# **Original Research Article**

DOI: http://dx.doi.org/10.18203/2349-2902.isj20171135

# Indications of ventriculoperitoneal shunt: a prospective study

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**Received:** 29 January 2017 **Accepted:** 27 February 2017

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### **ABSTRACT**

**Background:** Shunts have been used to drain the Cerebrospinal fluid into practically every body cavity, organ system and tissue spaces. Scraff has critically reviewed the efficacy of various shunts. These are of historical interest. Ventriculo peritoneal and ventriculo cardiac shunts continue to remain the chief surgical techniques in the management of hydrocephalus.

**Methods:** This study included sixty cases where VP shunt insertion surgery was indicated. Chhabra's medium pressure VP shunt was used in all 60 cases. 32 out of 60 cases were below 2 years (53.3%) .70% of the patients were male and 30% were female. Male to female ratio was 2.3:1. Out of 24 cases of congenital hydrocephalus 16 were due to aqueductal stenosis i.e. 66.6 % of cases. Dandy Walker malformation was found in 2 cases. And in 2 more cases, Arnold Chiari malformation was found. In acquired group 22 cases had tuberculous meningitis, 4 cases were of post meningitis aetiology and 10 cases were of communicating hydrocephalus with history of trauma.

**Results:** In congenital group of patients, most common clinical feature was 'enlargement of head' bulging of fontanelle. In acquired group of patients the common clinical features were headache, vomiting, fever and convulsions. USG cranium and CT scan proved to be highly informative investigations and were done wherever necessary. Out of 36 cases of acquired group the percentage of tuberculous meningitis was 61.6% and communicating hydrocephalus with trauma was about 27%. USG cranium was also used in follow up congenital hydrocephalus to assess the position and functioning of shunt. Even CT scan was used in adult age group to assess the position of shunt and condition of the brain. All patients of with VP shunt surgery were treated with higher antibiotics preoperatively and postoperatively.

**Conclusions:** Common complications included, shunt infections, shunt obstruction, shunt malposition. Rare complications included shunt migration through anus and shunt ascites. Four patients died after VP shunt surgery, two were operated case of encephalocele with associated congenital anomalies with uremia and other two were with dreaded shunt infection with septicaemia. Ten (16.6%) patients required revision of VP shunt surgery in present study.

Keywords: Congenital, Hydrocephalus, Rare complications, VP shunt

## **INTRODUCTION**

Shunts have been used to drain the Cerebrospinal fluid into practically every body cavity, organ system and tissue spaces. Scraff has critically reviewed the efficacy of various shunts. These are of historical interest.<sup>1</sup>

Ventriculo peritoneal and ventriculo cardiac shunts continue to remain the chief surgical techniques in the management of hydrocephalus.<sup>2</sup>

The clinical material of this study includes detailed study of 60 cases in which ventriculo peritoneal shunt was

indicated. It includes patients of all age groups and sex presenting in Shri. Chhatrapathi Shivaji Maharaj Sarvopchar Rugnalaya, Solapur, Maharashtra, India. Ventriculo peritoneal shunts was inserted in these patients and regular follow up of these patients was done.

Ventriculo peritoneal shunt surgery is commonly indicated lifesaving procedure. Though mortality has been reduced high morbidity is one of the complication of VP shunt surgery.

There is a wide spectrum of complications ranging from shunt malfunction, shunt infections to perforation of bowel by shunt or extrusion of distal end from anal orifice.<sup>3</sup> It has been demonstrated that ventriculo peritoneal shunt dysfunction is a major hurdle in rehabilitation of patient.<sup>4</sup> Shunt infection is still most dreaded complication of shunt surgery. In this study a continuous follow up of all cases had been done and revision of shunt surgery was done wherever needed.

## Aims and objectives

- To study various indications for ventri-culoperitoneal shunt surgery.
- To study etiopathological factors and clinical profile in various indications.
- To study prospectively the use of ventriculoperitoneal shunt.

## **METHODS**

The clinical material of the study included detailed study of 60 cases in which ventriculoperitoneal shunt is indicated. It includes patients of all age groups and sex presenting in SCSM Rugnalaya, Solapur, Maharashtra, India.

