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PROJECT REPORT

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Programme : **M Ch NEUROSURGERY**

Month & Year of submission : **November 2003.**

PROJECT REPORT

INTRACRANIAL NEUROENDOSCOPY – INDICATIONS AND OUTCOME.

Name :	**Dr. Sudish Karunakaran**
Programme :	**M Ch NEUROSURGERY**
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CERTIFICATE

I, Dr. Sudish Karunakaran hereby declare that I have actually performed or assisted all the procedures listed under the report.

Place : Thiruvanathapuram **Signature:**

Date : 01:11:2003 **Sudish Karunakaran**

Forwarded :

Dr. Sudish Karunakaran has carried out the minimum requirement of procedures/etc.

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INTRODUCTION

INTRODUCTION:

Endoscopy is accepted and well established in several surgical subspecialties, including laparoscopy, bronchoscopy, colonoscopy, thoracoscopy and gastroscopy. Even though endoscopy has been used in the brain for many decades only recently have it gained popularity in the field of neurosurgery. However, neuroendoscopy has not yet reached the same level of acceptance as endoscopy has in other surgical specialties.

Endoscopy in the brain was initially limited to the treatment of hydrocephalus. But hydrocephalus is still one of the major challenges in modern neurosurgery. Lespinasse, who was actually an urologist, performed the first intra cranial endoscopic procedure in 1910. Using a cystoscope designed for the adult bladder, he performed choroid plexus fulguration for hydrocephalus in two children. One died during surgery, the other lived for 5 years after surgery. Dandy known as the father of neuroendoscopy performed an endoscopic choroid plexus extirpation in 1918, with a funnel that used light reflected from a head mirror. Four of his five patients did not survive the procedure. Unsatisfied he chose not to pursue this avenue of treatment further. Mixter first used endoscopy successfully to treat hydrocephalus in 1923, when he used an urethroscope to perform endoscopic third ventriculostomy (ETV).

Poor equipment and high morbidity and mortality dissuaded most neurosurgeons from pursuing endoscopy in the treatment of hydrocephalus. With the introduction of valved shuts in 1949, interest declined even further, but recently there has been a resurgence in the use of endoscopy in neurosurgery. With the advances in optical & video technology combined with the knowledge & skill acquired from microneurosourgery during the last three decades, and with endoscopy's successful application in other surgical specialties, there has been an increased interest in the use of neuro endoscopy, not only for the treatment of hydrocephalus, but for other applications as well. This study analyses the endoscopic series in our institute for better delineation of its indications & outcome.

REVIEW OF LITERATURE

REVIEW OF LITERATURE:

Introduction:

Neuroendoscopic surgery is finding increasing application for various clinical conditions. Despite sophisticated developments such as programmable valves and antibiotic coated catheters, numerous revisions for malfunctioning and infected shunts are reported with extra cranial shunting. The concept of internal shunting though present for many decades has found recent revival owing to the advent of endoscopic techniques in the management of hydrocephalus. Recently there has been rekindling of interest in endoscopic neurosurgery, mainly due to a series of technological advances in endoscopic optics and miniaturization.

This allows the treatment of a variety of lesions less invasively than using traditional microsurgical procedures, with decreased morbidity and mortality rates. Endoscopic surgery enables -

* Minimal brain retraction,
* Excellent visualization,
* Ability to define and control blood supply of the lesion before attempting biopsy or resection,
* Restoration of cerebrospinal fluid (CSF) flow by means of ventriculostomy, septostomy or stent placement.

It has been shown to reduce morbidity, hospital stay, operative treatment & the cost of treatment, which are issues of importance especially in the developing world.

Instrumentation:

All endoscopes have several common features like light source, lens system, camera, video monitor and channels to pass other instruments through.

The brightness of the light source is important as it allows for superior visualization of the ventricular walls & maximized picture quality. Currently, the xenon system is the most powerful and common light source used, although a metal halide light source is also available.

The most common camera used is a single chip charge coupled device (CCD)[1], which is attached to the endoscope itself for viewing on a video monitor. Recently three chip charge coupled devices with real time computer enhancement has been introduced that details superior picture quality[1]. The screen resolution of the video monitor is also important for picture quality.

There are two types of endoscopes, rigid and flexible. The rigid endoscopes are composed of a solid rod lens system and a rigid sheath. The optics is superior to those of flexible endoscopes and they have improved light transmission, better and truer color and a wider viewing angle. The flexible endoscopes use fibreoptic cables to transmit light, which permit the tip of the scope to be steered. However, for maintaining flexibility the working channels have to be smaller, limiting which instruments can be used.

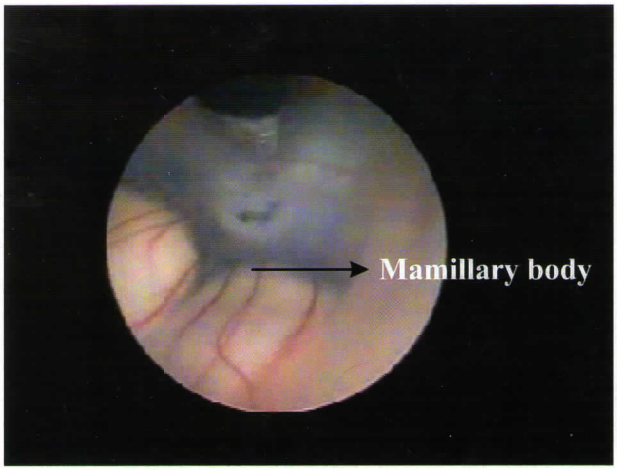
Numerous instruments have been developed specifically for neuroendoscopy:--

* Biopsy and grasping forceps for varying sizes and configurations.
* Devices for hemostasis include monopolar cautery, "Saline torch,"[1] bipolar cautery and various lasers. The three lasers currently in use are the neodymium: Yttrium - aluminium- garnet (Nd: YAG) laser, the argon laser and the potassium - titanyl - phosphate (KTP) laser.
* Micro balloon catheters & blunt sounds.
* Irrigation and suction catheters.
* Cutting instruments like scissors.

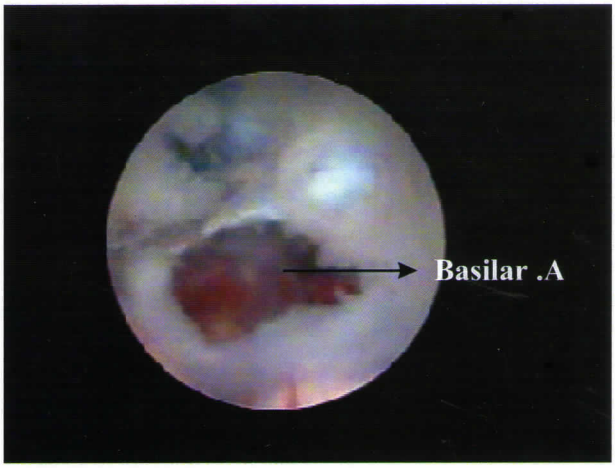
Endoscopic Ventricular anatomy[1]:

The floor of the lateral ventricles has a very characteristic anatomy. Several caudate veins located anterolateral to the foramen of Munroe, course medially and posteriorly to drain into the thalamostriate vein, which is posterolateral to the foramen and courses anteriorly & medially. Medial to the thalamostriate vein is a tuft of choroid plexus in the choroidal fissure containing the superior choroidal vein: this structure maybe followed to the foramen, and is one of the most useful anatomic landmarks to locate the foramen especially in a dilated lateral ventricle and also to orient oneself during endoscopic procedures. The septal vein overlying the septum pellucidum courses towards the foramen from an anteromedial location. All of these veins enter the foramen of Munroe at the venous angle and drain into the internal cerebral vein, which courses along the roof of the third ventricle.

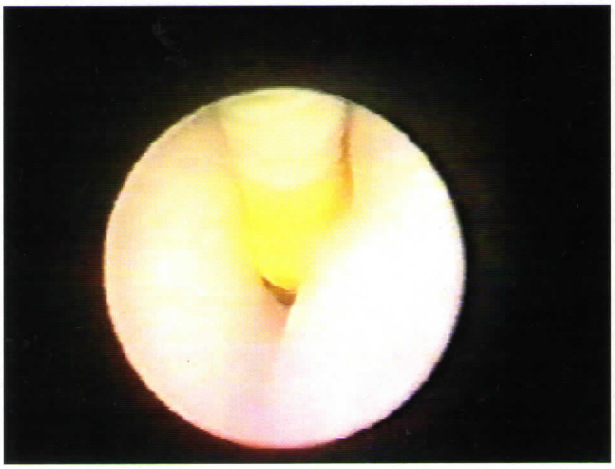
The anterior and medial borders of the foramen of Munroe are composed of the column and body of the fornix, respectively. The head of the caudate nucleus forms the floor and wall of the ventricle anteromedial to the foramen; the thalamus forms the floor and wall posterolaterally.



