Acta Neurochir (2012) 154:1517–1522
DOI 10.1007/s00701-012-1381-6

CLINICAL ARTICLE

Endoscopic septostomy through a standard precoronal ventricular access: feasibility and effectiveness

Gianpiero Tamburrini · Paolo Frassanito · Luca Massimi · Massimo Caldarelli · Concezio Di Rocco

Received: 21 March 2012 / Accepted: 1 May 2012 / Published online: 16 May 2012

Abstract
Background Although endoscopic septostomy is widely adopted in the treatment of unilateral or specific types of hydrocephalus, there is no consensus on surgical indications, technical aspects and postoperative outcome. In particular, the choice of the ventricular access has been recently debated. We investigated the results of endoscopic septostomy performed through a standard precoronal ventricular access using a rigid endoscope.
Methods Patients who underwent an endoscopic septostomy at our Institution from March 2001 to March 2011 were retrospectively identified. Clinico-radiological data and video recordings of the endoscopic procedures were reviewed.
Results Sixty-three patients (50 children and 13 adults) were collected. In adults, the obstruction of the cerebrospinal fluid (CSF) pathway was exclusively secondary to a tumor (neoplastic or pseudoneoplastic lesion). In the pediatric group hydrocephalus was most commonly due to a neoplasm (33 out of 50 patients), post-hemorrhagic and/or post-infectious hydrocephalus affecting 11 children and malformative hydrocephalus the remaining six children. We were able to perform the septostomy in all but two patients, presenting with a scarred multilayered septum secondary to post-hemorrhagic hydrocephalus. In 37 cases, one or more other endoscopic procedures were performed contemporarily.

The mean follow-up was 24 months (min-max: 5–96 months). Overall, all but one patient benefited clinically and radiologically from the endoscopic septostomy. Two patients harboring a pineal/mesencephalic tumor experienced a late obstruction of the stoma secondary to neoplastic infiltration of the septum.
Conclusions Endoscopic septostomy can be safely performed through a standard burr-hole. The effectiveness of this approach is testified by an early success rate of more than 95% and a long term success rate of 92%.

Keywords Cyst of the septum pellucidum · Endoscopic septostomy · Fenestration of the septum · Isolated ventricle · Neuroendoscopy · Precoronal burr-hole · Septum pellucidum

G. Tamburrini · P. Frassanito (✉) · L. Massimi · M. Caldarelli · C. Di Rocco
Pediatric Neurosurgery Unit, Catholic University Medical School, Largo Agostino Gemelli, 8,
00168 Rome, Italy
e-mail: paolo.frassanito@gmail.com

Introduction

Few published reports have clearly addressed the results of septostomy among other endoscopic procedures [8, 9, 14] and only three large series specifically deal with the technical aspects of this procedure [2, 7, 13]. Different approaches have been proposed; both an access through the occipital horn or the frontal horn of the lateral ventricles have been taken in consideration; it is also still discussed if it is more proper to enter primarily the smaller or the larger lateral ventricular cavity [4, 5, 21]. Concerning the access through the frontal horn, Aldana et al. [2] have proposed a 2– to 3-cm more lateral entry-point rather than standard Kocher's point, while Oertel et al. [13] suggest 7 cm from the midline burr-hole. The rationale of these technical recommendations is to offer a better work angle to approach the septum, which would make it easier to perform the septostomy. On the other hand, these presumptive advantages are counterbalanced by a more complicated primary access to the chosen lateral ventricle (i.e., the need for neuronavigation or other

image guidance) and the need for planning an intermediate route whenever an associated endoscopic procedure has to be performed.

The primary access of the frontal horn of the lateral ventricle through a standard precoronal burr-hole has been mostly considered disadvantageous, claimed as not allowing a sufficient view of the septal anatomy, which would render the perforation of the septum difficult to conduct.

In our Institution, since March 2001 we have moved from a more lateral frontal horn access (1 cm precoronal, 3–5 cm from the midline) to a standard Kocher's point burr-hole one; this choice was based on the fact that a good view of the septum was available during standard endoscopic third ventriculostomy (ETV) procedures, and that the lateral ventricle was much more easily accessed through this access if compared with the more lateral one. In the present paper we present our experience in performing septostomy through this standard endoscopic approach to the lateral ventricle.