Proforma of cases prepared included preliminary data, chief complaints, detailed history, birth history, systemic examination, routine and specific investigations wherever necessary. Resuscitation in form of IV line, RT, Catheterization was done wherever necessary.

Ventriculoperitoneal shunt was inserted in all indicated patients. Chhabra's medium pressure shunt was used in all patients.

Assessment of shunt functioning was done by taking following points in consideration

- History of headache, vomiting, convulsions, fever was asked.
- Physical examination was carried out.
- Neurological examination including vision, motor, sensory system was carried out.
- Local examination- Inspection and palpation of shunt system done and shunt pump tested for refill.

- On cranial USG placement of proximal shunt catheter was seen.
- CT scan- cross sectional imaging were taken for assessment wherever necessary.

Shunt revision- considered if earlier ventriculoperitoneal shunt was malfunctioning. Revision was done on same or other side. Cases were investigated, managed and followed accordingly.

#### **RESULTS**

Observations from the study of 60 cases in which VP shunt surgery was done divided into 3 groups.

- Age group below 2 years.
- Age more than 2 years but below 15 years.
- Age above 15 years.

The patient above age of 15 years are considered as adult patients. This was intended to investigate all cases of age above 15 years so as to make etiological diagnosis. In all indicated patients, specific investigations have been done and immediate management had been tried. The specific group below 2 years of age is nominated as infantile hydrocephalus.

These observations have been made from a study of patients admitted in surgery ward in whom VP shunt surgery was indicated during a period from January 2000 to December 2002. 60 cases were chosen randomly and by making diagnosis, giving treatment and post-operative follow up and inferences were drawn. The final observations from the study were compared with available literatures.

Table 1: Age distribution.

Age group	No. of cases	Percentage of cases
0-2 years	32	53.53%
2-15 years	18	30%
Above 15 years	10	16.66%
Total	60	100%

Infantile hydrocephalus (below 2 years) presented commonly as an indication for VP shunt surgery. The awareness and advanced radio imaging techniques like USG, CT scan are responsible for early detection and management.

**Table 2: Sex distribution.** 

Age group	No. of cases	Percentage of cases
Male	42	70%
Female	18	30%
Total	60	100%

Ratio of male to female is 2.3:1, in this study there was male preponderance.

**Table 3: Clinical features.** 

Clinical features	No. of cases
Enlargement of head	34
Bulging of Fontanelle	34
Convulsions	18
Setting sun sign	20
Crack pot sign	20
Altered consciousness	6
Loss of consciousness	6
Loss of power in limbs	2
Headache	18
Vomiting	20
Fever	26

Patients below age of 2 years presented commonly with bulging fontanelle and enlarged head, whereas patients above 15 years presented with headache, vomiting, fever and convulsions and patients in age group of 2 years to 15 years presented with both diversities.

**Table 4: Associated congenital anomalies.** 

Anomaly	No. of cases
Encephalocele or meningocele	8
Spina bifida	4
Pes cavus	2
Congenital heart diseases	2
Total	16

In patients of age below 2 years associated congenital anomalies was commonly found.

Table 5A: Aetiological distribution.

Age group	No. of cases	Percentage of cases
Congenital	24	40%
Acquired	36	60%
Total	60	100%

In age below 2 years congenital causes predominates whereas above 15 years acquired causes predominates.

Table 5B: Aetiological distribution.

Aetiology	No. of cases		Percentage	
	Congenital	Acquired	Congenital	Acquired
Operated case of encephalocele	4		6.6%	
Aqueductal stenosis or atresia	12		20%	
Operated case of encephalocele with aqueductal stenosis	4		6.6%	
Amold chairi malformation	2		3.3%	
Dandy-walker malformation	2		3.3%	
Tuberculous meningitis		22		36.6%
Post meningitis residual		4		6.6%
Communicating hydrocephalus with trauma		10		16.6%
Total	24	36	40%	60%

Table 5C: Aetiological distribution: congenital group.

Aetiology	No. of cases	Percentage in congenital group
Operated case of encephalocele	4	16.66%
Aqueductal stenosis or atresia	12	50%
Operated case of encephalocele with Aqueductal steno	sis 4	16.66%
Arnold chairi malformation	2	8.33%
Dandy-Walker malformation	2	8.33%
Total 2	24	100%

Table 5D: Aetiological distribution: acquired group.

