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A COMPARATIVE STUDY OF VALVE VERSUS NON-VALVE VENTRICULOPERITONEAL SHUNTS IN HYDROCEPHALUS

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ABSTRACT

Introduction: Variety of surgical techniques have been devised to affect extracranial shunting of cerebrospinal fluid in cases of hydrocephalus, the most common being ventriculoperitoneal, ventriculoatrial and lumboperitoneal shunts. Ventriculoperitoneal shunting is made either with the simple tubular device such as PVC tube (unishunts), or shunts with different types of valvular mechanism designed to control the flow of cerebrospinal fluid under varying circumstances. The protagonists of each type claim the advantages over the other. Ultimately however what matters would be the overall results obtainable by the two types. **Aims and Objectives:** Comparative evaluation of valve versus non-valve ventriculoperitoneal shunts in hydrocephalus cases. **Material and methods:** The present study was carried out on 45 patients suffering from hydrocephalus of different etiologies. All these cases were treated surgically by ventriculoperitoneal shunts. The shunt consisted of simple PVC tube (Ryle's tube or infant feeding tube) in 20 cases. A valvular shunt (Upadhyaya or Chhabra shunt) was employed in 25 cases. The efficacy and complications if any, were recorded and compared statistically in both the groups. The cases were followed for a period of 6-9 month. **Results and Observations:** 86.6% of subjects belonged to the *first decade of life*. A *preponderance of male* was observed in our study. 73.3% of cases comprised of *congenital hydrocephalus*. 10(22.2%) shunts developed *obstructions* during a period of followup. *Infection* was seen in 9(20%) out of 45 patients. Shunts were *revised* in 19(42.2%) out of 45 cases. **Conclusions**: Ventriculoperitoneal shunting of CSF is a safe and effective method of surgical treatment in all types of hydrocephalus. The success rate and frequency of complications is about the same in the *two types of shunts* i.e. unishunts and valvular shunts. However the unishunt is *economical* to the patient.

KEYWORDS: Hydrocephalus, Ventriculoperitoneal shunts, Shunts.

INTRODUCTION

The term 'Hydrocephalus' implies an increase in the volume of cerebrospinal fluid producing enlargement of any fluid cavity within the brain. It is not a disease entity per se. Multiple factors can lead to this condition. Although the underlying factor or factors may be incurable there are means to relieve the increase in intracranial pressure caused by the increased volume of cerebrospinal fluid. While the medical treatment of hydrocephalus as such have proved to be by and large ineffective, variety of surgical techniques have been devised to affect extracranial shunting of cerebrospinal fluid. Such procedures are currently the preferred methods of treating most cases of communicating hydrocephalus and cases of non-communicating hydrocephalus not amenable to direct operation or intracranial shunts.

Various organs like ureter, gall bladder, pleural cavity etc. have been utilized as drainage sites; at the present time the most common are ventriculoperitoneal, ventriculoatrial and lumboperitoneal shunts. Until the time the rapid advancing technology including position emission CT, magnetic resonance imaging, spectroscopy and other sophisticated methods provide more advanced knowledge of pathophysiology of brain and should open a new era in management of hydrocephalus, these shunting procedures are going to remain as the main stay in the management of this condition. Ventriculoperitoneal shunting is made either with the simple tubular device such as PVC tube (unishunts), or shunts with different types of valvular mechanism designed to control or regulate the flow of cerebrospinal fluid under varying circumstances. The protagonists of each type claim the advantages over the other. No doubt both the types have their merits and demerits. Ultimately

however what matters would be the overall results obtainable by the two types. It is in this context that a comparative evaluation of the two types is attempted in the present study.

AIMS AND OBJECTIVES

Comparative evaluation of valve versus non-valve ventriculoperitoneal shunts in hydrocephalus cases.

REVIEW OF LITERATURE

Hydrocephalus is regarded as the retention of CSF anywhere along its pathways. It results from an imbalance between CSF production and absorption and may or may not be accompanied by ventricular dilatation and/ or increase intracranial pressure. The history of management of hydrocephalus dates back to Hippocrates who was the first physician to attempt control of hydrocephalus by decompressing the ventricles. The first external ventricular drainage system was devised by Zrenner (1886) while Mikulicz (1893) inserted the first internal shunt. The shunting of CSF from the subarachnoid space (Ferguson 1898), or from the lateral ventricle (Kausch 1908) into the peritoneal cavity was then suggested.