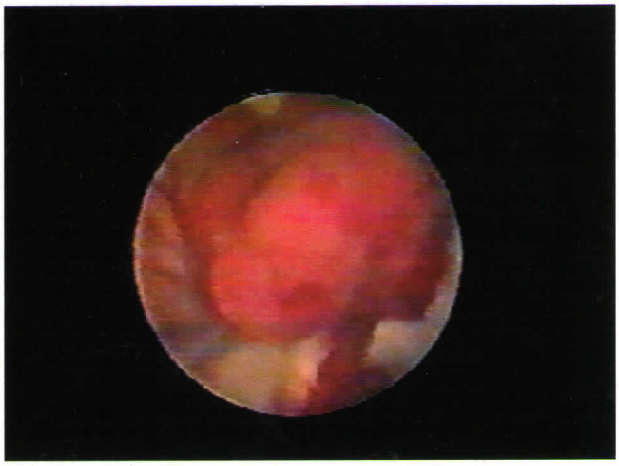
ETV : Site of Perforation



Post perforation



Aqueductoplasty using Fogarty Balloon catheter



1.Intraventricular lesion - Endoscopic view

By passing the endoscope through the foramen of Munroe, one can identify the mamillary bodies and the characteristic discoloration of the infundibular recess. The perforation of the floor of the third ventricle is ideally placed into the tuber cinerium between the infundibular recess of the pituitary stalk and the anterior border of the mamillary bodies to enter the prepontine cistern and to avoid injury to the basilar artery complex. From the third ventricle, directing the scope posteriorly visualizes the aqueduct.

Surgical technique:

After the induction of GA, the patient is placed in supine position & head is immobilized. One should always be prepared to do a craniotomy if required.

The location of the burr hole depends on the portion of the ventricle system to be accessed. Standard frontal or occipital burr holes provide access to the frontal & occipital horns, respectively. The anterior third ventricle can be accessed via a coronal burr hole, 3-4 cms from the midline. Access to the posterior third ventricle requires a more anteriorly placed burr hole.

After the burr hole is made, the ventricle is cannulated using a ventricular catheter and the endoscope is then introduced through the same track. The ventricular anatomy is used for orientation.

Because even a small amount of blood can obscure the endoscope, hemostasis must be maintained at all times. Bleeding is usually from small ependymal veins. Care must also be taken while passing the endoscope through the foramen of Munroe as injury to the veins or choroid plexus can cause troublesome bleeding[2].

Most bleeding is usually controlled with irrigation. More significant bleeding may require conversion to craniotomy or ventriculostomy. The irrigating fluid must be warmed to body temperature & should be isotonic (lactated ringers solution is preferred as its composition and PH are closer to that of CSF). It should always be remembered to keep the irrigation inflow equal to the outflow to prevent ventricular overdistension & its attendant complications.

Indications:

The indications of neuroendoscopy are numerous but it has proved most useful for the treatment of hydrocephalus with various procedures like –

* Third ventriculostomy
* Aqueductoplasty
* Foraminoplasty
* Fenestrations for loculated hydrocephalus
* Endoscope assisted shunt placements
* Septostomy.

Endoscopy has also been used for -

* Tumor biopsies of intra & paraventricular lesions
* Cyst fenestrations
* Endoscope assisted transsphenoidal procedures
* Endoscope assistance of microneurosurgical procedures.

Endoscopy VS Microsurgery

The endoscope offers several advantages over the microscope like -

* Superior optical characteristics offering wider field of view.(1)
* Higher magnification with better illumination.
* Viewing hidden structures behind obstructing tissues obviates the need for excess retraction or resection.
* Reduces operative morbidity, as it is less invasive.
* Speedy recovery and shorter hospital stay.

But there are several notable disadvantages to the endoscope like –

* Lack of depth perception, as the endoscope gives only two-dimensional images.
* Long learning curve for endoscopic skills.
* Currently, the variety of endoscopic instruments available is small, limiting the type of procedures possible.

Complications:

The reported complication rates for ventricular endoscopic procedures ranges from less than 2% to 7%[2]. They include wound infection, CSF leaks and subgaleal collections (pseudomeningocoele).

Other complications include direct injury to caudate or internal capsule when cannulating the lateral ventricle, traction injury to fornix or hypothalamus while cannulating the foramen of Munroe. Most symptoms are self-limited and improve over time.

IVH is usually clinically insignificant, but basal ganglionic infarcts after bleeding from ependymal veins have been reported.

Ventriculitis & meningitis (both infectious & aseptic) have been treated successfully with intravenous antibiotics. In addition, the subsequent inflammation & scarring can cause or potentiate hydrocephalus & ventricular loculations.

Endoscopic third Ventriculostomy: (ETV)

Presently ETV is thought to be one of the best techniques in tackling the problem of hydrocephalus because it combines a minimally invasive approach with brilliant visual control of manipulations. However, indications, surgical techniques and outcome related to different pathological findings are still under intensive investigations.

Impact of ETV in CSF dynamics:

ETV is considered superior to shunting in occlusive hydrocephalus due to the absence of a siphoning effect in upright position[3,4]. The delay in normalization of ICP dynamics may lead to initial problems in long term shunted patients who are used to stable ICP. An adaptation period is noticed before stabilization of ICP in case of ETV, during which time symptoms of raised ICP can occur which can falsely lead to the assumption that ETV has failed[2]. Post operative ICP monitoring has shown the presence of this adaptation period but has not been successful in identifying late failures.

Stereotactic ETV: There have also been reports of stereotactic CT based [2,5] & MRI based [6] guidance for ETV, some people have even tried ultrasonic guidance for ETV [7]. However, the major disadvantage is that, it is time consuming. It maybe helpful in the initial phase of the learning curve to avoid inadvertent complications.

It is especially of use in cases with

- inferior visual conditions
- distorted anatomy
- or if an additional procedure like biopsy or fenestration is desired.

Out come after ETV:

Favorable outcomes of 83 & 79% of cases have been reported for patients with aqueduct stenosis or lesions of the midbrain or posterior fossa causing obstructive hydrocephalus[3]. Significantly better outcomes have been noted in hydrocephalus due to benign space occupying lesions (SOL) rather than progressive tumorous conditions[3]. The complication rate was low at 6% with no permanent morbidities or mortalities.

Radiographic outcome:

Radiographic outcome is commonly assessed by MR flow studies, to demonstrate the flow void at the site of perforation[3,6,8]. Detailed measurements of configurations and diameters of the ventricles as well as volumetric studies demonstrated significant reductions in ventricular size in majority of these patients[3].

Radiological documentation of successful ETV is seen in 76% of cases and a clinicoradiological correlation of 96% has been reported[3]. However only 86% of pts with patent stoma as revealed by T 2 MRI, improved clinically.

Fukuhara et al[9] has observed that ventricular sizes do not consistently change after ETV & does not appear to correlate with clinical outcome. In his series, the ventricular size remained unchanged for 75% on the next day, 57.4% after 3 months, for 48.2% after 6 months and for 41.8% after 1 year.

He advocates the use of cine PC MRI as an ideal follow-up method and has shown good correlation between cine PC MRI findings and the conditions of the orifice at the time of re operation[9,10]. Frim et al also stresses on the usefulness of cine PC MRI for follow-up to demonstrate a patent & working stoma[12].

In a landmark study to identify the imaging correlates of successful ETV, Drake, et al[11] has identified the documented reduction in ventricle size as measured by the FOR (Frontal Horn, Occipital horn ratio) and the presence of a stomal flow void in T2 MRI to correlate with successful outcome.

Most authors have stressed on the absence of reduction in ventricular size even in clinically improved ETV patients[3,11,12] and even in the above series, also only 48% of patients among the clinically successful cases reported a decrease in ventricular size[11].

Other factors like disappearance of PVL or increased amount of convexity CSF etc did not correlate well with clinical status which may partly be due to the lack of a measuring scale with good inter observer reliability in these variables[11].

Wolpert et al[13] advocates the use of cine PC MRI velocity measurements, specifically the velocity ratio between the high pontine cistern and the space anterior to the spinal cord, to assess the functional status of ETV.

Patient Selection:

ETV is not thought to be indicated in patients with reduced CSF absorption capacity like in IVH, SAH or postmeningitic or in hydrocephalus associated with spinal dysraphism[3,14].

However, recent publications on ETV performed in patients with spinal dysraphism reports success rates of more than 70%[3,15]. Furthermore, there are series reports of 77%, 67% and 63% favorable outcomes following ETV in patients with meningitis, shunt infections & IVH respectively[3].

One possible explanation for this success is that a combination of obstruction & impaired CSF absorption is responsible for hydrocephalus in these patients. ETV may than enable access to previously inaccessible & possibly not impaired absorption areas. A second hypothesis supports the contention that the subarachanoid space is capable of developing and adapting to altered CSF dynamics, finally leading to an increase in reabsorption. The authors of these hypotheses feel that even a small chance to remain or to become shunt free renders offering ETV to these patients worthwhile[3].

ETV in pediatrics:

Pediatric patients benefit the most from ETV, but the best time to perform ETV is not yet clear. Jones et al report of successful ETV in a 1200gm mass premature patient[3], but most authors think ETV is significantly more effective in pediatric patients, older than 2years of age[3,16].

Fukuhara et al has advocated the use of ETV in congenital hydrocephalus with less than 6 months age, but has pointed out the high chance of failure owing to the poor CSF absorption abilities of newborn infants[9].

