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Endoscopic third ventriculostomy versus ventriculoperitoneal shunt for treatment of hydrocephalus in infants in a tribal population in India

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Keywords
endoscopic third ventriculostomy, ventriculoperitoneal shunt, hydrocephalus, infants, tribal population,

ABSTRACT

Study design: Prospective long term follow-up study

Background: Hydrocephalus remains a common cause of admission in pediatric neurosurgery units. Of the two prevalent modalities of treatment for hydrocephalus in infants, i.e., endoscopic third ventriculostomy and ventriculoperitoneal shunt, which one is a better option, especially in a tribal setting, is a matter of debate.

Aim: To determine and compare the effectiveness of endoscopic third ventriculostomy versus ventriculoperitoneal shunt for the treatment of infants in a tribal population.

Methods: A prospective follow-up study was carried out on 70 patients of hydrocephalus with age less than or equal to 12 months during a period of 7 years from August 2014 to June 2021. A detailed history, physical examination, and computed tomography scan were done in all the cases. Based on patient condition, aetiology and parents' choice, 30 patients were treated by Endoscopic third ventriculostomy and 40 patients were treated by ventriculoperitoneal shunt. At enrolment, baseline clinical data were collected. Postoperative data were collected, including assessments of complications and treatment failures.

Results: A total of 70 infants with hydrocephalus were enrolled in the study and out of them, 30 (42.86%) underwent ETV and 40 (57.14%) underwent VP shunt for the initial treatment of their hydrocephalus. The mean age of patients was 6.4±1.2 months with a range of 18 days to 342 days. Clinical improvement was shown in 76.67% and 70% in ETV and VP shunt groups respectively. No significant difference (p=0.53) was observed in clinical outcomes in both groups. In the 1 to 6 months of age group, 07 (30.43%) clinically improved patients were from the ETV group, while in the VP shunt group, 10 (35.71%) patients showed improvement. In the 7 to 12 months age group, 16 (69.57%) clinically improved patients were from the ETV group and 18 (64.29%) patients were from the VP shunt group (p=0.69). Association of treatment success with gender, term of gestation and aetiology of hydrocephalus was not statistically significant (p>0.05). Out of 70 patients with hydrocephalus, postoperative complications such as infection, CSF leak, haemorrhage and blockage were found in 09 (12.86%), 08 (11.43%), 05 (7.14%) and 08 (11.43%) patients respectively. A significant higher proportion of infection (p=0.043) and blockage (p=0.023) was found in the VP shunt group than in the ETV group.

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Conclusion: Treatment success was high in both procedures. VP shunt was found to be more successful than ETV in terms of clinical outcome in both age groups. However, the results were statistically insignificant. A significantly higher proportion of complications was found with VP shunt than ETV therefore greater benefits can be achieved using ETV. Thus, for a tribal population, where patient compliance is poor and healthcare accessibility, as well as regular follow-up, is difficult, a procedure like ETV can be considered better than VP shunt.

Introduction

Hydrocephalus can occur at any age but is most common in infants and adults aged 60 and older.[2] Hydrocephalus in children remains one of the more common etiologies for admission in the pediatric neurosurgical units.[6] Hydrocephalus is characterized by excessive accumulation of cerebrospinal fluid (CSF), leading to ventricular dilatation, raised intracranial pressure and may be accompanied by secondary brain parenchymal atrophy.[8] The pathophysiology of hydrocephalus is complicated and remains unclear, which creates challenges in the management of patients.[1] Because of that, optimal treatment for infant hydrocephalus is yet to be definitively determined. Two main surgical options exist namely: endoscopic third ventriculostomy (ETV) and ventriculoperitoneal shunt.[3]

Ventriculoperitoneal shunt remains the conventional treatment for hydrocephalus due to its relatively high safety features.[8] Recently, endoscopic third ventriculostomy was deemed to be indispensable for treating obstructive hydrocephalus, on account of least complications because it avoids foreign body associated infections.[7,13,16] However there is ambiguity regarding the relative benefits of these two procedures. Ventriculoperitoneal shunting is technically simple and has a lower rate of failure immediately after surgery than does ETV, but it is more prone to failure over the long term and patients with shunt-dependent hydrocephalus may require urgent shunt-revision surgery due to obstruction of the shunt tubing or valve. In contrast, ETV is technically more difficult than shunting, but it has the advantage that virtually all failures occur within 6 months, after which the risk of failure is low.[9,15] Nevertheless, it remains unclear as to which of these two is more beneficial to patients because both methods have advantages and disadvantages. In resource limited settings, especially in tribal area, there are economic, cultural and geographic barriers to accessing treatment. Considering these factors, this study was planned to find out the effectiveness of endoscopic third ventriculostomy versus ventriculoperitoneal shunt in infants in a tribal population.

