Endoscopic Third Ventriculostomy versus Ventriculo-Peritoneal Shunt in Management of Congenital Hydrocephalus in First Year of Life

Thesis

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Master Degree in ***Neurosurgery***

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Abstract

Objective: The study aims at comparing the outcome of endoscopic third ventriculostomy versus ventriculo-peritoneal shunt in management of hydrocephalus in the first year of life.

Methods: The study was done retrospectively in the Neurosurgery Department, on infants admitted in the period from January 2016 through February 2017, suffering from obstructive hydrocephalus. The study was carried out to study the success rate of ETV as a treatment for hydrocephalus in such age group, in comparison with V-P shunt application, Study started after enrollment of 40 infants to be divided to two groups, first to undergo ETV and second to undergo V-P shunt application as a CSF diversion methods to treat obstructive hydrocephalus.

Results: Infection was more in cases of ventriculo-peritoneal shunts (12/20 60%), while obstruction was less frequent in the case of ETV (7/20 75%), whereas the results were nearly similar in case of increased head size after surgery and the need for further surgical intervention.

Conclusion: we interpret our results to suggest that, for at least this unique group of patients, initial treatment with ETV might be considered a reasonable alternative to shunt, with some important caveats. First, treatment failure was much higher in the youngest patients, especially under 6 months. In these patients, the use of ETV must be exercised with care, keeping in mind the greater risk of failure, which should be conveyed in discussions with families. This group is also one in whom the role of CPC might be beneficial and should be investigated.

Keywords: ETV, “endoscopic third ventriculostomy”, “V-P shunt”, “obstructive hydrocephalus”, “congenital hydrocephalus”, “infant with hydrocephalus”, “first year of age”.

INTRODUCTION

Infantile hydrocephalus is one of the variable and complex diseases in neurological surgery, hydrocephalus is defined as distension of the ventricular system resulting from inadequate passage of cerebrospinal fluid from its point of production within the cerebral ventricles to its point of absorption into the systemic circulation. (1)

Hydrocephalus in infants which can be either congenital without obvious extrinsic cause or secondary to hemorrhage, infection or neoplasm needs intervention and treatment by one way or another. (1)

Another way of defining hydrocephalus is as a dynamic imbalance between the formation (production) and absorption of spinal fluid that results in an increase in the size of the fluid cavities within the brain and, in some situations, in an expansion of the spaces outside the brain, with or without an increase in the size of the ventricles. The pathophysiology can be regarded as obstructive at one or more of critical transit points that subsequently affects the resultant pattern of ventricular enlargement. (2)

A classification was presented by Dandy and Blackfan in the early twentieth century to Describe hydrocephalus. In their work, Dandy and Blackfan classified hydrocephalus as either communicating or non-communicating hydrocephalus based on the presence or absence of communication (detected by dye) between the cranial CSF compartment and the spinal CSF compartment. Today hydrocephalus is variably regarded by experts in flow dynamics as nearly entirely obstructive with only the site of obstruction (intraventricular vs. extraventricular, defining a difference). [(2)]

Hydrocephalus is one of the most common diagnoses encountered in pediatric clinical practice, typically, infants are asymptomatic and present with an enlarging head that starts to appear in the first year of life. Frontal bossing may be seen and, occasionally, slight motor developmental delay is noted. This is likely due to the large head causing neuromuscular issues with balance and walking with or without intrinsic effect upon brain development. [(2)]

Mechanical shunting by placement of a ventriculo-peritoneal (VP) shunt has traditionally been the treatment of choice in these patients. Recently, endoscopic procedures such as third ventriculostomy with or without choroid plexus cauterization have been considered as a treatment also. However, VP shunt insertion has continued to be the solely practiced method in many parts of the world, especially developing countries. Other forms of mechanical shunting such as with ventriculo-pleural and ventriculo-atrial are mostly reserved as a measure of last resort for difficult or complicated cases. [(3)]