Material and methods

Patients who underwent an endoscopic septostomy at our Institution from March 2001 to March 2011 were included; clinical, anamnestic, radiological charts and video recordings of the endoscopic procedures were reviewed. Patients outcome was referred at the last follow-up.

Preoperative diagnostic work-out

All patients underwent a preoperative MR with T2 and Fiesta sequences, and 3.5-mm axial, coronal and sagittal slices oriented to study the anatomy of the septum and the absence of communication among the two lateral ventricles; the position of the septum/septal membranes in comparison with the midline was considered among diagnostic parameters, a contralateral deviation confirming the isolation of the dilated lateral ventricular cavity.

Technique

A rigid 30° ventriculoscope (Decq endoscope, Karl Storz GmbH & Co., Tuttlingen, Germany) with a standard armamentarium was used for all the operations. Septostomy was the goal of the endoscopic procedure. All the operations were carried out under general anesthesia, with the patient in supine position and the head flexed 30° anteriorly. A 1-cm precoronal burr-hole centered on the mid-pupillary line (about 2 cm from the midline) was used to introduce the endoscope within the chosen lateral ventricle. The larger lateral ventricle was usually preferred. In case of a slit contralateral ventricle, we chose to enter the slit lateral ventricle with the aid of navigation in order to minimize the risk of injury of the contralateral thalamus while performing the septostomy. In children with a frontal catheter already in site, the pre-existent burr-hole was used and the endoscope was introduced parallel to the ventricular catheter. The ventricular cavities were carefully explored to identify the anatomical landmarks. The fenestration of the septum pellucidum was performed at the level of the avascular zone, sited between the anterior and the posterior septal veins. The fenestration/opening was realized by the sole mechanical action of the monopolar probe in case of a very thin septum or by means of the monopolar coagulation in case of thicker walls. The stoma was dilated by using a Fogarty balloon no. 2. In the last five procedures, the fenestration of the septum was obtained by means of thulium laser (RevoLix ®).

At the end of the septostomy, the endoscope was introduced into the stoma to inspect the contralateral ventricle. In particular, the contralateral foramen of Monro was checked, though the absence of dilation of the contralateral ventricle on the preoperative radiological exam is usually a good clue of its patency.

Postoperative diagnostic work-out

A control MR with T2 and Fiesta axial, coronal and sagittal sequences was performed during the immediate postoperative period in all cases (2–7 days after surgery). A further MR control was performed 3 months after surgery and after 1 year, or/and whenever clinical conditions and/or the primary pathological condition would have led to perform it.

Outcome parameters

Technical failures were defined as the impossibility to endoscopically perform the septostomy with the consequent need to implant a second shunt; clinical failures were defined as the need to implant an additional shunting device, in spite of an apparently intraoperative and postoperative MR documentation of patency of the stoma.

Results

Patients

Sixty-three patients (50 children and 13 adults) were collected. In the pediatric group, age ranged from 3 months to 18 years (mean age 7.6 years) and in the adult one, age ranged from 19 to 85 years (mean age 40.7 years). Male patients were 34 and females 29. In the large majority of cases obstructive hydrocephalus was secondary to neoplastic disease (46 out of 63 patients [73%], in particular 33 children and 13 adults). In particular in the pediatric group the most frequent tumor type was optic-hypothalamic

glioma (12 cases), followed by craniopharyngioma (five cases), subependymal giant-cell astrocytoma (four cases) and thalamic glioma (three cases). Other histotypes encountered in the third ventricle were: a teratoma, a papilloma, an astroblastoma, a glioneuronal tumoral supependymal gliomatosis, and a colloid cyst. The remaining four children harbored one each a pineal germinal tumor, a mesencephalic glioma, a lateral ventricle ependymoma, and a posterior cranial fossa pilocytic astrocytoma. Post-hemorrhagic and/or post-infectious hydrocephalus was the second more common etiology (11 out of 63 patients [17.5%]), all patients belonging to the pediatric age group. Finally, in the remaining six children (9.5%) the hydrocephalus recognized a malformative nature, three patients presenting a primary stenosis of the foramen of Monro and the other three patients harboring a cyst of the septum pellucidum.

All adult patients were affected by obstructive hydrocephalus, secondary to the presence of a neoplastic or pseudoneoplastic lesion, and generally referred as tumoral hydrocephalus. In particular, seven of them harbored a third ventricle colloid cyst, three a macroadenoma, two a glial tumor of the third ventricle and the last one a sphenoid wing meningioma (Table 1).

