ABSTRACT

Objectives: In the present paper we report and discuss our experience with endoscopic third ventriculostomies (ETVs). We will point out surgical, technical data and complications involved.

Methods: Between September 1995 and August 2007, we selected 283 patients with hydrocephalus which were submitted exclusively to ETV.

Results: In our series, 145 (51.24%) patients were male, and 138 (48.76%) female. Age varied from 2 days to 83 years-old (median of 15 years and 8 months). Most of the patients had obstruction at the cerebral aqueduct level (aqueduct stenosis, benign tectal tumors). In our series there was not a single death directly due to the procedure. However 20 patients (7%) evolved with post-surgical complications and 3 of them were permanent, with memory deficit in one and epilepsy in two. There was failure in the procedure during the early post-surgical period in 37 (13%) patients, who then needed ventricular shunt systems to resolve hydrocephalus.

Conclusions: Our results suggest that ETV should be considered as the initial treatment to hydrocephalus in all patients whose magnetic resonance exams shows a site of obstruction to the CSF flow. We consider that the most important factor to the treatment success is the adequate selection of patients.

Key-words: Hydrocephalus, third ventriculostomy, neuroendoscopy.

SUMÁRIO

Objetivos: Neste trabalho, relataremos nossa experiência na realização de terceiroventriculostomias endoscópicas (TVE’s). Discutiremos dados técnicos, cirúrgicos e as complicações ocorridas.

Métodos: No período de Setembro de 1995 a Agosto de 2007, selecionamos 283 pacientes com hidrocefalia submetidos exclusivamente a TVE.

Resultados: Na nossa série, 145 (51,24%) pacientes eram do gênero masculino e 138 (48,76%) do gênero feminino. A idade variou entre 2 dias a 83 anos de vida (média de 15 anos e 8 meses). A maioria dos pacientes apresentava obstrução ao nível do aqueduto cerebral (estenose aquedutal, tumores tectais). Na nossa série, não houve nenhum óbito relacionado ao procedimento. Entretanto, 20 (7%) pacientes evoluíram com complicações pós-operatórias sendo três permanentes, um com déficit de memória e dois com epilepsia. Ocorreu falha do procedimento no período pós-operatório precoce em 37 (13%) pacientes que necessitaram de sistemas de derivação ventricular para resolução da hidrocefalia.

Conclusões: Nossos resultados sugerem que a TVE deve ser considerada o tratamento inicial da hidrocefalia em pacientes cujos exames de ressonância magnética evidenciam um sítio de obstrução ao fluxo líquórico. Consideramos que o fator mais importante para o sucesso do tratamento é a adequada seleção dos pacientes.

Palavras-chave: Hidrocefalia, terceiroventriculostomia, neuroendoscopia.
INTRODUCTION AND OBJECTIVES

Hydrocephalus is one of the most common morbid conditions that take place in the central nervous system, and which has been recognized since Hippocratic periods. It is a medical condition that affects the normal physiology of production, circulation and/or absorption of the cerebrospinal fluid (CSF), resulting in its accumulation inside the cerebral ventricles. Hydrocephalus is generally classified as congenital or acquired, but also often described as obstructive (not communicant) or not (communicant). The latter classification gives fundamental details for adequate diagnostic and therapeutic options.

Treatment of hydrocephalus depends on its etiology. In many instances, however, precise diagnostic of the disease is not sufficient to get to its resolution. Therefore, it is frequently necessary to drain the accumulated CSF using ventricular shunt systems. As a consequence to the use of these prostheses, both infectious and non-infectious complications may arise.

Neuroendoscopic techniques for treatment of intracranial diseases started to be used early in the XXth century. However, due to the bad quality of the tools employed at the time, the technique was abandoned. In the 70’s, thanks to the great efforts of a minor group of neurosurgeons, neuroendoscopy was reincorporated to the medical practice. Many conditions can be treated through this method, but nowadays it is specially useful to treat hydrocephalus. Neuroendoscopic techniques allow for the efficient resolution of specific cases of obstructive hydrocephalus through a minimally invasive technique.

