

1 **Endoscopic Fenestration of Intraventricular Cerebrospinal Fluid Cysts: The**  
2 **Contralateral Approach**

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26 **RUNNING TITLE**

27 Contralateral endoscopic approach to intraventricular csf cysts

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30 **ABSTRACT**

31 **Object:** The endoscopic fenestration of intraventricular cerebrospinal fluid (CSF)  
32 cysts has evolved into a well-accepted treatment modality. However, definition of the  
33 optimal trajectory may be difficult. Distorted ventricular anatomy and poor visibility  
34 within the cyst due to its contents can make endoscopic fenestration challenging if  
35 approached from the ipsilateral side. In addition, transcortical approaches can  
36 theoretically cause injury to eloquent cortex, particularly in patients with dominant-  
37 sided lesions. The aim of this study was to examine the value of the contralateral  
38 transcortical transventricular approach in patients with dominant-sided ventricular  
39 cysts.

40 **Methods:** During a five-year period between 2007 and 2011, 31 patients with  
41 intraventricular CSF cysts underwent surgery by the senior author (RR), of which 14  
42 patients had cysts located on the dominant-side. An image-guided endoscopic cyst  
43 fenestration via the contralateral transcortical transventricular approach was  
44 performed in 11 patients. A retrospective chart review was performed in all patients to  
45 extract data on clinical presentation, operative technique, and surgical outcome.

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

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

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## 61 Introduction

62 Neuroendoscopy is widely accepted as a safe and effective treatment modality for  
63 intraventricular cystic lesions in modern neurosurgery<sup>2,6,8,9,14,15,17-20,23</sup>. In cases of  
64 suspected malignancy the indications for neuroendoscopy are still contentious,  
65 though there may be a role in tumor biopsy, cytoreduction, and the management of  
66 secondary hydrocephalus<sup>2,6,8,9,14,18,20,23</sup>. In benign disease such as cerebrospinal fluid  
67 (CSF) cysts, however, neuroendoscopic approaches may be curative<sup>2,8,9,15,17,19</sup>.

68 Although usually termed CSF or arachnoid cysts, they can contain CSF-like fluid, and  
69 the cells lining their walls may derive from the arachnoid, ependyma or choroid  
70 plexus; most are thought to be congenital reflecting some degree of aberrant brain  
71 development<sup>1</sup>. Regardless of their origin, large CSF cysts become clinically  
72 symptomatic through their space-occupying effect, or as a result of associated  
73 obstructive hydrocephalus. Several treatment options for intraventricular CSF cysts  
74 have been described in the literature including open microsurgical aspiration,  
75 excision or marsupialization, as well as cystoperitoneal shunting procedures.  
76 Fenestration of CSF cysts using a purely endoscopic technique has also been  
77 reported increasingly<sup>2,8,19</sup>. In most cases, endoscopic fenestrations are performed via  
78 an ipsilateral transcortical transventricular approach offering the shortest trajectory to  
79 the cyst. [However, anatomical orientation upon entering a ventricle which is occupied](#)  
80 [by a large cyst is often challenging, and visualization may be obscured as a result of](#)  
81 [the proteinaceous cyst contents. Furthermore, in patients with CSF cysts located in](#)  
82 [the dominant hemisphere a conventional ipsilateral approach can cause approach-](#)  
83 [related injury to eloquent cortex, and is theoretically associated with an increased risk](#)  
84 [of neurological deficits.](#)

85 In this study, we retrospectively review a series of patients with intraventricular CSF  
86 cysts located on the dominant hemisphere that underwent image-guided endoscopic  
87 fenestration via a novel contralateral approach in order to [improve intraventricular](#)  
88 [orientation and visualization, as well as](#) reduce the risk of approach-related morbidity  
89 [to the dominant hemisphere.](#)

## 90 Methods

91 Retrospective analysis

92 During a five-year period between 2007 and 2011, 31 patients with intraventricular  
93 CSF cysts underwent surgery by the senior author (RR). All patients underwent pre-  
94 operative general neuropsychological examination if possible. Brain dominance was  
95 established based on these neuropsychological examinations and handedness. In  
96 all, 14 patients had intraventricular cysts located in the dominant hemisphere.

97 A Magnetic Resonance Imaging (MRI) scan was performed as standard for planning  
98 of the procedure. The contralateral transcortical transventricular approach was only  
99 planned if 1) the right lateral ventricle still offered sufficient space to maneuver the  
100 neuroendoscope, 2) the midline could be crossed safely, 3) the planned approach  
101 offered an optimal trajectory for the fenestration, and 4) sufficient restoration of the  
102 CSF circulation. The possibility of supplemental procedures such as septum  
103 pellucidotomy or third ventriculostomy was also explored. In 3 patients with an  
104 intraventricular cyst in the dominant hemisphere, a suitable trajectory could not be  
105 identified, and a conventional ipsilateral transcortical approach to the cyst was  
106 utilized. In the remaining 11 patients, an image-guided endoscopic cyst fenestration  
107 via a contralateral transcortical transventricular approach was performed. Hospital  
108 charts and operative notes were reviewed in all patients to extract data on clinical  
109 presentation, operative technique, and surgical outcome.