Dandy was the first neurosurgeon to utilize the ventriculoscope to visualize the lateral ventricles in 1922. William Mixter a year later became the first to successfully perforate the floor of the third ventricle using an endoscope. The combined efforts of Dandy and Mixter remained unrevealed until recent decades when the ETV procedure began to gain widespread acceptance in part due to advances in optical and mechanical instrumentation and stereotactic/ultrasound guided techniques. [(4)]

Alternative and potentially more successful methods to divert CSF in infants with hydrocephalus are being explored. Endoscopic third ventriculostomy (ETV), the original hydrocephalus treatment modality from the early 20th century, has regained attention in recent years as an alternative to catheter-shunted CSF diversion. [(5)]

To help provide clarity, a lot of studies have been conducted such as the International Infant Hydrocephalus Study (IIHS) that was started in 2004, under the aegis of the International Federation of Neuroendoscopy (previously known as the International Study Group for Neuroendoscopy). The IIHS is an international, prospective, multicenter study that aimed to answer the question: in infants (<24 months old) with symptomatic triventricular hydrocephalus from aqueductal stenosis, the population of infants (<24 months) with obstructive hydrocephalus is a unique group. Their young age makes them less than ideal candidates for ETV, but their etiology (pure obstructive hydrocephalus) is among the most favorable for ETV. They are, therefore, an ideal population in which to compare ETV and shunt. [6]

AIM OF THE WORK

To compare the outcome of endoscopic third ventriculostomy versus ventriculo-peritoneal shunt in management of hydrocephalus in the first year of life.

Review of Literature

Epidemiology

A true global incidence or prevalence of macrocephaly is difficult to ascertain as it results from a variety of conditions. As mentioned previously, hydrocephalus is the most common pathologic cause of macrocephaly. (7)

However, not all of these children develop macrocephaly. Many of these cases worldwide are associated with meningeomyelocele /spina bifida, which may be treated prior to having an effect on Head Circumference. (7)

Prevalence estimates for infantile hydrocephalus vary between one and 32 per 10,000 births, depending on the definition used and the population studied. The most recent estimate of prevalence comes from a large, population-based investigation of idiopathic infantile hydrocephalus in Denmark over a 30 years period. (8)

The prevalence of congenital/infantile hydrocephalus in the US and Europe has been estimated to range from 0.5 to 0.8 per 1000 live births. (9)

Hydrocephalus represents a high health care burden in the US, with ventriculo-peritoneal (VP) shunting and its associated hospital charges totaling almost $2 billion annually in children 0–18 years. The burden of hydrocephalus is reported to be even higher in developing nations. [10]

Anatomy of the ventricular system

The ventricular system of the brain consists of four freely communicating, cerebrospinal fluid (CSF) filled cavities: the two lateral ventricles, the third ventricle, and the fourth ventricle. Each of the four ventricular chambers is bordered by a roof and a floor as well as by anteroposterior and lateral walls. Each of the individual ventricular chambers is associated with unique neural, arterial, and venous relationships. [11]

1- Lateral Ventricles:

The lateral ventricles are C-shaped cavities that lie deep in each cerebral hemisphere. [11]