Hydrocephalus caused by obstruction of the CSF flow to the cerebral aqueduct level, Luschka and Magendie foramina (Figure 1), can be treated through an endoscopic third ventriculostomy (ETV). This technique gives the neurosurgeon the option of reestablishing CSF flow through a “new route” between the third ventricle and interpeduncular and pre-pontine cisterns.

In the present work we report and discuss our experience with ETVs. We will point out pre-surgical, post-surgical, and technical data, besides the difficulties and possible complications involved.

Figure 1 - Possible etiologies of obstructive hydrocephalus. Legend: A – Membranous aqueductal stenosis; B – Distal aqueductal stenosis; C – Proximal aqueductal stenosis associated to posterior third ventricle herniation; D – Tectal tumor; E – Cisticercus obstructing cerebral aqueduct; F – Obstruction at the foramen of Magendie and Luschka.

MATERIAL AND METHODS

In our Institution, from a total of 600 patients treated by endoscopic means between September 1995 and August 2007, we selected 283 diagnosed with hydrocephalus which were submitted exclusively to ETV. We excluded patients who needed any other complementary procedure such biopsies, septostomies, etc. Analysis of medical records permitted selection of hydrocephalic patients bearing an obstruction to the CSF flow at a distal area to the third ventricle (cerebral aqueduct, IV ventricle, Luschka and Magendie foramina), as observed in magnetic resonance (MR) imaging, which was independent from other pathophysiological mechanisms that might be involved. Another group was composed of 19 patients with normal pressure hydrocephalus (NPH) having MR exams suggestive of obstruction to the CSF outflow.

Surgery was performed in the selected patients under general anesthetic, and orotracheal intubation. With the head at a neutral position and inclined about 30°, we proceeded with a short incision, followed by trepanation and dural opening at 2 cm anterior to the coronal suture, at the right medium-pupilar
line. When a ventricular asymmetry was evident, we chose the biggest side of ventriculomegaly. In patients whose bregmatic fontanela were open, the procedure involved short osteoplastic craniotomy in the region, followed by dural opening.

Subsequently, the neuroendoscope was introduced to the direction of the lateral ventricle frontal horn. After recognition of the appropriate neurovascular structures, we opened the III ventricle floor at the tuber cinereum region, using a four french Fogarty catheter. The stoma, which communicated the ventricular system directly with the interpeduncular and pre-pontine cisterns, was enlarged with the balloon (FIGURE 2). Once the pulse of the III ventricle floor was observed, we retrieved the neuroendoscope, placed a small hemostatic sponge patch in the most external segment of the tunnel formed by the tool, and performed hermetical stitches of the superficial levels (galea, subcutaneous layers, and skin). An extra dural hermetic stitch was carried out in patients with open bregmatic fontanel.

All patients were submitted to periodical post-surgical follow-up, which consisted of clinical and radiological evaluations (either computed tomography or MR with CSF-flow analysis). Special attention was paid to complication data. Procedure failures and the need for insertion of ventricular shunt systems have been analyzed. Failure was considered when the patient had persistent or recurrent intracranial hypertension, besides subgaleal collections under the surgical scar within the first post-surgical 15 days. In these cases, we performed lumbar punctures every two or three days to ensure better adaptation. Unsuccessful cases have been submitted to the traditional technique (ventriculoperitoneal shunting).