110 A number of tools were used intra-operatively to aid surgical performance (see  
111 illustrative case below). Neuronavigation systems were utilized in all cases to exactly  
112 define the transcortical transventricular trajectory. Endoscopy provided excellent  
113 intra-ventricular visualization through illumination, magnification, and a wide viewing  
114 angle. Moreover, the use of specially designed instruments through working channels  
115 allowed adequate dissection.

116 Post-operatively patients were routinely monitored on an intensive care unit. An early  
117 MRI or a Computed Tomography (CT) scan was performed within 24 hours to  
118 exclude operative complications such as hemorrhage or acute hydrocephalus. In  
119 addition, all patients had an MRI scan 3 months following their operation, with  
120 subsequent follow up imaging arranged as necessary. Antiepileptic drugs were not  
121 used peri-operatively. Finally, all patients also had a post-operative general  
122 neuropsychological re-evaluation.

123 Operative technique – an illustrative case

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

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

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

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

## 147 **Results**

### 148 Radiological features and clinical presentation

149 11 right handed patients with space-occupying intraventricular cysts on their  
150 dominant left side underwent detailed preoperative neuroradiological studies  
151 including a triplanar MRI. Cysts were located in the occipital horn in 6 cases, the  
152 atrium in 3 cases, and the frontal horn in 2 cases. Compression of the opposite  
153 ventricle was observed in all patients, and associated obstructive hydrocephalus was  
154 observed in 8 patients.

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

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

162 Image guidance was routinely used and the right lateral ventricle was successfully  
163 tapped on the first attempt in every case. In 6 cases, a septum pellucidotomy was  
164 performed to gain access to the contralateral side; in the remaining 5 cases, no  
165 septum was present. Endoscopic cyst fenestration achieved cystoventricular  
166 communication and restored CSF flow in all cases; in one case, endoscopic third  
167 ventriculostomy was also performed because of additional aqueductal compression.

#### 168 Surgical outcome

169 There were no permanent post-operative complications in the series. One patient had  
170 a minor transient memory deficit, with complete resolution of symptoms within five  
171 days. Postoperative imaging did not show structural damage to the fornix in any  
172 case. A small parenchymal hemorrhage around the cortical trajectory was found on  
173 postoperative CT in one case; this was, however, in the absence of clinical symptoms  
174 and signs, and without significant associated mass effect.

175 Routine clinical follow-up three months after surgery revealed no neurological  
176 deficits. Headache, the most common symptom upon first presentation, improved  
177 significantly in 6/8 patients; the remaining two patients suffered from unchanged  
178 migraine. All 8 patients with preoperative neuropsychological deficits showed  
179 improvement on detailed postoperative examination. None of the patients developed  
180 epileptic seizures. Postoperative MRI confirmed free flow of CSF in the fenestrated  
181 cysts in all cases and, over a mean follow-up period of two years and three months,  
182 no recurrence of symptoms or regrowth of cysts were observed.

#### 183 Discussion

184 [Anatomical orientation can be challenging when entering a ventricular space](#)  
185 [occupied by a large CSF cyst. In many cases, recognition of anatomical landmarks is](#)

186 [further impaired by poor visibility through the proteinaceous contents of the cyst. The](#)  
187 [contralateral approach to such intraventricular space occupying cysts may improve](#)  
188 [surgical orientation and visualization.](#)

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

198 In this study we report on the application of image-guided endoscopic fenestrations  
199 of dominant-sided CSF cysts via a contralateral transcortical transventricular  
200 approach. The concept of a contralateral approach to address lesions of the  
201 dominant side is well accepted in cranial microneurosurgery, allowing an optimal  
202 surgical exposure while avoiding approach-related damage to important  
203 neurovasculature of the dominant hemisphere.

204 Several authors have reported the use of contralateral approaches for the  
205 microsurgical management of intracranial aneurysms<sup>3,5,11,12,21</sup>. The contralateral  
206 supraorbital keyhole approach has also been described by the pupils of Perneczky in  
207 detail<sup>10,22</sup>. Novak *et al* reported a case of a recurrent posterior fossa  
208 craniopharyngioma approached through the cistern magna from the contralateral side  
209 with an excellent outcome<sup>16</sup>. Spetzler's group reported a series of 32 patients with  
210 lesions located laterally in or adjacent to the lateral ventricle, of which 29 patients had  
211 lesions in the dominant hemisphere; a contralateral interhemispheric transcallosal  
212 approach was utilized, achieving excellent surgical outcomes<sup>13</sup>. However, none of the  
213 aforementioned studies emphasized the importance of a contralateral approach for  
214 the treatment of intraventricular lesions.