Buxton et al[9,10] also advocates the use of ETV as an initial treatment in neonatal hydrocephalus because of the low morbidity rates of ETV and the enormous effect of shunt independence. There is another recent report which reveals that patients less than 6 months of age can undergo third ventriculostomy alone with comparatively good outcome if the procedure is performed using endoscopic guidance[9,17].

In another series, 50% of patients younger than 2 years of age and 100% of cases below one year of age did not respond to ETV, which supports the conclusion that an age less than 2 yrs was associated with a significantly low rate of success.

Brockmeyer et al reports a 26% procedure abandonce rate, due to unfavorable anatomy or technical reasons, which included 36% of hydrocephalus with myelomeningocoele (MMC)[18]. The likelihood of a patient's prior history of shunt placement leading to ETV abandoning was high with statistical significance[18]. The overall success rate was only 49% with the breakup based on diagnosis as follows:

MMC	-	50%
AS	-	56%
Posterior fossa tumor	-	50%
Tectal plate tumor	-	75%
Slit ventricle syndrome	-	50%
Congenital Hydrocephalus	-	40%
Post hemorrhagic HC	-	0%

Their analysis did not show any statistical difference with respect to age in cases of AS for which ETV was done. The complication rates reported in this series were also high.

Ventriculitis	- 2 cases
Transient alteration is sensorium	- 1
Transient hemi paresis	- 1
Basilar perforation[19]	- 1.

In the series reported by Fukuhara et al, 89 pts who underwent ETV has been analyzed[9]. He reports an overall success rate of 61.7% at 5.3yrs follow-up period. Identifying possible risk factors for failure of ETV, he has identified a history of CNS infection as an important indicator of failure with statistical significance. Other factors proposed by him include a history of shunt infection or multiple shunt revisions (3 or more) or hydrocephalus associated with Chiari malformation. He has advocated the use of ETV in congenital hydrocephalus with less than 6 months age, but has pointed out the high chance of failure owing to the poor CSF absorption abilities of newborn infants.

Frim et al advocates the use of ETV in cases of shunt malfunction with removal of shunt with good overall outcomes of 73%. Frim et al also stresses on the usefulness of cine PC MRI for follow-up to demonstrate a patent & working stoma[12].

Predictors of ETV failure:

Grzybowska et al from Poland[20] brought out the concept of early & late efficacy of ETV in relation to etiology. They advocate the use of ETV as a temporary measure in tumors with hydrocephalus before definitive treatment. They also propound the use of ETV in palliative treatment for progressive tumor with hydrocephalus. Significant predictors of failure in their study included the presence of CNS infections and congenital malformations.

In the epic study conducted by Cinnalli et al[17] to identify the ETV failures in aqueduct stenosis (AS) in children (213 cases) he states the importance of the learning curve with technical failure rate approaching 0% from 6% as the surgeon matures. He also highlights the concept of late failures of ETV, which stresses the importance of continued follow-up of apparently successful ETV.

He attributes secondary closure of the stoma to proliferation of gliotic tissue or arachnoid adhesions developing months to years after the procedure[21]. Repeat cine PC MRI imaging to demonstrate patency of stoma gives a clue as to which patients would benefit from a second endoscopic procedure[12,22].

He also addresses the issue of increased failure rate among children less than 6 months of age and concludes that though the risk of secondary stomal closure and impaired CSF absorption are quite high in the younger age group, ETV should be attempted, as failures that occur in this age group occur early and hence can be picked up for planned secondary intervention by close follow up for the first year.

He also presents the life table analysis of patients which shows that all treatments failures were seen within 5 yrs and no patient required repeat intervention after 5 years. Long term cine PC MRI Imaging studies ensures satisfactory intracranial CSF shunt upto 17 years post operatively, indicating that ETV is a long term & definitive cure for obstructive hydrocephalus in the majority of patients comparable to the long term results of extracranial shunts[23]. His overall success rate was more than 70%.

In a study comparing the efficacy of ETV and extra cranial shunts, in the treatment of hydrocephalus due to tumor or aqueduct stenosis, Drake et al[24] has come to conclusion that though failure rates were almost identical, TV was found to be superior in terms of long term complications as well as duration of hospital stay.

Gupta et al[25] has reported on his series of neuroendoscopic procedures from India, concludes that it cuts down on the operative time as well as hospital stay, thereby reducing cost and resulting in faster turnover of patients and so is especially useful in busy neurosurgical centers of developing countries.

ETV for shunt malfunction :

ETV is a viable and effective option for patients who present with shunt malfunction and can lead to a shunt free state of existence. Krauss et al reports a 82% shunt free success rate for ETV in shunt malfunction[26], which compares with the 76% rate quoted by Cinnalli et al[27]. But they also have concluded that predictors of failure of ETV in shunt malfunction included a history of meningitis or shunt infection or multiple shunt revisions[26].

Regarding removal of the malfunctioning shunt following ETV the following reasons are cited -

* Foreign bodies are more prone for infection.
* Remaining flow through shunt tube can lead to low flow through stoma causing its closure.

The authors advocate the removal / atleast ligature of shunt tube at the same sitting as the ETV. They categorically conclude by questioning the validity of the statement 'once a shunt, always a shunt'[26].

Cinnalli et al[27] in his series of ETV for shunt malfunction has advocated its use as a first line treatment for shunt malfunction with a success rate of 76.7%. He also reports that as all failures are manifest within a short period, the success is likely to be more durable.

Neuroendoscopy in intracranial cysts:

Perneczky et al[28] advocates the use of different endoscopic techniques like endoscopic fenestration (EF), endoscope assisted microneurosurgery (EAM) and endoscope-controlled microneurosurgery (ECM) in the treatment of selected intracranial cysts.

In his series of 36 patients with intracranial cystic lesions either arachnoid cysts or intraventricular cysts, overall clinical improvement was seen in 70%. The best results were obtained in intraventricular cysts with 89% clinical improvement and radiological improvement was seen in 72% of cases. The overall complication rate was 14% including subdural hematomas or hygromas, meningitis etc.

The selection of the endoscopic technique for intra cranial cysts should be based on the individual characteristic of the cyst, the equipment available & the surgeon's experience.

ETV in congenital malformations:

ETV has shown limited effectiveness is patients with chiari malformation or myelomeningocoele or other forms of spinal dysraphism[3,15,29,30]. The lower success rate of ETV in relieving hydrocephalus in such situations is related to the structural immaturity of the subaracnoid space or occurrence of sub clinical adhesive inflammation in this space, which precludes adequate CSF absorption[3,15,31,32].

However there are studies showing efficacy of third ventriculostomy in fourth ventricular outlet obstruction associated with Chiari malformation[17,29,33,34]. In a case report from Kyushu university Japan, Fukui et al presents the successful use of ETV in a case of Chiari malformation with fourth ventricular outlet obstruction, hydrocephalus and syringomyelia, leading to complete resolution of clinical symptoms & radiological improvement too[29]. They advocate the use of ETV in treatment of hydrocephalus associated with congenital malformations because of the advantages it has over alternative procedures. Several authors have stressed the importance of pulsatile CSF flow in causing symptoms associated with communicating hydrocephalus and proposed ETV in hydrocephalic cases, which has a communicating component.

Endoscopy in pineal region lesions:

Pineal region tumors constitute 1% of all adult brain tumors and 3-11% of childhood brain tumors. Though there is existing controversy regarding the optimal method of managing pineal region tumors, there is agreement that biopsy and early treatment of hydrocephalus is important[35,36,37,38]. The histological nature of these tumors critically determines optimal treatment[35,39] and the two conventional techniques which have been used are stereotactic biopsy and direct open surgery[35,40,41].

However, stereotactic surgery can be hazardous because of the proximity of the pineal region to vital neurovascular structures and is associated with the considerable risk of sampling error. The advantage quoted is the ability to acquire a sample from the center of the lesion whereas endoscopy allows sampling only from the periphery of the lesion. Open surgery is a major procedure, which may not be always necessary, particularly in cases of undifferentiated germinoma[35,42].

In this ongoing debate, neuroendoscopy has opened up a new avenue with the following benefits quoted[35,36,42]:

(i) Direct control of noncommunicating hydrocephalus without the use of external ventricular drain or VP shunt, which is associated with risk of infection, malfunction and dissemination of some pineal tumors [37,43,44].

(ii) Allows safe tumor biopsy of adequate amount of tissue with more than 90% diagnosis rate in various series[35].

(iii) Allows collection of CSF sample for assay of tumor markers and for cytology.

(iv) Being a minimally invasive procedure can be safely applied to challenging patient groups both medically as well as age wise.

Coakham et al[35] have reported a series of 34 patients with pineal region tumors who underwent ETV with tumor biopsy, where the diagnosis rate was 94%. There was only one case of ETV failure, with no operative mortality or major procedure related complications. Definitive treatment for each tumor was designed based on the tumor histology.

Cohen et al[43] has also concluded, on a report of his series of pineal tumors where ETV and biopsy was instituted as the initial management, that neuroendoscopy contributes to the safe & minimally invasive initial management of patients with pineal region neoplasms and symptomatic hydrocephalus that can guide further definitive management.