The precise mechanism of ventricular dilatation in hydrocephalus is not known. In the early stages, alteration in pulse pressure (DiRocco et al 1978) and viscoelastteity of the brain (Hakim and Hakim 1984), against the backflow due to CSF retention in subarachnold spaces, may play important role. In intraparenchymal hydrocephalus, there may be increase in brain compliance with the result that pulse waves originating from choroid plexus may cause ventricular dilatation even under normal intraventricular pressure. Whereas ventricular dilatation may be absent in the early stages of hydrocephalus, there may be marked dilatation of the subarachnoid spaces. In congenital hydrocephalus there is disturbance of CSF absorption associated with increased CSF volume. Even though intracranial retention of CSF occurs in all forms of hydrocephalus, it is not always accompanied by ventricular dilatation or increased intracranial pressure (Raimondi 1987). Based on the suspected site of obstruction along the CSF pathways, hydrocephalus is termed as communicating or non-communicating. *Non-communicating* hydrocephalus is due to intraventricular obstruction and is characterized by the absence of communication between the ventricles and the subarachnoid spaces. In the *communicating* type, the obstruction is at the level of subarachnoid spice.

While the medical treatment of hydrocephalus as such has proved to be ineffective, a number of surgical techniques have been devised to provide extracranial shunting of CSF. Such procedures are now employed as a routine for treating all cases of hydrocephalus.

Although various organs like mastoid antrum, ureter, fallopian tubes, gall bladder, Stepson's duct and pleural cavity etc. have been utilized as drainage sites in the past, at present the common types of shunts are ventriculoperitoneal, ventriculoatrial and thecoperitoneal. The ventriculoperitoneal shunts have certain disadvantages such as frequent blocks, overdrainage and infection. Thus the material and design of the shunts have undergone various modifications from time to time. The shunts can be *divided* as a simple tubular device such as PVC catheter (unishunts) or shunts with different types of valvular mechanisms designed to control or regulate the flow of CSF under varying circumstances such as CSF pressure, body posture etc. (valvular shunts).

MATERIAL AND METHODS

The study was carried out in the Department of General Surgery, J.N. Medical college and hospital, AMU, Aligarh for six years both in retrospective and prospective ways.

The study comprises 45 (Number of patients) infants, children and adults suffering from hydrocephalus whether *congenital* or *post meningitic* (mostly tubercular). All of them underwent shunt surgery for the treatment of hydrocephalus. Subjects were divided into two groups *Group I* having valvular shunts (n=25) and *Group II* having non valvular shunts (n=20). Patients with brain tumours were *excluded* from the study.

Criteria For Diagnosis

A. Clinical: Positive history of enlargement of head, craniofacial disproportion with expansion of domes and low set ears and eyes including family history were taken. Presence of signs and symptoms like 'setting sun' sign, failure of scalp veins to collapse, failure of fontanelle to pulsate, tense and buldging fontanelle and' Cracked pot' sound over the dilated segments of ventricular system (Mc Even's sign) were noted.

B. Investigations

- Blood: Hb%, TLC, DLC, ESR
- Montoux Test (1 unit of tuberculin 1: 1000 dilution)
- X- ray skull- AP and lateral views to note any evidence of Increased ICP and any intracranial calcification (Fig. 2,3).
- Fundus Examination

The following criteria supported the diagnosis of *tuberculous meningitis*

- A positive smear or culture for tubercular bacilli in CSF.
- Predominance of lymphocytes on microscopic examination of CSF.
- Raised protein and decreased sugar contents in CSF.
- A sterile CSF culture for pyogenic bacteria.
- A positive Montoux test.
- Evidence of pulmonary tuberculosis.
- Family history of tuberculosis.
- CAT scanning or ultrasound

Shunt surgery

A written consent was taken from either of the parents before subjecting them to shunt surgery. For shunting the cerebrospinal fluid from ventricles to peritoneal cavity either nonvalvular shunt i.e. plain PVC tube (Infant Feeding tube or Ryle's tube of different sizes depending upon the age of the patient) (Fig. 4) or valvular shunt of various kinds (either Upadhyaya or Chhabra Shunt) (Fig. 5) were used.