Aetiology	No. of cases	Percentage in congenital group
Tuberculous meningitis	22	66.6%
Post meningitis residual	4	11.1%
Communicating hydrocephalus with trauma	10	27.7%
Total	36	100%

In congenital group Aqueductal stenosis or atresia was the most common cause and in acquired group tuberculous meningitis was most common (Table 5B).

Isolated aqueductal stenosis or atresia was found in 50% of cases where as in operated case of encephalocele in 2 cases aqueductal stenosis was found (16.6%) (Table 5C). As shown in Table 5D, tuberculous meningitis was the most common cause in acquired group.

Table 5E: Aetiological distribution.

Total no. of congenital hydrocephalus	Aqueductal stenosis or atresia as a cause	Percentage of aqueductal obstruction
24	16	66.6%

Aqueductal stenosis or atresia is the most common cause of hydrocephalus about 66% in congenital group.

Table 6: Type of shunt used.

Type of shunt	No. of cases	Percentage
Chabbra's medium	60	100%
pressure shunt	00	10070

In all cases VP shunt surgery was done.

Table 7: Management.

Aetiology	No. of cases	Percentage in congenital group
Cases treated with shunt and higher antibiotics	28	46.6%
Cases treated with shunt, antibiotics and antitubercular therapy	22	36.66%
Cases treated with shunt, Diamox and antibiotics	32	53.3%

**Table 8: Complications.** 

Particulars	No. of cases	Percentage
Infection	6	10%
Blocked shunt	4	6.6%
Disconnection of Ventricular Catheter with Distal Part	2	3.33%
Malposition	2	3.3%
Extrusion of shunt through anus	s 2	3.3%
Shunt ascites	2	3.3%
Seizures	2	3.3%
Total	20	33.3%

Shunt infection was the most common cause of complication but in present study complication like

extrusion of shunt through anus and shunt ascites had occurred in 1 case each.

**Table 9: Incidence of complications.** 

No. of operated for VP shunt surgery	No. of cases with complications	Percentage
60	20	33.3%

Table 10: Mortality chart.

Cause of mortality	No. of cases	Percentage
Operated case of Encephalocele with congenital anamolies with Uremia	2	3.3%
Shunt infection with septicaemia	2	3.3%
Total	4	6.6%

#### DISCUSSION

## Study plan

This study includes operated cases of VP Shunt surgery admitted in SCSM Rugnalaya, Solapur, Maharashtra, India during period of January 2000 to December 2002.

The indications were divided into broad categories of

- Congenial group
- Acquired group

Diagnosis of hydrocephalus was almost obvious clinically in most of the cases. By various radio-imaging and laboratory investigations the case of hydrocephalus was found out by taking every possible effort. Thus, out of 60 cases of hydrocephalus under this study 24 were of congenital aetiology and 36 were of acquired aetiology.

Surgical treatment was provided to all cases either curative or as adjuvant. Ventriculo-peritoneal shunt surgery was performed by using Chhabra's medium pressure VP shunt system in all cases either as primary treatment or as a supportive treatment. Infantile hydrocephalus cases were treated primarily by shunt operation, post meningitis hydrocephalus cases were treated with shunt surgery as a palliation or adjuvant means of treatment.

The study was done under various headings as aetiology, diagnosis, management and complications.

## Composition of series

Even though this work does not result in giving accurate incidence of hydrocephalus in this geographical area i.e. State of Maharashtra, India, but attracts attention towards the magnitude of the problem.

Boon gave the global composition of hydrocephalus and indications for VP shunt surgery which varies between 0.12% to 3.5% of live births.

## Age and sex distribution

Though the incidence of hydrocephalus in infancy is showing high values than any other paediatric age, changing trends of shift to higher age group is seen. Male predominance is observed in this series of work which is similar to the observation of Milhorat.<sup>5</sup>

#### Measurement

Enlargement of head is a common presentation in infancy and should be plotted on a standard chart according to patients age and sex (Welhause 1968) for confirmation. More importance is attributed to serial head circumference measurements taken at timely intervals. Such enlargement of head need to be differentiated also from subdural collection, intracranial cysts and tumors, constitutional macrocephaly, encephalopathy, degenerative brain disease and malnutrition.