Aims and Objectives

To determine and compare the effectiveness of endoscopic third ventriculostomy versus ventriculoperitoneal shunt for treatment of infants in a tribal population.

Materials and Method

Study design: Prospective follow-up study conducted under the Department of Neurosurgery, RNT Medical College, Udaipur over a study period of 7 years (August 2014 to July 2021) for data collection, analysis and report writing, taking infants with hydrocephalus as the study population.

Inclusion criteria

1. Patients of hydrocephalus with age ≤ 12 months.
2. Both genders.
3. Consenting parents.

Exclusion criteria

1. Associated congenital anomalies such as spina bifida.
2. Dysmorphic brain anatomical features.
3. Known chromosomal abnormality.
4. Associated intra-ventricular or intra-cerebral hemorrhage
5. Non-consenting parents.

Method

A prospective follow-up study was carried out on 70 patients of hydrocephalus with age ≤ 12 months and admitted in the Neurosurgery department of RNT Medical College during August 2014 to July 2021. A detailed history, physical examination, and computed tomography scan was done in all the cases. Based on patient condition, etiology and parents choice, 30 patients were treated by Endoscopic third ventriculostomy and 40 patients were treated by ventriculoperitoneal shunt. At enrolment, baseline clinical data were collected. Postoperative data were collected, including assessments of complications and treatment failures.

Follow-up

Following the initial intervention, patients were regularly followed as per departmental and surgeon's practice with scheduled visits at post-op day 15, 1 month, 3months, 6months, 12 months and yearly thereafter. Adverse events were documented. All the information was recorded in individual case record sheets.

Procedures

1. Endoscopic third ventriculostomy - ETV was performed using a rigid pediatric endoscope (Karl Storz Tuttlingen, Germany), size 17F. The scope was introduced via anterior fontanels or a burr hole was placed just anterior to the coronal suture in the mid pupillary line in the patients with small fontanel. The floor of the third ventricle was punctured using a Fogarty catheter and the fenestration was enlarged using a Fogarty catheter balloon. Successful creation of stoma was confirmed by appreciating clap sign as the indicator of establishing CSF flow as well as visualization of basilar artery complex intra-operatively.

2. Ventriculoperitoneal shunt- The VP shunt involved creating a burr hole in the frontal or parietal regions and cannulating the ventricle with a silastic catheter. This was then attached to a slit and spring valve mechanism and distal silastic tubing of a medium pressure ventriculoperitoneal (MPVP) shunt which ran subcutaneously to the peritoneal cavity.

Outcome

Success of procedure was defined clinically (by the criteria of improvement in the patient neurological status) and surgically (if no further CSF diversion procedure required during the follow-up period of 1 year). Treatment failure was consider if further CSF diversion procedure was required or the patient dies. Because of very low socioeconomic status and affordability issues radiological parameters were not used to assess the success of procedures.

Complications of procedure such as intra-operative bleeding, postoperative infections, CSF leak and blockage leading to failure of procedure were evaluated and recorded.

Statistical analysis

Statistical analysis was performed with SPSS 20.0 (trial version). Data was presented in form of tables and graphs. Chi square test was used as test of significance and p value of <0.05 was considered statistically significant.

Ethical clearance

Enrollment of patients was started after taking ethical clearance from institutional ethic committee. Written consent was taken from all the parents.

Results

Total 70 infants with hydrocephalus were enrolled in study and out of them, 30 (42.86%) underwent ETV and 40 (57.14%) underwent VP shunt for the initial treatment of their hydrocephalus. Mean age of patients was 6.4±1.2 months with range of 18 days to 342 days. Male were 65.71% and female were 34.29%. Ten (14.29%) infants born preterm and all of them have low birth weight (<2500Gm). On the basis of clinical and radiological evaluation, cause of hydrocephalus was aqueductal stenosis among 51 (72.86%), arachnoid cyst among 06 (8.57%), Dandy–Walker cyst among 04 (5.71%) and Tubercular meningitis among 03 (4.26%) patients. (Table 1)

Table 1. Characteristics of study participants.