Shunt surgery was considered *successful* if:

- Features of raised intracranial pressure subsided rapidly.
- Level of consciousness, motor weakness and vision improved and.
- Frequency of convulsions and head size decreased.

Shunt infection was defined by Schoenbaum (1975) as recovery of a bacterial isolate from two or more cultures taken from blood, CSF, wound, shunt tubings, valves or a combination of these sites.

Follow up

Subjects were personally examined fortnightly during the first month, then monthly for the next two months and every three months thereafter. During the follow up examination a careful history was taken with the view to find out about presence or absence of convulsions, hyperactivity, hearing defect, hyperkinesia, loss of vision and aphasia.

Technique For Surgical Revisions

Replacing the ventricular catheter: Replacement of the ventricular catheter in the frontal horn can be difficult in older well controlled hydrocephalic patients who have acquired small ventricles. Insertion of catheter through a new frontal burr hole may carry the best possibility for success. To avoid these technical difficulties, the position of the ventricular catheter was checked by X-ray at the time of routine revision of the catheter.

Valve assembly: A revision designed to replace the valve assembly with one of lower resistance occasionally will be indicated early if head growth and a full fontanelle persist and there is no evidence of shunt obstruction. If a severely depressed fontanelle indicates overdrainage, a change to valve of higher resistance may be required.

OBSERVATION

The present study was carried out on 45 individuals of different sex and different age groups having hydrocephalus of different origins.

Table shows **Comparative Analysis Of The Two Types Of Shunts**

	VALVULAR SHUNTS (Group I) n=25						**NON-VALVULAR SHUNTS (Group II) n=20**						
	Congenital		Post-meningitc		Total (%)		Congenital		Post-meningitc		Total (%)		P Value
	No.	(%)	No.	(%)			No.	(%)	No.	(%)			
Age													
0-1 year	19	76	02	08	21	84	08	40	01	05	09	45	
1-3 years	03	12	01	04	04	16	03	15	01	05	04	20	
3-10 years	-	-	-	-	-	-	-	-	01	05	01	05	
10-20 years	-	-	-	-	-	-	-	-	02	10	02	10	
20-30 years	-	-	-	-	-	-	-	-	04	20	04	20	
Total	22	88	03	12	25	100	11	55	09	45	20	100	<0.02
Sex													
Male	08	32	06	24	14	56	09	45	06	30	15	75	
Female	06	24	05	20	11	44	03	15	02	10	05	25	
Total	14	56	11	44	25	100	12	60	08	40	20	100	<0.01
Complications													
Infection	04	16	01	04	05	20	02	10	02	10	04	20	<0.16
Obstruction	03	12	02	08	05	20	02	10	03	15	05	25	<0.19
Migration	01	04	01	04	02	08	-	-	01	05	01	05	<0.20
Total	08	32	04	16	12	48	04	20	06	30	10	50	<0.50
Number of Revision	07	28	04	16	11	44	02	10	06	30	08	40	<0.10
Causes of Revision													
Infection	03	12	01	04	04	16	-	-	02	10	02	10	
Obstruction	03	12	02	08	05	20	02	10	03	15	05	25	
Migration	01	04	01	04	02	08	-	-	01	05	01	05	
Total	07	28	04	16	11	44	02	10	06	30	08	40	<0.10

DISCUSSION

The present study was carried out on 45 patients suffering from hydrocephalus of different etiologies. All these cases were treated surgically by ventriculoperitoneal shunts. The shunt consisted of simple PVC tube (Ryle's tube or infant feeding tube) in 20 cases. A valvular shunt (Upadhyaya or Chhabra shunt) was employed in 25 cases. The efficacy and complications if any, were recorded and compared statistically in both the groups. The cases were followed for a period of 6-9 month.

A vast majority of our patients (86.6%) belonged to the *first decade of life* for the obvious reason that hydrocephalus is basically a prenatal or a neonatal disease. By and large in the older age groups, the increased intracranial pressure was the result of meningitis or its complications. Further, nearly 60% of cases in the first decade were below 1 year.