Neuroendoscopy in intraventricular lesions:

Colloid cysts -

Colloid cysts are benign tumors that usually arise from the roof of the third ventricle. The treatment considerations include conservative observation with serial radiographic studies, ventricular shunting to manage the hydrocephalus and direct obliteration of the lesion. Traditionally colloid cysts have been treated by microsurgical resection, using either the transcallosal or transfrontal approach[2,45]. Stereotactic aspiration is one alternative but has the disadvantage of being a blind procedure that is associated with a high rate of recurrence[2,46].

During recent years, endoscopic techniques have been refined & have increasingly been used to treat an assortment of pathological processes inside and outside of the ventricles including colloid cysts[2,47,48,49].

King et al[2] has reported on their series of 14 cases of colloid cysts that underwent endoscopic resection, with total excision in 12 patients but two had to undergo craniotomy as endoscopic

resection failed. Complications included short-term memory loss and hemiparesis in one patient each.

Colloid cysts have been approached endoscopically for longer than 10 years[2,49,50]. Successful aspiration & partial resection were reported by Power et al[49] in 1983 and Auer et al[50] respectively.

But the use of endoscope in colloid cyst resections can be challenging especially in cases with small ventricles and small cysts attached to the roof of the third ventricle posterior to the foramen of Munroe.

But most of the recent reports[2,47,48,49,50] advocate an aggressive endoscopic approach using modern instrumentation which offers the advantages of good optical resolution, high illumination and magnification and total resections with little morbidity, shortened operative time, reduced length of stay and good resolution of symptoms in cases of colloid cysts, although acknowledging the presence of a steep learning curve for the skills.

Intraventricular lesions -

Intraventricular lesions present a formidable microneurosurgical challenge as these lesions have be approached from a considerable distance through normal brain tissue, avoiding damage to vital brain structures with minimal brain retraction and dissection. However, in select cases, endoscopic techniques might prove to be as effective as microneurosurgery and less invasive.

Advantages -

* Brain retraction can be largely avoided.
* Good visualization of the lesion
* Better definition of the origin of blood supply & tumor vasculature.
* In addition to tumor removal or biopsy, it is often possible to restore obstructed CSF pathways with ventriculostomy, septostomy or stent implants.
* Shorter time
* Lesser morbidity

Disadvantages:

* Can be used only for select lesions

* Tumors less than 2 cms in size are more amenable to endoscopic resections[51].

* Tumor consistency is a limiting factor with difficulty increasing with lesions, which are firm in consistency.

Gaab et al[51] in his series of 30 intraventricular lesions, reports of only two cases of subependymomas (2 cms in diameter) where the endoscopic procedure had to be abandoned for a microsurgical procedure. The average duration ranged from 35 to 170 minutes.

All colloid cysts & epidermoid lesions were totally excised and five of the solid lesions were totally removed. The hydrocephalus related symptoms were relieved in all the 22 cases, which presented with CSF path obstruction without the need for a shunt. There was no procedure related mortality.

He concludes that neuroendoscopy is a safe and effective technique is the management of intraventricular tumors, enabling one to do, tumor, biopsy, decompressions, total excision & internal CSF diversions with minimal complications & morbidity.

AIMS &
OBJECTIVES

AIM :

The advent of neuroendoscopy has been viewed at least in some centers with studied speculation, owing to the use of this technique by some specialists with the same enthusiasm as a two year old with a new toy. However, in the present era, neuroendoscopy has etched a place for itself in the field of modern neurosurgery.

Multiple centers have reported considerable experience with endoscopic techniques in managing a wide variety of neurosurgical problems including hydrocephalus. It is new well accepted that ETV is an effective procedure for managing certain causes of hydrocephalus which include congenital and acquired aqueduct stenosis, tumors with hydrocephalus, and myelomeningocoele associated hydrocephalus.

More recently, it is suggested that the applications might be expanded to include certain causes of communicating hydrocephalus and selected cases of shunt malfunction as well. There are also reports of successful ETV's performed in less than six months of age, which was earlier thought to be a contra indication for ETV.

ETV is thought to be less successful in patients who experience intra ventricular hemorrhage (IVH) or subarachnoid hemorrhage (SAH) and in patients with meningitis, spinal dysraphism or post radiation.

The changing trends in the indication as well as the confusion regarding the outcome has led many centers to temper their initial enthusiasm with knowledge gained from insight based on experience.

The goal of this retrospective study is to analyze our experience, including overall outcome, rates of post operative ventricular size decreases and complications, with an effort to identify possible predictors of failure that will ultimately help to redefine the indications so as to achieve the best possible results.

OBJECTIVES:

i) Report our experience with neuroendoscopy.

ii) Assess overall outcome with regard to clinical status.

iii) Postoperative radiological status.

iv) Relevance of postoperative radiological appearance as compared to clinical status.

v) List the neuroendoscopic procedural armamentarium.

vi) Outline the complications.

vii) Identify the possible predictors of failure of ETV.

viii) Redefine indications of ETV to achieve a better outcome.

ix) List the various present day indications for which neuroendoscopy is used.

MATERIALS & METHODS

MATERIALS ANDMETHODS

During the period from September 1999 to January 2003 a total of 162 consecutive patients underwent intracranial endoscopic procedures for various indications. The present study was conducted retrospectively by analyzing the clinicoradiological data of these patients, which included the age at presentation, sex, the clinical presentation, radiological data and clinical as well as radiological outcome in the immediate postoperative period as well as during followup period.

An attempt is made to identify the present day indications of intracranial endoscopy with importance to hydrocephalus and to analyze the outcome in this patient group. All patients underwent the procedures using rigid endoscopes and all were evaluated preoperatively with either CT or MRI scans. Postoperative radiological evaluation was tailored to individual case requirement based on clinical judgement.

Neuroendoscopy was introduced in the department in September 1999 since when we have matured through a steep learning curve with regard to the indications, patient selection, surgical challenges and techniques, avoidance as well as management of complications and followup protocol in this 'neurosurgical subspecialty', if it maybe called so, based on our experience and from guidance from pioneers of the field like Prof. Axel Pernezcky and Prof. Andre Grotenhuis.

Evolution has been gradual but definite and experience has undoubtedly tempered the initial enthusiasm helping us realize higher goals and better patient benefit which has prompted this retrospective analysis and compilation with a view to share our experience.