### Associated cranial anomalies

Congenital lesions producing CSF pathway block leading to hydrocephalus is a major causative factor. Aqueductal obstruction comprised 69.5% in the series of 139 cases of Milhorat.<sup>6</sup> Dandy W Cyst, operated cases encephalocele and Arnold Chiari's malformation (Russel et al) are other important intracranial congenital lesions found in this study.<sup>7-9</sup>

Other types of associated extra-cranial anomalies were also found in the infantile group because one congenital anomaly is mostly associated with other (Hellman, 1973).

## **Symptoms**

## Enlarged head

In present study infantile group presented as enlarged head commonly. Out of 60 cases 14 had history of large head since birth, 20 developed later on. Blackwood et al had described post meningitis CSF pathway block producing cranial enlargement.

In the patients of age group of above of 2 years common indications for VP shunt surgery had been tuberculous meningitis, communicating hydrocephalus with trauma, and post meningitis hydrocephalus.

## Headache-fever-vomiting-convulsions

Headache, vomiting and convulsions are the common and invariable manifestations of raised intracranial tension in adults. <sup>10</sup> Headache, vomiting, fever and convulsions were major clinical features in acquired group of hydrocephalus.

The brain offers little resistance to change in shape due to its high elasticity (Hualboun, 1949). This quality of elasticity depends upon volumetric shifts within the fluid compartment of the brain (including CSF, cavities, intracellular and extra cellular space, blood vessels) and serves to dissipate change in ICP. When the cranial vault is expansible, as it is in infants due to open frontanelle volume can expand with substantial change in ICP (Merit and Freemount, Smith). As soon as the elastic capacity of the brain and its covering is exceeded, a further increase in intracranial volume will manifest features of raised ICT; this happens in severe infantile hydrocephalus in children and in adult hydrocephalus due to more rigid and inexpansible cranium, same is observed with symptoms of raised ICT (headache, vomiting, convulsions) in the present study, only 6 out of 32 cases of 0-2 years age group manifested these features, while 20 out of 30 cases from acquired group had this presentation.

## Visual abnormality

Papillioedema and subsequently optic atrophy is the end result of raised intracranial tension, but due to the expansibility of the infant skull it is a rate finding. Since the visual acuity is difficult to test in infants, blindness must be judged by criteria such as roving type of movements, absent or poor papillary response to light and absent opticokinetic nystagmus. Only 4 cases out of infantile hydrocephalus had visual errors. This low figure corresponds to the explanations given below and difficulty in diagnosis of visual abnormalities. But the cases with visual abnormality constitutes as important mode of presentation in more than 16 years of age group, due to early development of optic atrophy due to inexpansile cranium. 8 cases of adult age group presented with this complication.

#### Mental- motor- retardation

Due to raised ICP mental motor retardation also develops. In present study this was observed in 4 out of 32 cases of infantile hydrocephalus and 2 out of 30 cases of acquired hydrocephalus.

## Sign

- Widely opened and bulging fontanelle.
- Prominent scalp veins.
- Setting sun sign.

The above finding were expressions of compensation of raised ICP in the expansible cranium as in infancy. Shape of the head changes according to the underlying anatomical dilatation of the ventricles or mass lesions. The face does not participate in this expansion due to its relation rigidity and hence eyes and ears assumes lowest position as an expression of the craniofacial disproportion with the expansion.

Raised CSF pressure invariably results in increased cerebral pressure owing to thin and unsupported cerebral veins and dural sinuses as observed by Clims (1939) and Bowcher. Shulaman and Ranschoff (1965) described their obstruction at or near the jugular foramina by the enclosed ventricular system. The scalp gets distended as a consequence and fail to collapse.

Dilated lateral ventricles exerts pressure on the thinned out orbital roofs and the eye balls get displaced downwards to such an extent that the iris get partially hidden under the lower eye lids and a rim of conjunctiva become visible above the iris. This is called: setting sun sign.

In the present study 34 cases presented with bulging of frontanelle and prominent scalp veins, 20 cases had setting sun sign.