Patients' characteristics	ETV (n=30)	VP shunt (n=40)	Total (n=70)
Age in months			
1 -3	05 (16.67)	08 (20)	13
4 – 6	07 (23.33)	11 (27.5)	18
7 -12	18 (60)	21 (52.5)	39
Gender			
Male	20 (66.67)	26 (65)	46
Female	10 (33.33)	14 (35)	24
Term of gestation			
Preterm	05 (16.67)	05 (12.5)	10
Full term	25 (83.33)	35 (87.5)	60
Etiology			
Aqueductal stenosis	25 (83.33)	32 (80)	57
Arachnoid cyst	02 (6.67)	04 (10)	06
Dandy-Walker cyst	02 (6.67)	02 (5)	04
TBM	01 (3.33)	02 (5)	03

Clinical improvement was shown in 76.67% and 70% in ETV and VP shunt groups respectively. No significant difference (p=0.53) was observed in clinical outcome in both groups. There were two mortalities in ETV and three mortalities in VP shunt group and rest were required revision surgeries within one ear of follow-up. (Table 2 & Figure 1)

Table 3 depicts association of patient characteristics with treatment success of either

procedure. In the 1 to 6 months of age group, 07 (30.43%) clinically improved patients were from the ETV group, while in VP shunt group, 10 (35.71%) patients showed improvement. In 7 to 12 months age group, 16 (69.57%) clinically improved patients were from ETV group and 18 (64.29%) patients were from VP shunt group (p=0.69). This suggested better results in VP shunt group compared to ETV group, however the results are not statistically significant. (Figure 2) Association of treatment success with gender, term of gestation and etiology of hydrocephalus was not statistical significant (p>0.05).

Table 2. Distribution of participants according to type of treatment and clinical outcome.

clinical outcome	ETV	VP shunt	P value*
Successful	23 (76.67)	28 (70)	0.53
Failure	07 (23.33)	12 (30)	

Table 3. Distribution of study participants according to Clinical improvement.

Patients' characteristics	ETV (n=23)	VP shunt (n=28)	P value*
Age in months			0.69
1 -6	07 (30.43)	10 (35.71)	
7 -12	16 (69.57)	18 (64.29)	
Gender			0.84
Male	17 (73.91)	20 (71.43)	
Female	06 (26.09)	08 (28.57)	
Term of gestation			0.86
Preterm	01 (4.35)	02 (7.14)	
Full term	22 (95.65)	26 (92.86)	
Etiology			0.99
Aqueductal stenosis	21 (91.30)	23 (82.14)	
Arachnoid cyst	01 (4.35)	02 (7.14)	
Dandy-Walker cyst	01 (4.35)	02 (7.14)	
TBM	0 (0)	01 (3.57)	

Table 4. Distribution of study participants according to Clinical complications.

Clinical complications	ETV (out of 30)	VP shunt (out of 40)	Total	P value*
Infection	01 (3.33%)	08 (20%)	09	0.043
CSF leak	06 (20%)	02 (05%)	08	0.11
Hemorrhage	04 (13.33%)	01 (2.5%)	05	0.20
Blockage rate	01 (3.33%)	07 (17.5%)	08	0.023

*Chi square test was used as test of significance and p value of <0.05 was considered statistically significant.

Out of 70 patients of hydrocephalus, postoperative complication such as infection, CSF leak, hemorrhage and blockage was found in 09 (12.86%), 08 (11.43%), 05 (7.14%) and 08 (11.43%) patients respectively. Significant higher proportion of infection (p=0.043) and blockage (p=0.023) was found in VP shunt group than ETV group. (Table 4 and Figure 3).

Figure 1. Treatment outcome of study participants.

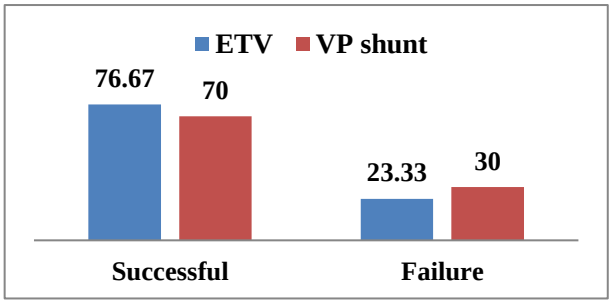


Figure 2. Comparison of clinical improvement in ETV and VP shunt as per age group of study participants.