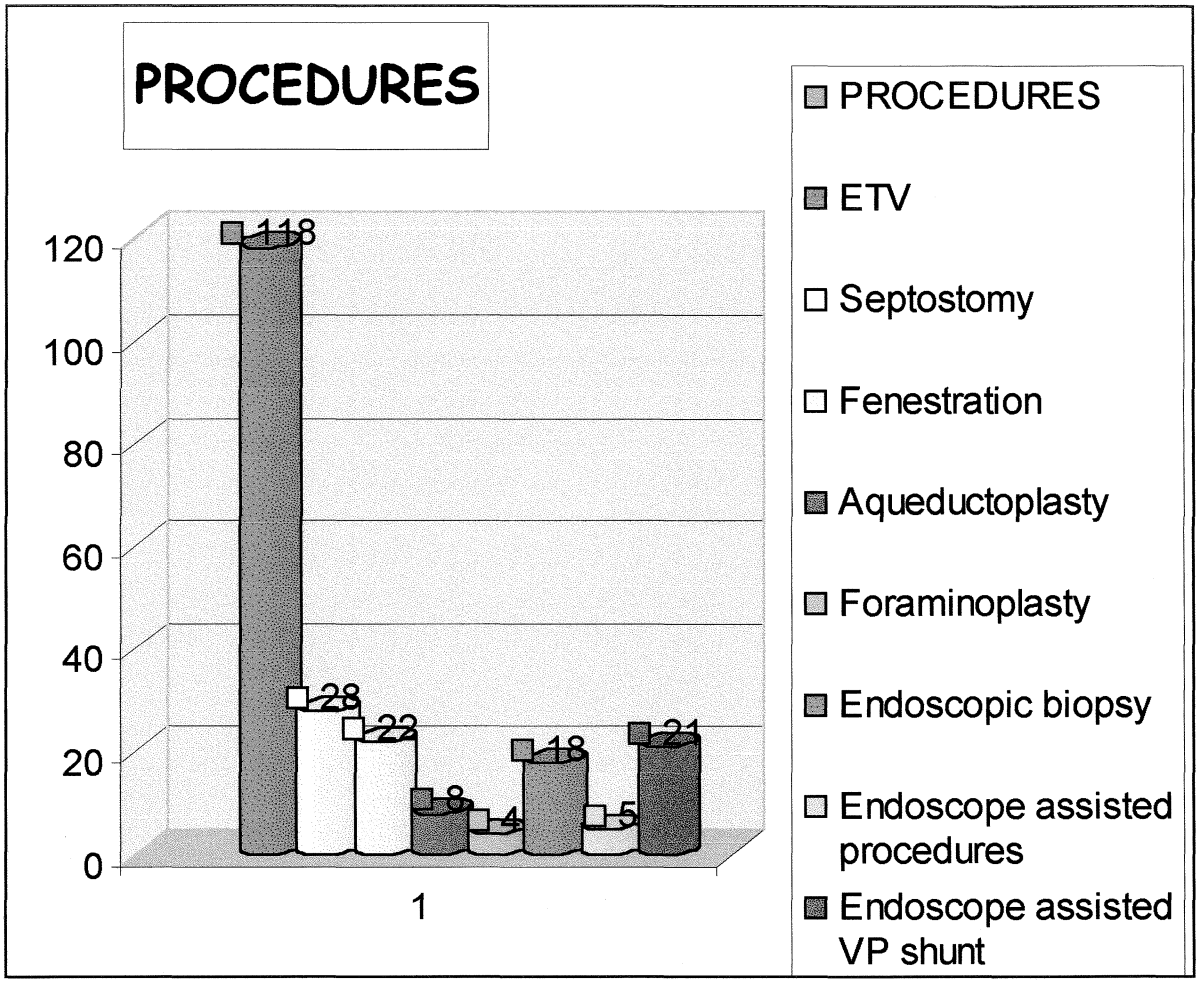
RESULTS & ANALYSIS

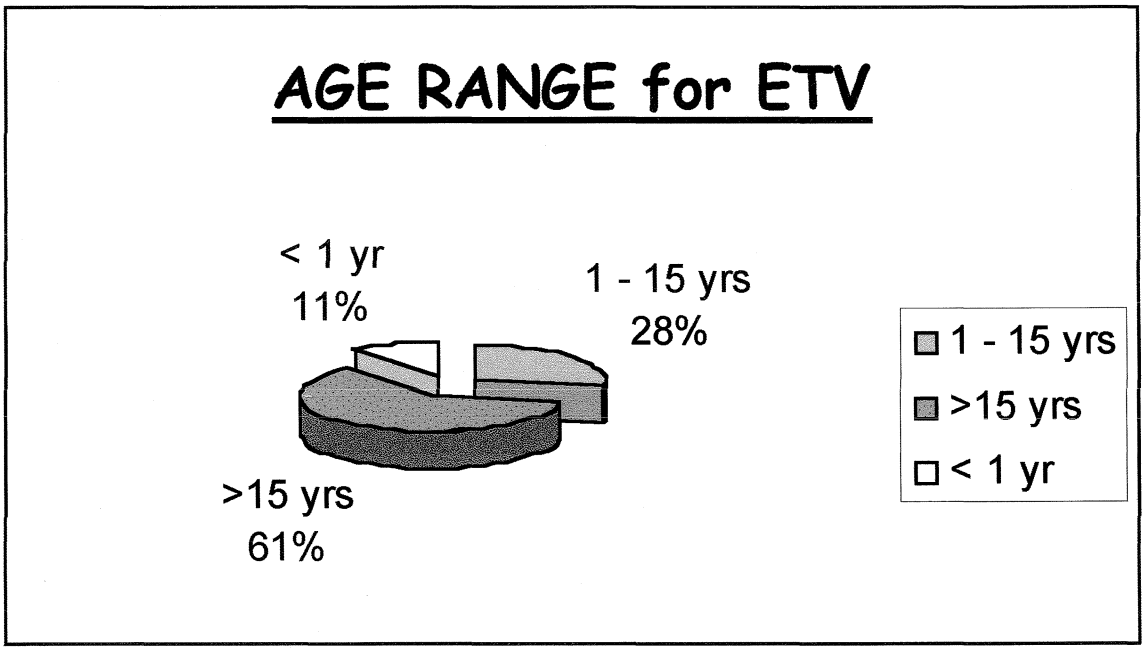
RESULTS AND ANALYSIS:

During the period of 40 months from September 1999 to January 2003, a total of 162 patients underwent endoscopic procedures for various indications in our institute which included 105 males and 57 females.

The various endoscopic procedures done are given in the table below.

PROCEDURES	
ETV (Endoscopic third ventriculostomy)	118
Septostomy	28
Fenestration	22
Aqueductoplasty	8
Foraminoplasty	4
Endoscopic biopsy	18
Endoscope assisted procedures	5
Endoscope assisted VP shunt	21


PROCEDURES
120
100
80
60
40
20
0
118
28
22
8
4
18
5
21
1
PROCEDURES
ETV
Septostomy
Fenestration
Aqueductoplasty
Foraminoplasty
Endoscopic biopsy
Endoscope assisted procedures
Endoscope assisted VP shunt


AGE RANGE for ETV
< 1 yr
11%
1 - 15 yrs
28%
>15 yrs
61%
1 - 15 yrs
>15 yrs
< 1 yr

ENDOSCOPIC THIRD VENTRICULOSTOMY

118 patients underwent endoscopic third ventriculostomy for various causes of hydrocephalus. There were 73 males and 45 females of which 72 patients were above the age of 15 yrs. 13 patients were less than 1 year old at the time of the procedure. The age range of the patient group is given below:

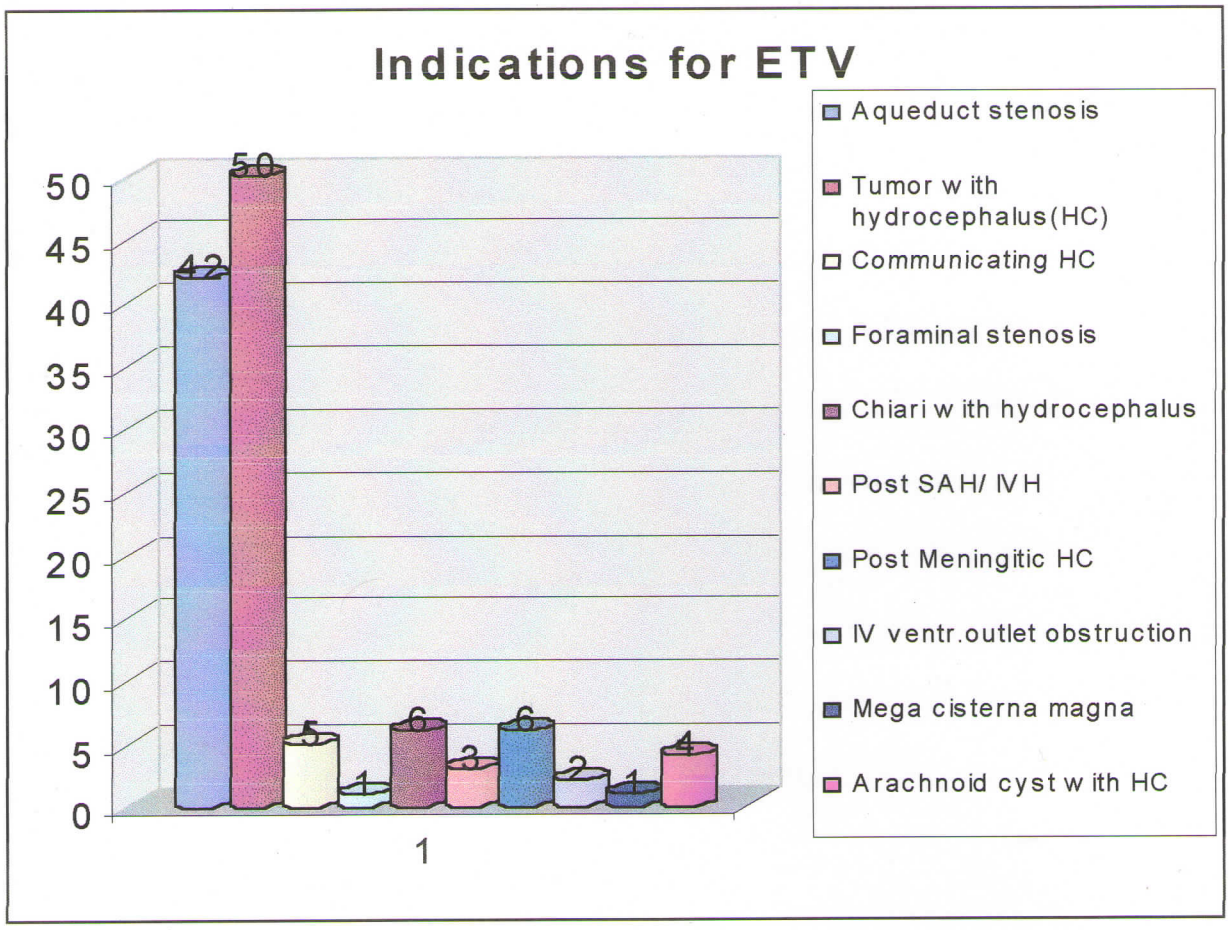
AGE RANGE	ETV
1 - 15 yrs	33
>15 yrs	72
< 1 yr	13
Grand Total	118