Outcome

We were able to perform the septostomy in all but two cases, despite an optimal visualization of the septum and a good working angle for the endoscopic tools. Both these patients were affected by post-hemorrhagic hydrocephalus and the technical failure to perform the septostomy was related to the intraoperative evidence of a scarred multilayered septum.

Septostomy was associated in 37 cases to one or more other contemporarily performed endoscopic procedures. In particular, cyst or tumor resection was performed in nine cases, tumor biopsy in eight cases, third ventriculostomy in six cases, monroplasty in five cases, positioning of an intracystic catheter in three cases and debridement of the proximal cathether of a pre-existing extrathecal CSF shunt in further three cases.

In 24 patients the endoscopic procedure was associated to the elective positioning of a ventriculo-peritoneal shunt, whereas in 6 cases the septostomy allowed to successfully remove a previously implanted CSF shunting device.

The mean follow-up was 24 months (min 5 months; max 96 months). Overall, all but one patient benefited clinically and radiologically from the endoscopic septostomy. This child, who was affected by a malformative hydrocephalus, did not show any radiological improvement of the ventricular asymmetry after septostomy, despite the patency of the stoma that was confirmed at immediate postoperative MR; due to the compromised neurological conditions already at first admission, hampering a correct evaluation of the eventual neurological improvement, it was decided to implant an additional CSF shunting as a protective measure.

Table 1 Synopsis of the ethiology of hydrocephalus and the failures of endoscopic septostomy

Disease (no. of patients)			Failure/complication	
			Technical failure	Clinical failure
Tumoral hydrocephalus (46)	Children (33)	OHG (12)		
		CRF (5)		
		SEGA (4)		
		Thalamic glioma (3)		
		Pineal/mesencephalic tumor (2)		2
		Others (7)		
	Adults (13)	Colloid cyst (7)		
		Adenoma (3)		
		III ventricle glioma (2)		
		Sphenoid wing meningioma (1)		
Post-hemorrhagic and/or post-infectious hydrocephalus (11)	Children (11)	Post-IVH (8)	2	
		Post-IVH/post-infectious (2)		
		Post-infectious (1)		
Malformative hydrocephalus (6)	Children (6)	Foramen of Monro stenosis (3)		
		Cyst of the septum pellucidum (3)		

OHG optic-hypothalamic glioma, *CRF* craniopharyngioma, *SEGA* subependymal giant cell astrocytoma, *IVH* intraventricular hemorrhage

Two other patients harboring a pineal tumor experienced a late obstruction of the stoma secondary to neoplastic infiltration of the septum. Thus, the indication for the revision of the septostomy was ruled out due to the tumor progression and an additional extrathecal CSF shunting device was positioned. These cases were referred to as clinical failures in Table 1.

Finally, 17 patients required further treatment in order to manage the tumor progression or hydrocephalus complications after endoscopic septostomy; only two of them underwent a subsequent endoscopic procedure—namely, a marsupialization of an intraventricular cyst in a case of post-hemorrhagic/post-infectious hydrocephalus and a laser-assisted partial resection of a craniopharyngioma in another child. In all these cases, however, the septostomy remained patent and functional.

Discussion

Endoscopic septostomy is a procedure with potentially limited risk and high benefit, as proved by the results in the treatment of isolated ventricle [6, 7] and cyst of the septum pellucidum [5, 12]. In order to minimize risk and maximize benefit of endoscopic septostomy, indications and surgical technique should be carefully addressed.

The ideal indication is the obstruction of the foramen of Monro. The septostomy allows the obstruction to be bypassed by creating a CSF circulation between the obstructed ventricle and the contralateral one communicating with the third ventricle. Thus, septostomy avoids the need for an extrathecal CSF shunting device. The same aim can be attended by performing a monroplasty, but the higher risk of injuring the adjacent fornix, veins, and hypothalamus should be considered.

According to our experience, the value of endoscopic septostomy is unquestionable also whenever both foramina of Monro are obstructed. Indeed, septostomy makes the lateral ventricles to be considered as a unique ventricular cavity. Additionally, a communication with the third ventricle can be created by means of a monroplasty. Alternatively, if the latter procedure is not technically possible, the ventricular compartment can be drained by a unique extrathecal CSF shunting device.