215 The use of endoscopes for the treatment of cystic intracranial lesions has gained  
216 broader acceptance in modern neurosurgery<sup>2,6,8,9,14,15,17-20,23</sup>. Although available  
217 neuroendoscopic equipment is rapidly advancing, the use of rigid instruments

218 through narrow working channels is entirely co-axial, and most neurosurgical  
219 approaches leave little room for maneuver, making tissue manipulation challenging.  
220 CSF cysts may therefore be considered as prime candidates for endoscopic  
221 fenestration since the operation does not involve extensive tissue resection, and  
222 cysts and ventricles offer sufficient CSF space to maneuver the endoscope.  
223 Talamonti *et al* reported a high rate of clinical improvement (40/44; 91%) and  
224 reduction of cyst size (37/44; 74%) with no mortality and no permanent morbidity in  
225 endoscopically treated patients with developmental intraventricular cysts.<sup>19</sup> In their  
226 publication, the choice of the optimal approach is however not elaborated in detail.

227 Gangemi *et al* reviewed their experience with 22 patients with intraventricular (13  
228 cases) and paraventricular (9 cases) CSF cysts, operated upon with endoscopic  
229 techniques.<sup>8</sup> In their series all midline lesions (6/22) were approached through a right  
230 sided transcortical access according to the principle of entry through the non-  
231 dominant hemisphere. Ipsilateral access through the enlarged ventricle was used in 4  
232 cases and through the contralateral compressed ventricle in 2 cases to treat cysts of  
233 the choroid plexus. Hemispheric dominance did not influence the choice of approach  
234 in these cases.

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

238 The absence of significant postoperative morbidity or recurrent cyst-related  
239 symptoms in this case series is promising, supporting the continued use of the  
240 contralateral transcortical transventricular approach for dominant-hemisphere cysts.  
241 We consider a number of preconditions necessary for success when utilizing the  
242 contralateral approach. Careful case selection is essential, to ensure that there is  
243 sufficient room within the compressed non-dominant ventricle, to allow a fenestration  
244 of the cyst using a contralateral approach. Crossing the midline through a septum  
245 pellucidotomy has the inherent risk of damaging the fornix with subsequent memory  
246 impairment<sup>7</sup>. Only one patient postoperatively showed transient memory deficits with  
247 complete regression of symptoms within five days. These results could be achieved  
248 by image guidance of the surgical approach along a narrow transcortical  
249 transventricular trajectory and by endoscopy, which provides optimal visualization of



250 the contralateral target region. Rigid instruments used through endoscopic working  
251 channels allow an effective cyst perforation.

252 Although this study provides important results on the surgical outcome of a novel  
253 contralateral transcortical transventricular approach to dominant-sided ventricular  
254 CSF cysts, it has minor limitations. Firstly, the retrospective nature of this single  
255 surgeon case series raises the inherent possibility of a confounding case selection  
256 bias. Moreover, in the absence of a control group, the favorable outcomes reported  
257 here may be the result of the minimally invasive nature of the surgery rather than the  
258 contralateral approach *per se*. Secondly, future studies require clear primary  
259 endpoints such as quantitative peri-operative neurological and neuropsychological  
260 patient outcomes. Finally, a longer follow-up period would be needed to exclude late  
261 recurrence of cysts.

## 262 **Conclusions**

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

268

269 **Figures**

270 Fig.1 Preoperative T2w axial (a-d) and contrast-enhanced T1w coronal images (e-h)  
271 showing large intraventricular CSF cyst with space-occupying effect and  
272 herniation of the dominant hemisphere. The right ventricle is compressed, but  
273 there remains sufficient space for an endoscopic approach. Note the displaced  
274 septum and the medial wall of the cyst (arrow) on image c.

275 Fig.2 Intraoperative use of a rigid ventriculoscope (Aesculap AG, Tuttlingen,  
276 Germany). Navigation is mandatory for planning the optimum trajectory to  
277 enter the ventricular chamber (BrainLAB AG, Feldkirchen, Germany). Note  
278 bimanual dissection through the working and overflow channels (a).

279 Fig.3 Intraoperative photographs showing steps of the procedure. After entering the  
280 right frontal horn, the septum is fenestrated with coagulating, grasping and  
281 cutting devices (a). Through the fenestrated septum, the contralateral ventricle  
282 is approached and the cyst membrane opened (b). Note the left caudate  
283 nucleus (\*), thalamostriate vein (arrow) and the white surface of the thalamus.  
284 After sufficient cyst fenestration, the extremely enlarged occipital horn is  
285 exposed (c). Note the tentorium (\*), straight sinus (arrow) and the falx (\*\*)  
286 by partial aplasia of the occipital lobe. The endoscope is moved back into the  
287 right frontal horn, confirming normal CSF flow through the foramen of Monro  
288 (arrow). Note bilateral exposure after septal fenestration (d).

289 Fig.4 Postoperative T2w axial (a-d) and contrast-enhanced T1w coronal images (e-  
290 h) showing successful cyst fenestration and normal CSF flow within the  
291 ventricular chamber. The cyst is collapsed, the septum is in the midline and  
292 the gyral surface demonstrates effective decompression of the dominant  
293 hemisphere. Note placement of the septal fenestration on images b and e  
294 (arrows).

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