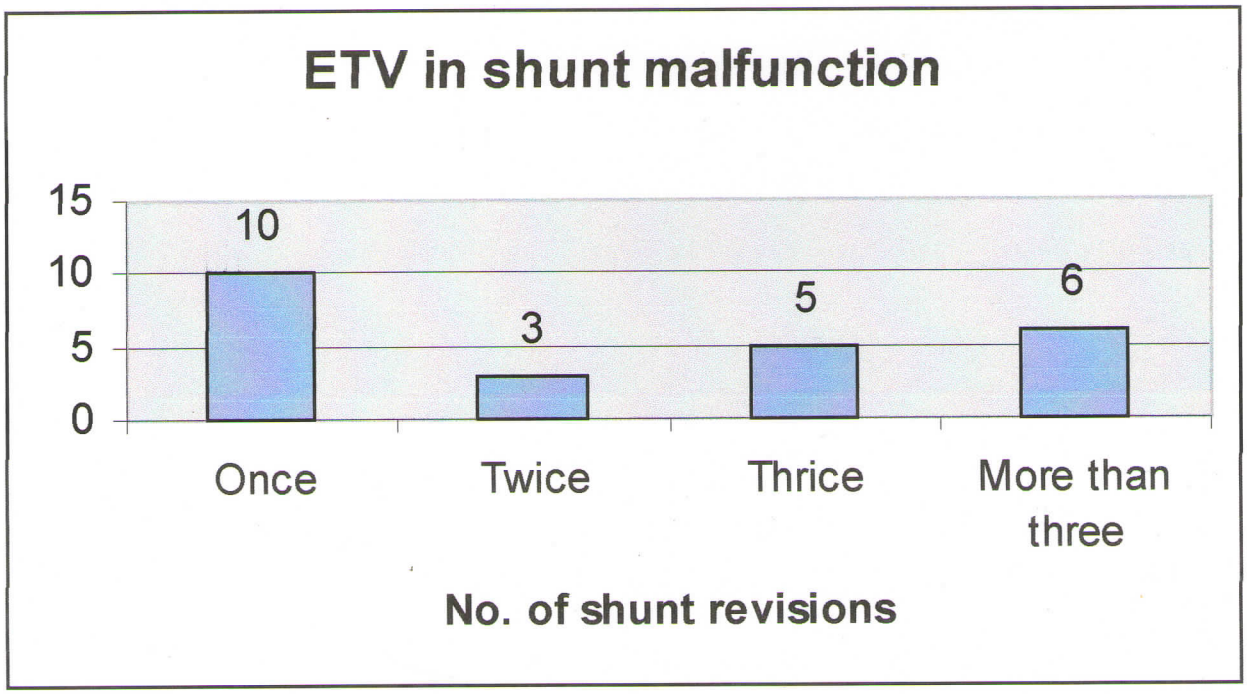
The presenting complaints of the patients were analyzed which showed that the majority had presented with raised ICP symptoms.

PRESENTING COMPLAINTS (ETV)	
Raised ICP	72
Nonspecific headache	18
Altered sensorium	4
Seizures	4
NPH	5
Raised HC / delayed milestones	9
Others	6
Grand Total	118

The indications for which endoscopy was tried in this group ranged from both pediatric as well as adult aqueduct stenosis to other causes of obstructive hydrocephalus including space occupying lesions and cases of communicating hydrocephalus like postmeningitic and post subarachnoid hemorrhage (SAH) hydrocephalus.

INDICATIONS FOR ETV	
Aqueduct stenosis	42
Tumor with hydrocephalus (HC)	50
Communicating HC	5
Foraminal stenosis	1
Chiari with hydrocephalus	6
Post SAH/ IVH	3
Post Meningitic HC	6
IV ventr. Outlet obstruction	2
Mega cisterna magna	1
Arachnoid cyst with HC	4
TOTAL	118


Indications for ETV
50
45
40
35
30
25
20
15
10
5
0
42
50
5
1
6
3
6
2
1
4
1
Aqueduct stenosis
Tumor with hydrocephalus(HC)
Communicating HC
Foraminal stenosis
Chiari with hydrocephalus
Post SAH/ IVH
Post Meningitic HC
IV ventr.outlet obstruction
Mega cisterna magna
Arachnoid cyst with HC


ETV in shunt malfunction
15
10
5
0
10
3
5
6
Once
Twice
Thrice
More than three
No. of shunt revisions

ETV IN SHUNT MALFUNCTION

Of this group of 118 patients, 24 patients had presented with a history of previous shunt insertion which was malfunctioning. 14 out of these 24 patients had a history of multiple shunt revisions with one adult patient with aqueduct stenosis having a history of as high as 14 shunt revisions.

ETV IN SHUNT MALFUNCTION	
Number of previous Shunt revisions	No. of cases
1	10
2	3
3	5
4	2
5	2
7	1
14	1
Grand Total	24

Of the 32 patients who presented with shunt malfunction ETV alone was done in 24 cases with endoscopic assisted shunt being done in 7 cases and 1 patient underwent cyst fenestration for an intraventricular arachnoid cyst causing hydrocephalus for which a VP shunt was done earlier elsewhere and which was malfunctioning. In 18 cases (75%) the patients became shunt independent with ETV with maintained status at followup.

Radiological outcome:

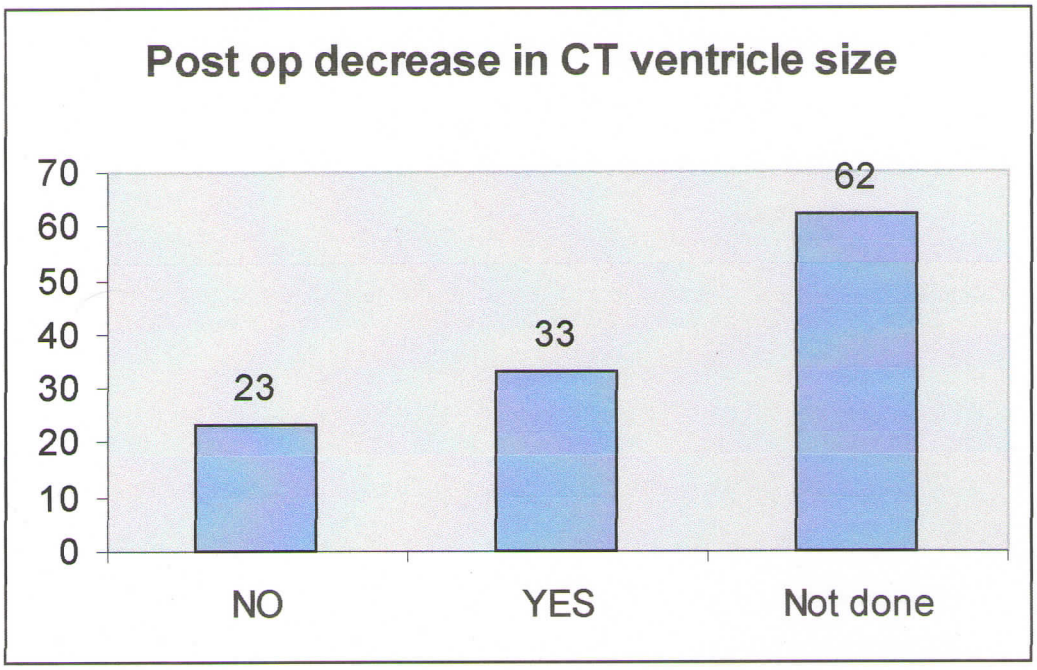
All patients had undergone either preoperative CT or MRI evaluation. 79 of 118 patients underwent post op CT scans in the immediate post op (56) and subsequent followup period. Two parameters, decrease in ventricular size and disappearance of periventricular lucency (PVL) was studied to assess radiological outcome.

Of the 79 patients, 53 patients showed post operative radiological improvement.

Post op decrease in CT ventricle size (Total)	
NO	26
YES	53
Not done	39

56 patients underwent immediate post op CT scans of which 33 patients had a documented evidence of decrease in ventricular size. Among the 23 who had persistent ventricle size 17 had evidence of decompression in the form of absence of periventricular lucency (PVL).

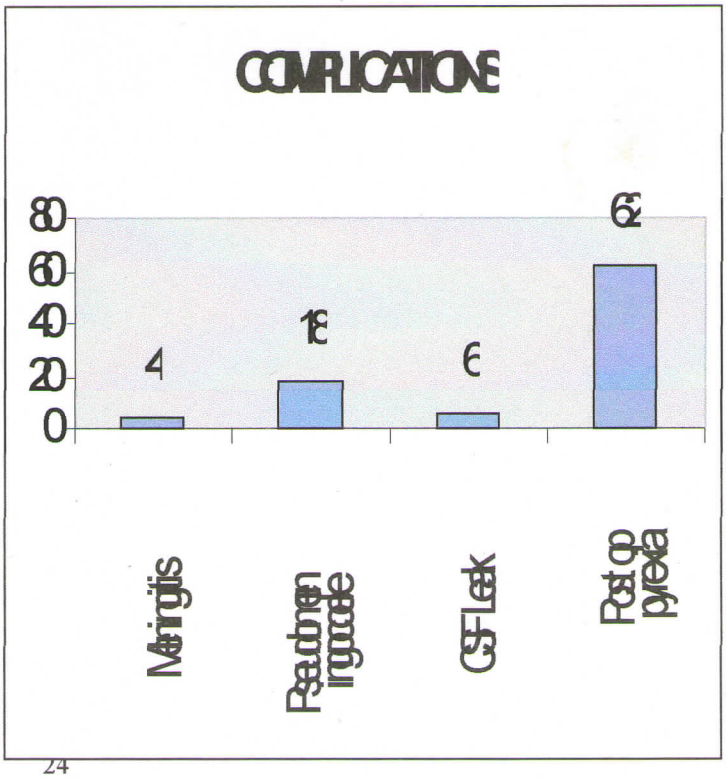
Imm. post op decrease in CT ventricle size	
NO	23
YES	33



