access through the enlarged ventricle was used in 4 cases and through the contralateral compressed ventricle in 2 cases to treat cysts of the choroid plexus. Hemispheric dominance did not influence the choice of approach in these cases.

In our study we present a series of 11 patients, each with a space-occupying CSF cyst on the dominant-side, who underwent image-guided endoscopic fenestration via a contralateral transcortical transventricular approach.

The absence of significant postoperative morbidity or recurrent cyst-related symptoms in this case series is promising, supporting the continued use of the contralateral transcortical transventricular approach for dominant-hemisphere cysts. We consider a number of preconditions necessary for success when utilizing the contralateral approach. Careful case selection is essential to ensure that there is sufficient room within the compressed nondominant ventricle to allow a fenestration of the cyst using a contralateral approach. Crossing the midline through a septum pellucidotomy has the inherent risk of damaging

the fornix with subsequent memory impairment.⁷ Only 1 patient showed transient memory deficits postoperatively, with complete regression of symptoms within 5 days. These results could be achieved by image guidance of the surgical approach along a narrow transcortical transventricular trajectory and by endoscopy, which provides optimal visualization of the contralateral target region. Rigid instruments used through endoscopic working channels allow an effective cyst perforation.

Although this study provides important results on the surgical outcome of a novel contralateral transcortical transventricular approach to dominant-sided ventricular CSF cysts, it has minor limitations. First, the retrospective nature of this single-surgeon case series raises the inherent possibility of a confounding case selection bias. Moreover, in the absence of a control group, the favorable outcomes reported here may be the result of the minimally invasive nature of the surgery rather than the contralateral approach per se. Second, future studies require clear primary endpoints such as quantitative perioperative neurological and neuropsychological patient outcomes. And finally, a longer follow-up period would be needed to exclude late recurrence of cysts.

Conclusions

Our study has provided encouraging initial results, suggesting that the image-guided endoscopic fenestration of dominant-hemisphere ventricular cysts via a contralateral approach is a safe and efficacious technique with very low approach-related morbidity. Further prospective studies with longer follow-up durations are necessary to validate these initial findings.

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Disclosure

Dr. Reisch is an advisor for Karl Storz GmbH & Co.

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Conception and design: Hugelshofer, Reisch. Acquisition of data: Hugelshofer. Analysis and interpretation of data: Hugelshofer, Marcus. Drafting the article: Hugelshofer, Marcus, Kockro. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Koechlin. Statistical analysis: Hugelshofer. Administrative/technical/material support: Reisch. Study supervision: Reisch.

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