In our series, septostomy allowed to avoid the positioning of a CSF shunting device in 9 cases, to position one CSF shunting device instead of two in 32 cases and to remove or simplify, by removing one out of two ventricular catheters, an already implanted CSF shunting system in seven cases.

In patients with third-ventricle colloid cysts, we performed septostomy as an adjunctive preventive measure after the cyst removal in order to overcome any possible impairment of the CSF circulation due to potential postoperative scarring at the level of the foramen of Monro.

Concerning the technique, the ideal site to fenestrate the septum pellucidum is not uniformly described in the literature [2, 7, 13, 20]. We fenestrated the septum in the zone between the anterior and posterior septal vein, as already reported by Hamada et al. [7]. However, although apparent differences in the literature descriptions, the site of fenestration finally corresponds, as observed by Roth et al. [17]. Furthermore, due to the possible asymmetry of contralateral veins, thinning out the septum layer by layer to bring contralateral veins into view, whenever possible, has been recommended [17].

More debated is the choice of the best cranial access to perform an endoscopic septostomy, due to the recent proposal by Oertel et al. [13] of employing a more lateral (5–7 cm from the midline) burr-hole to enter the lateral ventricle. This proposal is based on the assumption that this entry point can assure an ideal approach to the septum and consequently an ideal angle for the endoscopic work sheath and tools.

Our experience suggests that endoscopic septostomy can be safely and effectively performed through a standard burr-hole using a rigid endoscope. The limits of a tangential view of the septum pellucidum are remedied by the use of a 30-degree lens and by the latero-medial tilting of the endoscope. This range of motion can be limited in patients presenting a thick calvarial bone. In such cases the bone circumferentially limiting the burr-hole can be easily undermined by a Kerrison rongeur. Medial tilting and rotation of the endoscope towards the septum up to 90 degrees offer the possibility to obtain a good trajectory for work sheath and tools (Fig. 1).

Nonetheless, some advantageous aspects of the standard approach should be highlighted.

The use of the standard coronal burr-hole allows any additional scar to be avoided. Indeed patients affected by congenital hydrocephalus could require, before or after septostomy, an external ventriculostomy. In such a case, the same cutaneous coronal flap used for endoscopic septostomy can be used.

Moreover in patients affected by tumors, an incision 7 cm from the midline could stand in the central portion of a wider surgical cutaneous flap necessary for the resection of the tumor. Furthermore, the coronal burr-hole allows to have standard anatomic landmarks to access the ventricular cavities and to face a more confidential standard ventricular anatomy. In such a context the role of neuronavigation appears to be needed only in particular circumstances, such as complex anatomy as in the case of multiloculated hydrocephalus or small frontal horns. On the contrary, a burr-hole 7 cm from the midline makes neuronavigation necessary or even mandatory to access normally sized or only mildly enlarged ventricle.