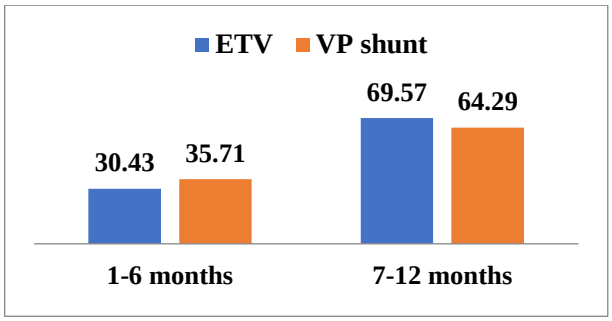
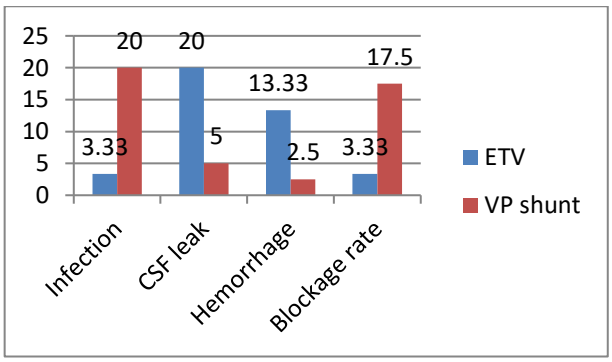


Figure 3. Comparison of complication rates in ETV and VP shunt groups.



Numbers shown in figure are percentages.

Discussion

The disturbance of CSF formation, flow or absorption on account of obstacles, congenital or acquired, leads to an increase in overall CSF volume in the central nervous system result in hydrocephalus. Based on patient's condition, two popular methods, ETV and VP shunt are available for infants. The impact of ETV compared to shunt on long-term outcome is not known and has been one of the most important questions in pediatric hydrocephalus. To compare effectiveness of these two procedures, a prospective follow-up study was conducted at Neurosurgery department of RNT Medical College.

In present study, out of 70 infants with hydrocephalus, ETV was performed in 30 (42.86%) and VP shunt was performed in 40 (57.14%) patients. Mean age of patients was 6.4±1.2 months with range of 18 days to 342 days. Male predominance was seen with 65.71%. Abhaya V. Kulkarni et al[11] study 78 patients hydrocephalus and found mean age 5.1 months and male to female ratio of 1.29:1. Out of 78 patients, 75.65% were treated by ETV and 24.35% were treated by VP shunt. Another study done by Abhaya V. Kulkarni et al[10] on 100 patients of hydrocephalus and found mean age of patients was 3.1 (2.6 to 4.1) months and among them 39 were female. Sarah C. Jernigan et al[8] conduct study on 872 infants (16.1%) initially underwent ETV and 4544 (83.9%) underwent ventricular shunt placement. The median infant age was 37 days (IQR 11–122 days) with male predominance.

In this study, most common cause of hydrocephalus was aqueductal stenosis (72.86%), followed by arachnoid cyst (8.57%), Dandy–Walker cyst (5.71%) and Tubercular meningitis (4.26%). Clinical improvement was shown in 76.67% and 70% in ETV and VP shunt groups respectively with no statistical difference in success rate. Pavlos Texakalidiset et al[14] study various study and published a meta-analysis report that also shows aqueductal stenosis as a common cause of hydrocephalus. In contrast to present study, Abhaya V. Kulkarni et al[11] reported that ETV success was 66.3% at 6 months and 64.1% at 36 months, while shunt success was 87.8 % at 6 months and 79.1 % at 36 months. These initial results suggest that shunting has a superior success rate compared to ETV, although the success rate for both was relatively high. Similar to this study, Pawan Goyal et al[4] found 68% of success rate in cases underwent VP shunt and 42% success rate among ETV group and there is no significant difference in success rate.

Treatment of choice was depending on many factors such as age, presence of complications, accessibility of treatment and follow-up. For a tribal population, where patient compliance is poor and healthcare accessibility, as well as regular follow-up is difficult, a procedure like ETV can be considered better than VP shunt.

In present study, association of treatment success was found insignificantly with age of patients, gender, term of gestation and etiology of hydrocephalus. Significant higher proportion of infection and blockage was found in VP shunt group than ETV group. Overall rate of infection and hemorrhage was 6.4% and 5.1% in study of Abhaya V. Kulkarni et al[11] although rate of infection and hemorrhage was not statistically different in both group. Similar to present study, result of Meta analysis done by Liang Lu et al[12] showed significantly lower postoperative infection, hemorrhage and blockage rates in the ETV group than VP shunt group.

Conclusion

Treatment success was high in both procedures (76.67% for ETV and 70% for VP shunt). VP shunt was found to be more successful than ETV in terms of clinical outcome in the in both age groups. However, the results were statistically insignificant. Significant higher proportion of complication was found with VP shunt than ETV therefore greater benefits can be achieved using ETV. Thus for a tribal population, where patient compliance is poor and healthcare accessibility as well as regular follow-up is difficult, a procedure like ETV can be considered better than VP shunt.

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