PVL disappearance in CT (imm. post op)	
NO	9
YES	48

Complications

COMPLICATIONS	
Meningitis	4
Pseudomeningocoele	18
CSF Leak	6
Post op pyrexia	62

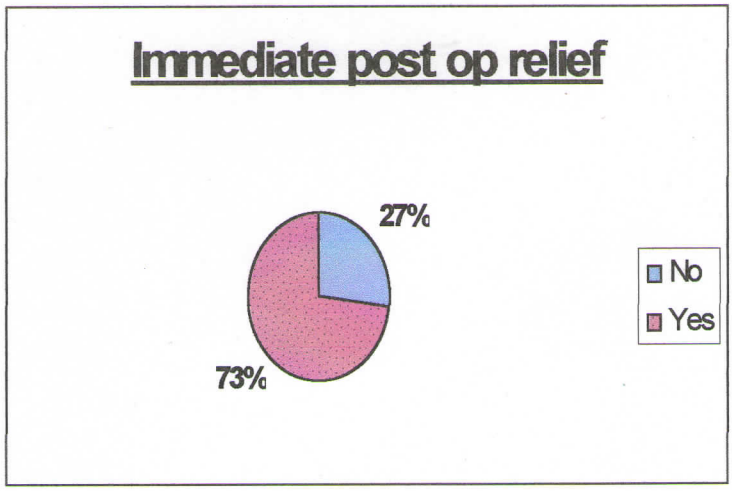


Clinical outcome

Immediate post operative period

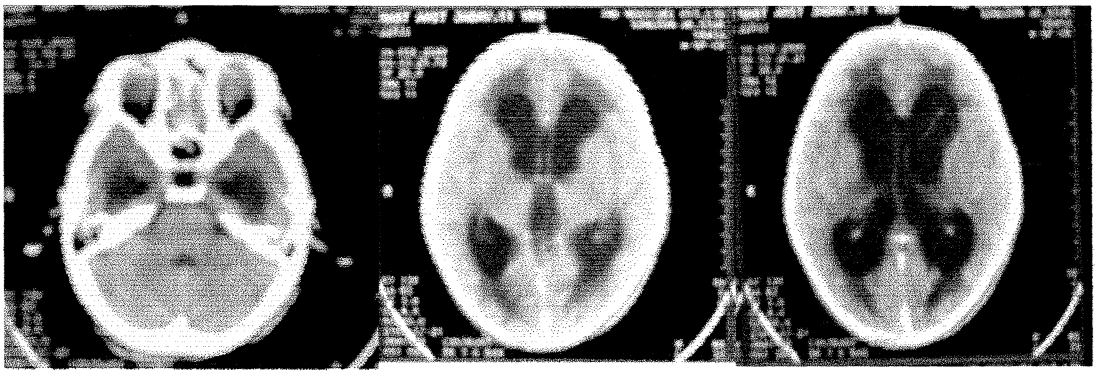
In the immediate post operative period 85 patients (72%) had relief of their presenting complaint which was maintained in the post operative followup period as well. One patient who had massive intraventricular hemorrhage intraoperatively from injury to the thalamostriate vein expired in the post operative period which was the sole mortality in the series.

Immediate post op relief in ETV	
No	32
Yes	85
Expired	1

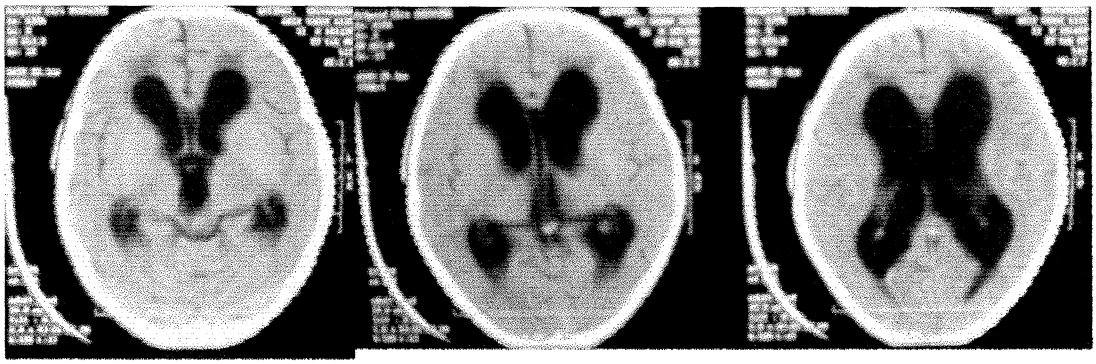


Of the 32 patients without any symptomatic relief in the post operative period 17 patients underwent shunt surgeries in the same admission or during followup period. Among the remaining 15 patients, 12 showed clinical improvement in the followup period with conservative measures and 3 were lost to followup.

Pre operative scans

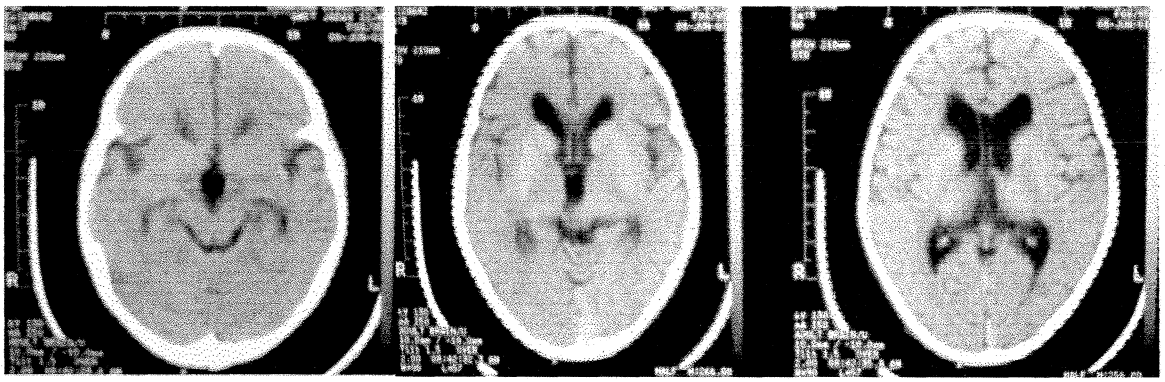


Immediate post op



1 year follow up

2 year follow up



Failures

Definition – Failures were defined as those patients who had no relief of presenting complaints and required a CSF diversion procedure like a shunt insertion in the immediate postoperative or followup period.

Causes of failure

Immediate post operative period

There were 11 failures in the immediate postoperative period of which 4 patients had a history of multiple shunt revisions (more than 4 times) and 3 had post meningitic hydrocephalus. One of the three patients who had post meningitic hydrocephalus also had a history of multiple shunt revisions (3 times). 2 patients had hydrocephalus due to prior intraventricular bleed, 1 patient had communicating hydrocephalus and 2 patients were infant aqueduct stenosis (< 1 year old).

Followup period

There were 6 failures in the follow up period all of which interestingly occurred within the first followup period of 6 weeks. 2 patients had a history of multiple shunt revisions for aqueduct stenosis with shunt malfunction, 2 were paediatric patients aged 7 months and 15 months with aqueduct stenosis and 1 patient had a communicating hydrocephalus following neurocysticercosis.1 patient was a post operative case of cerebellar astrocytoma who had presented with hydrocephalus.