**RESULTS**

In our series, 145 (51.24%) patients were male, and 138 (48.76%) female. Age varied from 2 days to 83 years-old (medium of 15 years and 8 months) (TABLE 1). Most of the patients had obstruction at the cerebral aqueduct level (aqueduct stenosis, benign tectal tumors), as seen in TABLE 2.

| Table 1 - Patient’s age |
|-------------------------|
| AGE                      | PATIENTS (%) |
| 0 – 1 month             | 25 (8.83%)   |
| 1 – 6 months            | 50 (17.67%)  |
| 6 months – 1 year       | 27 (9.54%)   |
| 1 – 5 years             | 38 (13.43%)  |
| 5 – 10 years            | 21 (7.42%)   |
| 10 – 15 years           | 22 (7.77%)   |
| 15 – 20 years           | 15 (5.30%)   |
| 20 – 30 years           | 29 (10.25%)  |
| 30 – 40 years           | 14 (4.95%)   |
| 40 – 50 years           | 09 (3.18%)   |
| 50 – 60 years           | 15 (5.30%)   |
| > 60 years              | 18 (6.36%)   |

| Table 2 - Etiological diagnosis |
|-------------------------------|
| ETIOLOGY                      | PATIENTS (%) |
| TECTAL/ PINEAL TUMOR          | 102 (36.04%) |
| AQUEDUCT STENOSIS             | 78 (27.56%)  |
| CHIARI MALFORMATION           | 25 (8.83%)   |
| POSTERIOR FOSSA TUMORS        | 22 (7.77%)   |
| NORMAL PRESSURE HYDROCEPHALUS | 19 (6.71%)   |
| DANDY-WALKER MALFORMATION     | 13 (4.60%)   |
| NEONATAL HEMORRHAGE           | 11 (3.89%)   |
| NEUROCISTICERCOSIS            | 10 (3.53%)   |
| SLIT VENTRICLE SYNDROME       | 02 (0.70%)   |
| POST-VENTRICULITIS            | 01 (0.035%)  |

In our series there was not a single death directly due to the procedure. However 20 patients (7%) evolved with post-surgical complications and 3 of them were permanent, with memory deficit in one and epilepsy in two. One of the patients needed,
at later stages, surgical treatment to drain a chronic subdural hematoma. The remaining patients have been treated clinically (TABLE 3).

### Table 3 - Post-surgical complications

| COMPLICATIONS                  | PATIENTS (%) |
|-------------------------------|--------------|
| MENINGITIS                    | 13 (4.60%)   |
| EPILEPSY                      | 02 (0.70%)   |
| INTRAVENTRICULAR HEMORRHAGE   | 02 (0.70%)   |
| MEMORY DEFICIT               | 01 (0.35%)   |
| SUBDURAL HEMORRHAGE           | 01 (0.35%)   |
| SUBGALEAL EFUSION             | 01 (0.35%)   |

There was failure in the procedure during the early post-surgical period in 37 (13%) patients, who then needed ventricular shunt systems to resolve hydrocephalus (TABLES 4 e 5). It was necessary to perform new procedure related to stoma closure in five patients with aqueduct stenosis after the sixth month of surgery. Follow-up ranged from 5 to 148 months (medium of 98 months).

### Table 4 - Failure in ETV related to etiology

| DIAGNOSIS                      | FAILURE ETV |
|--------------------------------|-------------|
| SLIT VENTRICLE SYNDROME        | 02/ 02 (100%)|
| NEONATAL HEMORRHAGE           | 06/ 11 (54.54%)|
| CHIARI MALFORMATION           | 07/ 25 (28.0%)|
| NEUROCISTICERCOSIS            | 02/ 10 (20.0%)|
| POSTERIOR FOSSA TUMORS        | 03/ 22 (13.64%)|
| NORMAL PRESSURE HYDROCEPHALUS | 02/ 19 (10,53%)|
| AQUEDUCT STENOSIS             | 08/ 78 (10,26%)|
| DANDY-WALKER MALFORMATION     | 01/ 13 (7,70%)|
| TECTAL/ PINEAL TUMORS         | 06/ 102 (6,89%)|