## Focal neurological deficits

- Cranial nerve affection
- Ataxia

Russel et al and Blackwood et al (1963) have studied gross white matter atrophy in grossly expanded ventricles of infantile hydrocephalus cases, producing focal neurological deficits. It is observed in severe affection of frontal and occipital areas. The production of paraparesis secures due to stretching of the fibres of the para lateral motor cortex as they course around the expanded ventricles. Relatively greater involvement of lower extremities has been related to the longer course of the para central motor fibres. Lower cranial nerve deficits were associated with hind brain malformations. Presence of local neurological deficits pertain to the site of the lesion or damage consequent to hydrocephalus.

Out of 24 cases of congenital group only two patients had neurological signs and in acquired group out of 36 patients six had neurological signs like motor and sensory affections.

# Investigation

## Plain X-ray skull

Plain x-ray skull in AP and lateral view was done in cases of hydrocephalus. This investigation indicated various nonspecific findings of raised ICT and certain localized findings in connection with anatomical site, their nature and their effect of the lesion. Silver bitten appearance (convolutional makrings), erosion or demineralization of the dorsum sellae and posterior clinoid, enlargement of emissary veins, sutural separation were the radiological signs of raised ICT.

Plain x-ray findings of specific lesions include, ipsilateral hemicranial expansion in blockage of single formina of Monro, bilateral hemicranial expansion and small

posterior fossa in aqueductal stenosis, symmetrical rounded expansion in communicated hydrocephalus, large posterior fossa enlargement in infratentional tumors. In present study most of the above feature were observed.

## Ultra-sonography

Ultra-sonography was done in some cases for primary diagnosis of infantile hydrocephalus. Real-time high frequency ultra sound is a non-invasive and easily performed investigation. It is an excellent screening procedure in infants with open frontanelles. The findings of USG through anterior frontanelles gives idea about the size of ventricles and differentiate hydrocephalus from other causes of enlargement of head. It also give idea about aqueductal stenosis or atresia. In cases of infantile hydrocephalus ventricular was evidence on USG and has assisted in differentiating hydrocephalus from arachnoid and porencephic cysts.

### Computerised tomography scan

The diagnosis of raised intracranial pressure and hydrocephalus has become simpler and more accurate with advent of the CT scan. It is mandatory to have CT for confirmation before any treatment is undertaken. CT scan was done in majority of cases in whom VP shunt surgery was indicated. CT scan can give information of-

- Nature and degree of ventricular dilatation.
- Intracranial SOL
- Tuberculomas
- Foreign body
- Position of shunt
- Misplaced shunts
- Hematomas
- Abscesses
- Cyst
- Arnold Chairi malformation
- Aqueductal stenosis or atresia
- Fracture cranial bones
- Celebral infarcts
- Communicating hydrocephalus
- Residual meningitis

In present study 16 cases had aqueductal stenosis or Atresia, 2 cases had Dandy Walker Malformation, 2 had Arnold Chiari Malformation and 22 CT scans were suggestive of tuberculous meningitis and 10 were of communicating hydrocephalus with trauma.

# CSF examination

CSF examination was done for biochemical and cytological examination. In each case with suspicion of pyogenic meningitis and Tuberculous meningitis the sample was sent for AFB staining and culture sensitivity

test and accordingly patients were treated with antibiotics.

In present study out of 32 cases of infantile hydrocephalus CSF examination was within normal limits in all cases and out of 36 cases of acquired hydrocephalus four reports were suggestive of pyogenic meningitis and 22 reports were suggestive of tubercular meningitis.

#### Management

All cases studied in the present series were treated with V.P. shunt surgery either as primary management or as a palliative treatment. Chhabra's medium pressure shunt system was used while performing VP shunt surgery.

#### Preoperative management

Preparation of Patient: Patient's head was shaved in infantile Hydrocephalus and in adult age group shaving of head, chest, abdomen and thighs done. Patient kept Nil by mouth for at least 6 hours before surgery. Prophylactic antibiotics were given in all cases.

### Post-operative management

Patient were kept NBM for 6 hours, I.V. fluids were given during this period. After 6 hours started with liquid diet in all cases and subsequently full diet, according to age of patient.

## Antibiotics

Injectable cefotaxime, gentamycine, metronidazole were given in majority of cases. Antibiotics were changed in the view of culture sensitivity reports accordingly.

Antitubercular therapy was given for 1½ years in patients of tuberculous meningitis.

Diamox and mannitol used post operatively in selected cases.