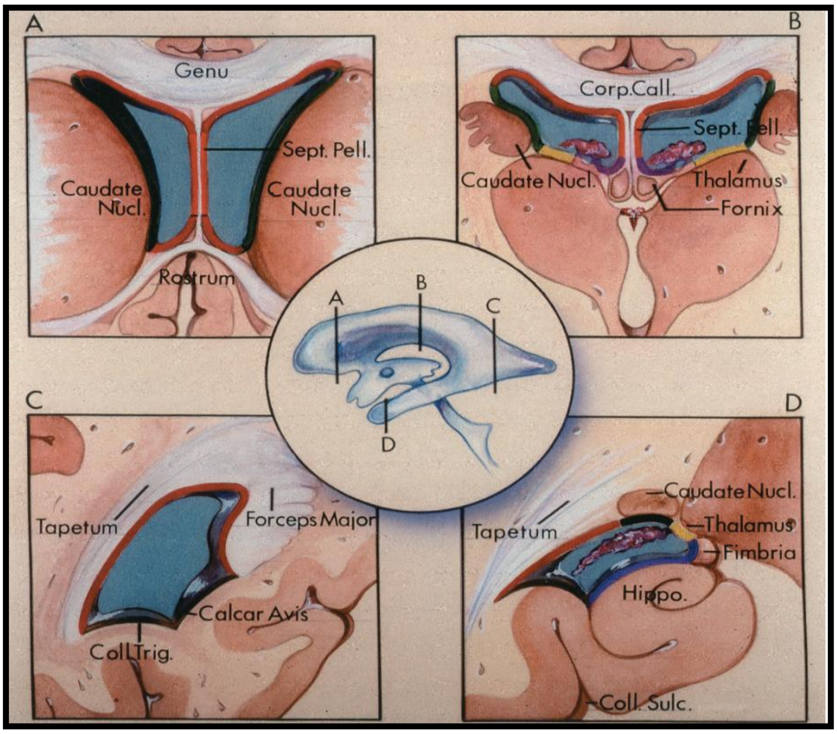

Figure (1): Structures in the walls of the lateral ventricles. The central diagram shows the level of the cross sections through the frontal horn (A), body (B), atrium (C), and temporal horn (D) [12]

Each of the paired lateral ventricles can be subdivided into five regions: The frontal horn, the body, the atrium, the temporal horn, and the occipital horn. [12]

The frontal horn (12)

- It extends anteriorly from the interventricular foramen into the frontal lobe.
- The medial wall: septum pellucidum, separating the frontal horns on both sides.

- The anterior wall and roof: the genu of the corpus callosum.
- The lateral: the head of the caudate nucleus.
- The floor: the rostrum of the corpus callosum.

The body (12)

- It occupies the parietal lobe and extends from the posterior edge of the foramen of Monro to the point where the septum pellucidum disappears and the corpus callosum and fornix meet.
- The lateral wall: the caudate nucleus superiorly and the thalamus inferiorly, separated by the striothalamic sulcus, the groove in which the stria terminalis, and the thalamostriate vein course.
- The medial wall: the septum pellucidum superiorly and the body of the fornix inferiorly.
- The floor: the supero-medial surface of the thalamus.
- The roof: the body of the corpus callosum.

The atrium (12)

- The roof: the body, splenium, and tapetum of the corpus callosum.

- The floor: the collateral trigone, a triangular area overlying the posterior end of the collateral sulcus.
- The medial wall: the bulb of the corpus calllosum superiorly and calcar avis inferiorly.
- The lateral wall: anteriorly by the caudate nucleus and posteriorly by fibers of the tapetum of the corpus callosum.
- The anterior wall: pulvinar of the thalamus.

The occipital horn (12)

- It curves postero-medially from the atrium towards the occipital lobe to form a triangular or diamond-shaped cavity.
- The medial wall: the bulb of the corpus callosum superiorly and the calcar avis inferiorly.
- The roof and lateral wall: the tapetum of the corpus callosum, overlaid laterally by the optic radiation, and then the inferior longitudinal fasciculus.
- The floor: the collateral trigone.

The temporal horn (12)

- It is the largest part of the lateral ventricles.

- The anterior wall: the amygdaloid nucleus.
- The floor: the hippocampus and laterally by the collateral eminence.
- The roof: medially by the inferior surface of the thalamus and the tail of the caudate nucleus separated by the striothalamic sulcus, laterally by the tapetum of the corpus callosum.
- The lateral wall of the temporal horn: tapetum of the corpus callosum.
- The medial wall: the choroidal fissure, a narrow cleft situated between the inferolateral part of the thalamus, and the fimbria of the fornix.

2- Foramen of Monro: (13)

- After introducing the endoscope into the lateral ventricle it is often the first structure visualized and if it is not seen it should be sought because it is the single most important and helpful landmark in gaining orientation.
- It forms the communicating canal between the lateral ventricle on either side and the third ventricle at the junction of the roof and the anterior wall.
- It has a diameter of 3–4 mm.