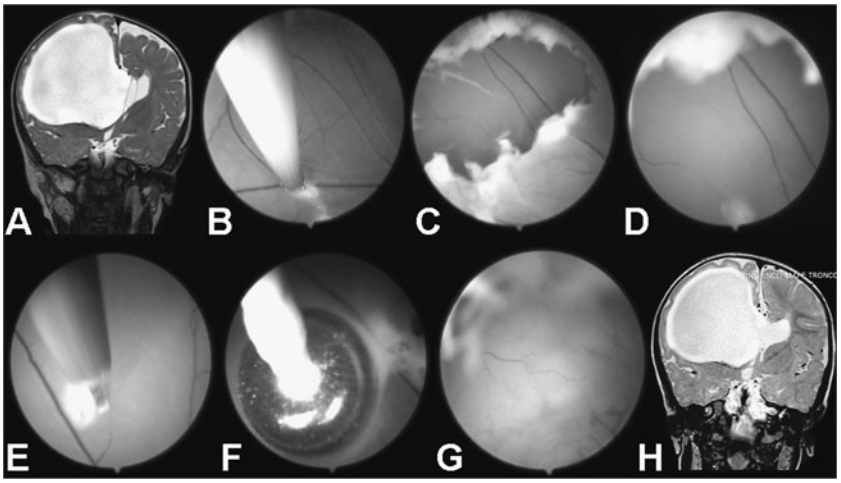

Fig. 1 A 3-month-old baby girl with a history of intraventricular hemorrhage; pre-operative coronal T2-weighted MR image shows a right isolated ventricle with contralateral shift of the septum pellucidum (**a**). A standard precoronal access to the right ventricle allows the septum to be approached and visualized well: the first wall is fenestrated by means of monopolar coagulation due to its thickness (**b**). A wide stoma is achieved (**c**) and the cavum septi is visualized (**d**). The second wall of the septum is fenestrated in a similar fashion (**e**) and the stoma is dilated by means of a Fogarty balloon (**f**). The contralateral left ventricle is inspected through the stoma (**g**). Post-operative MR confirmed the good results of septostomy (**h**)

In our experience endoscopic septostomy was associated to other endoscopic procedures in 37 patients (58.7%). In such cases there was no need to plan an intermediate burr-hole, as proposed by Oertel et al. [13]. Indeed, a standard coronal burr-hole offered the possibility to navigate the lateral ventricle until the trigone and to access the third ventricle through a standard trajectory, thus allowing joint procedures to be performed [10, 11, 15, 16, 18], together with the septostomy.

The effectiveness of a standard precoronal burr-hole access is testified by an early success rate of more than 95% and a long-term success rate of 92% in our series. According to our experience, the risk of technical failure is related to the etiology of the hydrocephalus, as the two technical failures described in this paper were not imputable to the trajectory imposed by the standard burr-hole. Indeed, in two children affected by post-hemorrhagic hydrocephalus, presenting a very thick and fibrous septum, we were able to successfully approach the septum but we were not able to adequately fenestrate it due to their multilayered appearance. A lower success rate of this procedure in patients with post-hemorrhagic hydrocephalus is consistent with previous literature report [8]. Similar intraoperative difficulty could occur in patients with a history of severe meningitis [7]. The constant evolution of radiological techniques, namely the use of new sequences enabling to characterize the features of the septum in the preoperative planning, and the advances in endoscopic tools (e.g., thulium laser [3, 19]) will contribute to minimize the risk of technical failure also in this kind of patients.

Similarly, the clinical failures observed in our experience can be imputable to the etiology of the hydrocephalus, with a higher success rate in case of simply obstructive hydrocephalus secondary to pseudoneoplastic lesions or benign tumors. In fact, the only two cases of late failure were related to the progression of a malignant tumor. On the contrary, in our experience the age under 2 years is not related to the risk of stoma occlusion, as observed by Hamada et al. [7]. Finally, our data do not confirm the relationship between the risk of failure of the initial septostomy and a previous history of repeated extrathecal CSF shunting procedures, as proposed by Aldana et al. [2]. In our series, 15 children (23.8% of patients) had already undergone multiple shunt procedures, no patient requiring a revision of the septostomy. Despite our good results in pediatric group, we agree with the cautious opinion of Aldana on the results of septostomy in pediatric hydrocephalus, in particular secondary to intraventricular hemorrhage and/or infection [1]. Indeed all failures described in this paper were observed in pediatric patients, consistently with a higher percentage of children among treated patients but also with the fact that all the adult patients who underwent the endoscopic septostomy, harbored a simply obstructive hydrocephalus secondary to a pseudotumoral lesion or a benign tumor.

Conclusions

Endoscopic septostomy is an effective treatment of isolated lateral ventricle, whichever the cause of the obstruction of the CSF pathway. The fenestration of the septum pellucidum can be safely performed through a standard precoronal ventricular access using a rigid endoscope. This approach has to be considered advantageous as navigation system is

not mandatory to entry the lateral ventricle, septostomy can be performed concomitantly to other endoscopic procedure and the neurosurgeon could face the standard ventricular anatomy. The feasibility of the septostomy is mainly affected by the ethiology of hydrocephalus, history of intraventricular hemorrhage being associated with thickening of the septum potentially preventing an effective endoscopic fenestration. In patients affected by malignant tumor, strict radiological follow-up should also assess the patency of the stoma in order to promptly detect a closure of the septostomy secondary to neoplastic progression.

Conflicts of interest None.