# **Complications**

In period from January 2000 to December 2002 the 20 patients presented with complications in whom VP shunt surgery was done. The total percentage of complications was 33.3 in present study.

Though many complications have been noted in literature still shunt infection is most common and dreaded complication.

Shunt infection occurs in about 10-20% of shunt surgeries. In present study the rate was 10%. Haines et al and Langley et al noted in an analysis of controlled study and found that prophylactic antibiotic therapy

significantly reduced the rates of shunt infections and similar was experienced in present study. 12,13

Venes et al stressed the importance of meticulous prepping, draping and aseptic operative technique. <sup>14</sup>

Shunt infection may manifest as pyrexia of unknown origin, anemia, meningitis, peritonitis and ventriculitis.

The management of shunt infection is shunt removal if shunt is blocked and with higher antibiotics for longer period.

Drake and Kulkarni found that "removal of infected shunt equipment and external ventricular drainage, produce highest infection cure rate and lowest mortality rate." <sup>15</sup>

Shunt malfunction is usually suspected when the clinical symptoms return or child becomes irritable. Though shunt pumping test is used to diagnose malfunction of the shunt it is reliable only in 20%, hence one cannot rely on this test and must proceed to investigations like Doppler USG and CT scan.<sup>16</sup>

Martinez and Lange summarised the mechanical complications encountered like collapse of valve, disconnection of various component.<sup>17</sup> In present study we have noted two cases of disconnection of ventricular catheter from distal part.

Shunt obstruction is next major cause of morbidity next to infections. Most common cause of block is due to obstruction by debris during insertion or after insertion immediately. Revision of shunt surgery should be done with prophylactic antibiotics coverage. Proximal obstruction is the commonest cause of shunt obstruction.<sup>18</sup>

Though CSF ascites is a very rare complication, is noted in one of our patient operated for VP shunt surgery. No definite explanation has been offered for inability of the peritoneum to absorb CSF. The treatment of choice is conversion of VP shunt to ventriculo atrial shunt.<sup>19</sup>

Extrusion of shunt through anal orifice is very rare complication.<sup>20</sup> It has been observed in one patient of present study operated for VP shunt surgery. From review of pertinent literature pathogenesis is mostly related to bowel perforation due to local infective adhesions. Treatment does not imply major surgery. Pulling out the extruded end and removal of shunt was done.

In present study one patient had malposition of VP shunt that is in which the proximal part of shunt was dislodged and winded up in neck. In only one patient of VP shunt surgery the patient developed convulsions post operatively and treated with anticonvulsant therapy. Puca et al confirmed that meticulous surgical technique and

preoperative prophylactic antibiotics could minimize the complications occurring after VP shunt surgery.<sup>21</sup>

#### CONCLUSION

A total number of 60 cases were studied where VP shunt surgery was indicated during period from January 2000 to December 2002. Twenty-four cases were of congenital aetiology and eighteen were of acquired aetiology where VP shunt surgery was indicated. In 24 cases of congenital aetiology 8 were having aqueductal stenosis or atresia (66.6%) and 4 were of operated case of encephalocele, 2 of Arnold Chiari malformation and 2 of Dandy Walker malformation. In 36 cases of acquired group 22 cases where VP shunt surgery was indicated were tuberculous meningitis, 4 were of post meningitis aetiology and 10 were of communicating hydrocephalus with history of trauma. In congenital group enlargement of head, bulging of frontanelle was the commonest way of presentation. In acquired group of patients headache, fever, convulsions and vomiting was the commonest way of presentation. Aim of VP shunt surgery was to relieve the increased intracranial pressure. VP shunt surgery under general anaesthesia using chhabra's medium pressure shunt system can be considered as method of choice. Shunt infection, shunt blockade, shunt malposition and disconnection were complications found commonly. Early diagnosis and surgery appeared to be protective to brain and can give better results in both congenital and acquired group. VP shunt surgery can be used in both as a primary or palliative treatment of raised intracranial pressure. VP shunt surgery arrest the further damage to the brain and improves in patients with raised intracranial pressure in hydrocephalus.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

 $institutional\ ethics\ committee$ 

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**Cite this article as:** Jaykar RD, Patil SP. Indications of ventriculoperitoneal shunt: a prospective study. Int Surg J 2017;4:1319-26.