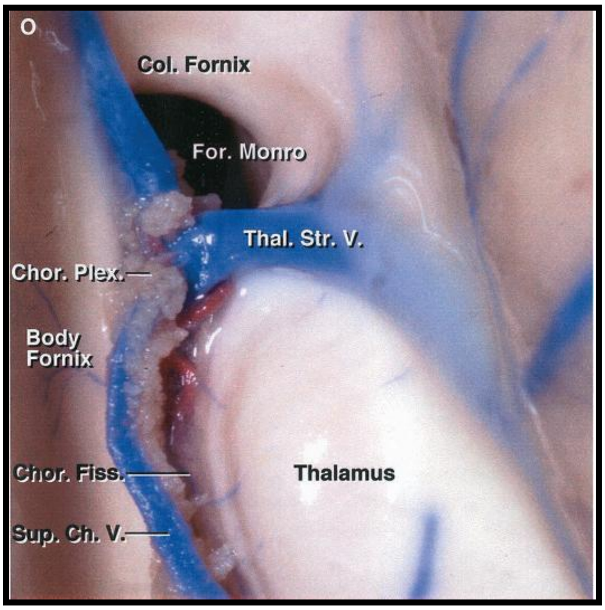

Figure (2): Enlarged view of the foramen of Monro. [12]

- It is bounded anteriorly by the junction of the body and the columns of the fornix and posteriorly by the anterior pole of the thalamus, and has a posterior concavity.
- The structures that pass through the foramen are the choroid plexus, the distal branches of the medial posterior choroidal arteries, and the thalamostriate, superior choroidal, and septal veins.

3- Third ventricle:

- The third ventricle is a narrow, funnel-shaped, unilocular, midline cavity. It communicates with the lateral ventricles through the interventricular foramen of Monro on its anterosuperior aspect, and with the cerebral aqueduct of Sylvius on its posteroinferior aspect. [13]

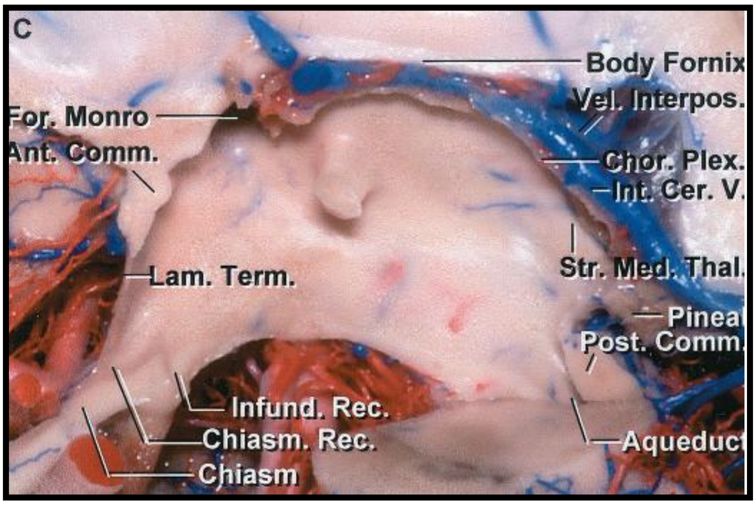

Figure (3): Enlarged view of the third ventricle showing body of the fornix above, lamina terminalis anteriorly, internal carotid vein with the choroid plexus posteriorly and optic chiasm inferiorly with appearance of the aquiduct of sylvius postero-inferriorly. (12)

- **The roof of the third ventricle**
  - Extends from the foramen of Monro anteriorly to the suprapineal recess posteriorly. (13)
  - It has four layers:
    - One neural layer, the uppermost layer, formed by the body of the fornix anteriorly and by the crura and the hippocampal commissure posteriorly, the septum pellucidum is attached to the upper surface of the body of the fornix. (13)
    - Below the neural layer, there are two thin membranous layers of tela choroidea and a layer of blood vessels between the sheets of tela choroidea. (13)