A *preponderance of male* was observed in our study. No difference in sex incidence has been reported in any other series. In this small series the sex difference appears to be incidental or perhaps might have been influenced by the undesirable tendency of average parents in our society to provide better attention to male children.

73.3% of cases comprised of *congenital hydrocephalus* while in rest of them hydrocephalic state was the result of meningitis or its complications. Out of 25 patients in *group I (valvular*), 22(88%) were suffering from congenital hydrocephalus while in 3(12%) patients, the hydrocephalus was due to tuberculous meningitis. In *group II (non-valvular*) having 20 patients, 11(55%) were congenital and 9(45%) were postmeningitic (tuberculous) hydrocephalus. In group I most of the patients were below 3 years of age while in group II, some patients were even of the age of 28 years.

In the present study, 10(22.2%) shunts developed *obstructions* during a period of followup varying from 6-9 months. The incidence of block was 5 each in multisystem shunts and unishunts i.e. 20% and 25% respectively. In group I 3(12%) shunts were blocked in congenital type 2(8%) shunts got obstructed in postmeningitis type. In group II, 2(10%) shunts were blocked in the congenital type and 3(15%) in postmeningitic type. No significant difference was seen statistically in two groups.

In our study, the *infection* was seen in 9(20%) out of 45 patients, 5(20%) in group I and 4(20%) in group II. In group I 4(16%) shunts were infected in congenital type and 1(4%) in postmeningitic type, while in group II, 2(10%) shunts got infected in each subgroup. Statistically no significant difference was seen in the two types.

Amongst other complications, *migration of the catheter* was seen in 2(8%) cases of group I, 1(4%) belonged to congenital and other (4%) postmeningitic type. Only 1(5%) case of migration was seen in group II which belonged to postmeningitic hydrocephalus. Statistically, no difference was seen in two groups.

In the present study shunts were *revised* in 19(42.2%) out of 45 cases. Out of these, 11(44%) shunts were revised in group I and 8(40%) in group II. Single revision was done in all cases. The cause requiring the revision was either obstruction (10 cases -22.2%), infection (6 cases -13.3%) and migration of catheter (3 cases -6.7%). In group I, 11(44%) shunts were revised in which 7(28%) revisions were done in congenital type; 3(12%) due to infection, 3(12%) due to blockage and one 1(4%) due to migration of catheter. 4(16%) revisions were performed in postmeningitic subgroup of group I; 1(4%) due to infection, 2(8%) due to blockage and 1(4%) due to migration of the catheter. In group II, 8(40%) revisions of shunts were done. Here, 2(10%) revisions were done in congenital subgroup; both of them were revised due to blockage of the shunts. 6(30%) shunts were again implanted in postmeningitic type in group II; 2(10%) because of infection, 3(15%) due to blockage and 1(5%) due to migration of catheter. Statistically no significant difference were observed in two groups and subgroups.

On analysing the *complications* during each visit in the *followup* period, it was seen that infection leading to shunt revison was most rampant in the immediate postoperative period, while migration was rare at that time resulting mostly in late shunt revisions. However, obstruction giving rise to revision of shunt had almost similar incidence in all stages of the followup. Complications such as overdrainage, pseudocyst formation, bowel perforation, intestinal obstruction, subdural haematoma, postshunt craniosynostosis and slit ventricle syndrome were not seen in our study. In our study, when the complications were compared in each group and subgroup, they were statistically insignificant.

SUMMARY AND CONCLUSIONS

From the above observations, the following conclusions can be drawn:

1. Hydrocephalus can menifest as a congenital condition or may develop as consequence of some disease later in life e.g. post tuberculous meningitis.
2. Majority of cases of hydrocephalus are of congenital type.
3. Cerebrospinal shunting provides a useful ameliorative tool in the control of increased CSF pressure.
4. Ventriculoperitoneal shunting of CSF is a safe and effective method of surgical treatment in all types of hydrocephalus.
5. Complications attributed to ventriculoperitoneal shunting though not infrequent, are seldom of serious nature.

6. The success rate and frequency of complications is about the same in the two types of shunts i.e. unishunts and valvular shunts. However the unishunt is economical to the patient.

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