### Table 5 - Failure in ETV related to age

| AGE                  | FAILURE ETV |
|----------------------|-------------|
| 0 – 1 month          | 11/ 25 (44,00%)|
| 5 – 10 years         | 04/ 21 (19,05%)|
| 1 – 6 months         | 08/ 50 (16,00%)|
| 30 – 40 years        | 02/ 14 (14,29%)|
| 6 months – 1 year    | 03/ 27 (11,11%)|
| > 60 years           | 02/ 18 (11,11%)|
| 40 – 50 years        | 01/ 09 (11,11%)|
| 1 – 5 years          | 04/ 38 (10,53%)|
| 50 – 60 years        | 01/ 15 (6,67%)|
| 20 – 30 years        | 01/ 29 (3,45%)|

### Discussion

We can easily assume that nowadays endoscopic third ventriculostomy (ETV) is the treatment of choice for obstructive triventricular hydrocephalus (lateral and III ventricle)\(^1,2,9,11,13,17\). That is due to the recent advances of modern technologies, creation and development of surgical materials, and popularization of minimally invasive procedures, in addition to the frequent complications associated with the ventricular shunt systems. Efficacy of ETV is confirmed by a number of series\(^1,2,9,11,13,16,17\).

Nonetheless, limitations associated with the endoscopic technique are still a matter of discussion. Some authors defend the idea that children less than 6 months-old are not eligible candidates for the procedure due to the high rate of failure involved\(^9,13\). In our series, children under one-year-old were more prone to failure. It is noteworthy, however, that within this age there was a greater number of cases of hydrocephalus associated with neonatal hemorrhage and Chiari malformation, where hydrocephalus pathophysiology is multifactorial and poorly understood, which certainly contributes to the lack of success\(^15,18\). However, in cases where the obstruction site is clearly found in MR exams, and whose anatomy is favorable\(^15\) (small intertalamic adherence, wide interpundicular cistern), we strongly recommend ETV, no matter the patient’s age\(^7,16\). Even in NPH patients, obstructive mechanisms can be found on MR. In selected patients, ETV is an excellent alternative to the classical ventriculoperitoneal shunt\(^6\).

We performed post-surgical MR with CSF flow analysis as much as possible. Partial reduction of the lateral ventricle dimensions is expected in 10 to 50% of the cases. However, the most sensitive and precocious sign to suggest surgery success is diameter reduction of the width of the III ventricle\(^1\). We also analyzed sagital T2-weighted images that demonstrated flow-void sign suggestive of CSF motion through the stoma\(^16\) (FIGURE 3).

![Preoperative and postoperative images. Legend: A – Preoperative CT; B – Postoperative CT (note the reduction of the third ventricles’ width); C – T2 weighted MRI. Flow-void signal through the third ventricle floor.](image-url)
nix lesion. Two patients evolved to epilepsy, as compared with patients with ventricular tumors approached through transcortical routes. Meningitis was the most common complication. Hydroelectrolytic disturbances occurred in some patients and were attributed to manipulation of the III ventricle floor and hypothalamic structures.

Intraventricular hemorrhages happened in two patients during the opening of the III ventricle as a consequence of lesions in small veins. In these situations, we kept the endoscope in the site, driving it to the bleeding foci, and performing copious irrigation with ringer solution. Hemostasis occurred after several minutes. There was not the need for re-intervention or placement of an external ventricular drainage catheter in these cases.

**CONCLUSION**

Our results suggest that ETV should be considered as the initial treatment to hydrocephalus in all patients whose MR exams shows a site of obstruction to the CSF flow localized in the cerebral aqueduct, IV ventricle, and Luschka and Magendie foramina. Age should not be considered a limitation to the procedure.

We consider that the most important factor to the treatment success is the adequate selection of patients. When failure occurs, repetitive lumbar punctures, and later, neuroendoscopic re-intervention, will allow the neurosurgeon to keep the patient free from ventricular shunt systems and their complications in many instances.

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Photograph of a nasopharyngoscope used mainly in the 1940s. The light source was an Edison lamp positioned at the terminal end of the endoscope, distal to the optic system. Inset: Magnified view of area identified by the circle. (Courtesy of the Claude Moore Health Sciences Library Historical Collections.)

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