References

1. Aldana PR (2010) Endoscopic stomy of the septum pellucidium. Neurosurgery 67:E878
2. Aldana PR, Kestle JR, Brockmeyer DL, Walker ML (2003) Results of endoscopic septal fenestration in the treatment of isolated ventricular hydrocephalus. Pediatr Neurosurg 38:286–294
3. Bilici T, Mutlu S, Kalaycioglu H, Kurt A, Sennaroglu A, Gulsoy M (2011) Development of a thulium (Tm:YAP) laser system for brain tissue ablation. Lasers Med Sci 26:699–706
4. Gaab MR, Schroeder HW (1999) Neuroendoscopic approach to intraventricular lesions. Neurosurg Focus 6:e5
5. Gangemi M, Maiuri F, Cappabianca P, Alafaci C, de Divitiis O, Tomasello F, de Divitiis E (2002) Endoscopic fenestration of symptomatic septum pellucidum cysts: three case reports with discussion on the approaches and technique. Minim Invasive Neurosurg 45:105–108
6. Gangemi M, Maiuri F, Donati PA, Signorelli F, Basile D (1999) Endoscopic surgery for monoventricular hydrocephalus. Surg Neurol 52:246–250, discussion 250–241
7. Hamada H, Hayashi N, Kurimoto M, Umemura K, Hirashima Y, Endo S (2003) Neuroendoscopic septostomy for isolated lateral ventricle. Neurol Med Chir (Tokyo) 43:582–587, discussion 588
8. Hayashi N, Hamada H, Hirashima Y, Kurimoto M, Takaku A, Endo S (2000) Clinical features in patients requiring reoperation after failed endoscopic procedures for hydrocephalus. Minim Invasive Neurosurg 43:181–186
9. Heilman CB, Cohen AR (1991) Endoscopic ventricular fenestration using a "saline torch". J Neurosurg 74:224–229
10. Longatti P, Fiorindi A, Feletti A, Baratto V (2006) Endoscopic opening of the foramen of magendie using transaqueductal navigation for membrane obstruction of the fourth ventricle outlets. Technical note. J Neurosurg 105:924–927
11. Massimi L, Di Rocco C, Tamburrini G, Caldarelli M, Iannelli A (2004) Endoscopic third ventriculostomy: complications and failures. Minerva Pediatr 56:167–181
12. Meng H, Feng H, Le F, Lu JY (2006) Neuroendoscopic management of symptomatic septum pellucidum cysts. Neurosurgery 59:278–283, discussion 278–283
13. Oertel JM, Schroeder HW, Gaab MR (2009) Endoscopic stomy of the septum pellucidum: indications, technique, and results. Neurosurgery 64:482–491, discussion 491–483
14. Oi S, Hidaka M, Honda Y, Togo K, Shinoda M, Shimoda M, Tsugane R, Sato O (1999) Neuroendoscopic surgery for specific forms of hydrocephalus. Childs Nerv Syst 15:56–68
15. Pettorini BL, Frassanito P, Tamburrini G, Massimi L, Caldarelli M, Di Rocco C (2008) Retrieval of ventricular catheter with the aid of endoscopy: technical note. J Neurosurg Pediatr 2:71–74
16. Pettorini BL, Tamburrini G, Massimi L, Caldarelli M, Di Rocco C (2009) Endoscopic transventricular positioning of intracystic catheter for treatment of craniopharyngioma. Technical note. J Neurosurg Pediatr 4:245–248
17. Roth J, Olasunkanmi A, Rubinson K, Wisoff JH (2010) Septal vein symmetry: implications for endoscopic septum pellucidotomy. Neurosurgery 67:395–401
18. Tamburrini G, D'Angelo L, Paternoster G, Massimi L, Caldarelli M, Di Rocco C (2007) Endoscopic management of intra and paraventricular CSF cysts. Childs Nerv Syst 23:645–651
19. Treat MR, Trokel SL, Reynolds RD, DeFilippi VJ, Andrew J, Liu JY, Cohen MG (1988) Preliminary evaluation of a pulsed 2.15-Micron laser system for fiberoptic endoscopic surgery. Lasers Surg Med 8:322–326
20. Vinas FC, Castillo C, Diaz FG (1998) Microanatomical considerations for the fenestration of the septum pellucidum. Minim Invasive Neurosurg 41:20–26
21. Walker ML PJ, Carey CM (1994) Ventriculoscopy. In: Cheek WR MA, McLone DG, Reigel DH, Walker ML (ed) Pediatric Neurosurgery: Surgery of the Developing Nervous System. W.B. Saunders Philadelphia, pp 572–581