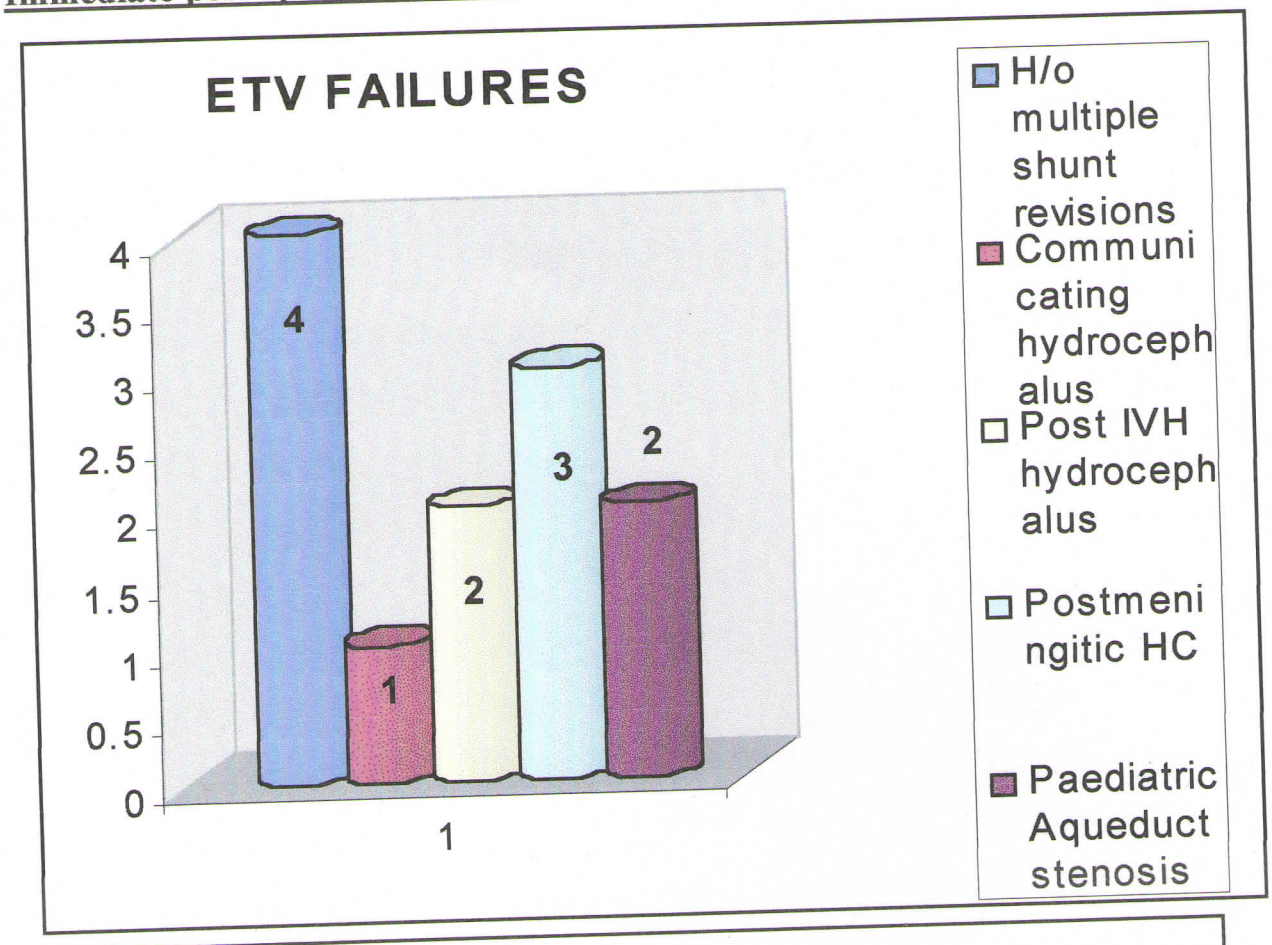
Immediate post operative period

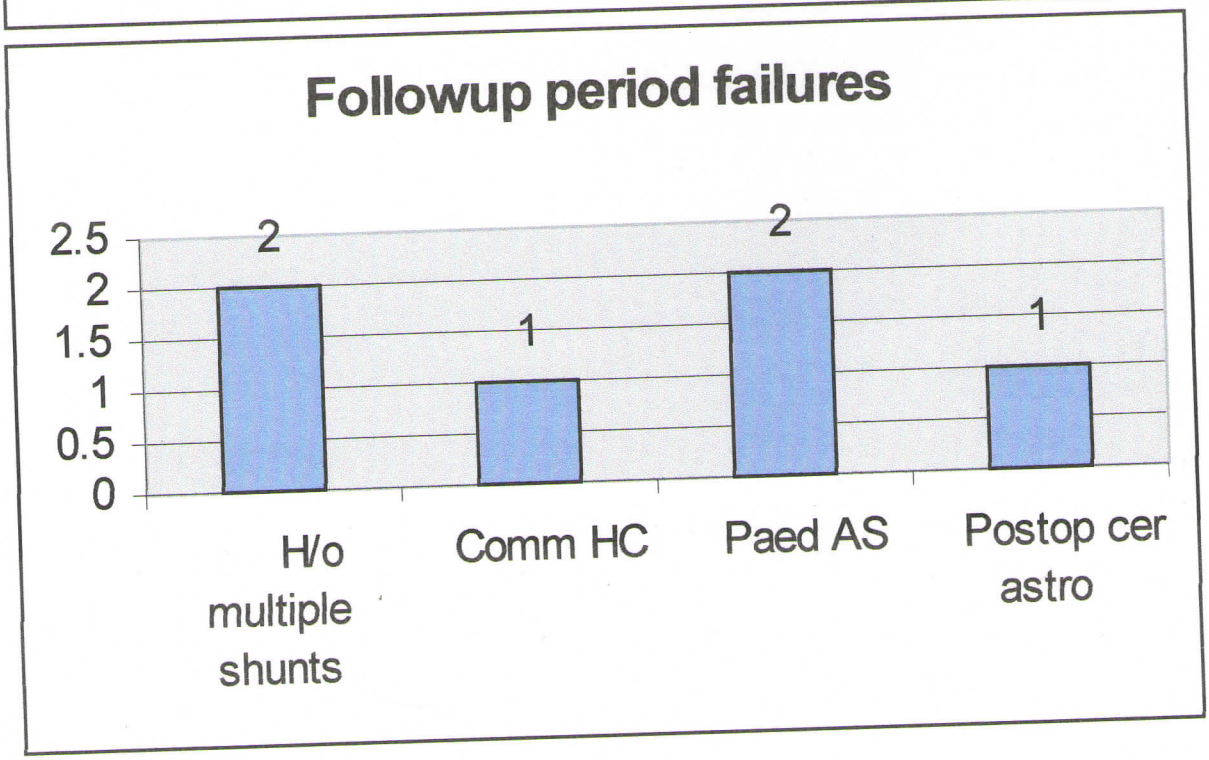
ETV Failures (Post op shunt requirement) VS Diagnosis	
H/o multiple shunt revisions	4 (36.3%)
Communicating hydrocephalus	1 (09%)
Post neonatal IVH hydrocephalus	2 (18.1%)
Postmeningitic HC (1 patient had h/o multiple shunt revisions)	3 (27.2%)
Infant Aqueduct stenosis	2 (18.1%)
Total	**11**

Followup period

ETV Failures (Post op shunt requirement) VS Diagnosis	
H/o multiple shunt revisions	2
Communicating hydrocephalus	1
Paediatric Aqueduct stenosis	2
Post op cerebellar astrocytoma	1
Total	**6**

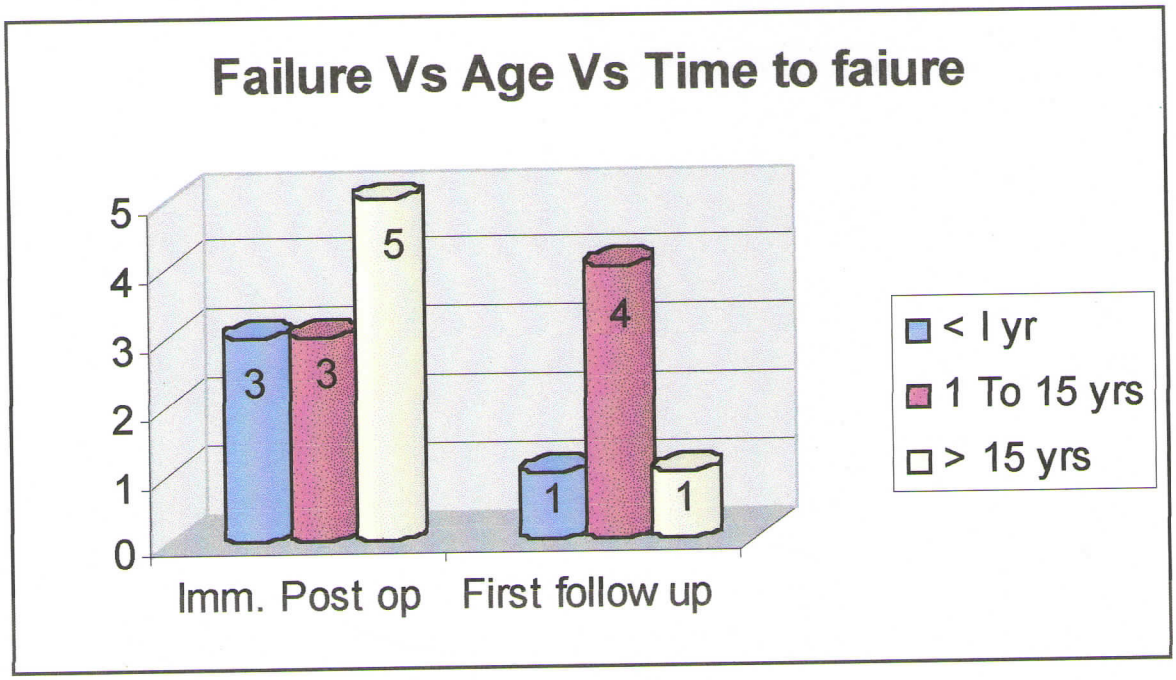
Immediate post operative period





Age Vs failure

ETV Failures (Postop shunt requirement)				
Age	Imm. Post op	First follow up	Second follow up	Third followup
< 1 yr	3	1	0	0
1 to 15 yrs	3	4	0	0
> 15 yrs	5	1	0	0
Total	11	6		
Grand Total				17 (14.4%)



Post op conservative measures

Drainage LP	7 (1 VP shunt)
Lumbar drain	5
External Ventricular Drain (EVD)	5 (All underwent VP shunts)

Of the patients who did not show post operative improvement 7 patients underwent repeated drainage LPs of which 6 improved but 1 had to be shunted. 5 patients improved with lumbar drains for an average of 4 days and 5 patients required post operative EVD all of whom underwent a VP shunt insertion.

Followup

First Followup (6 weeks):

6 patients had to undergo VP shunt surgeries within the first followup period. All except 5 patients maintained clinical improvement. Four tumor patients with hydrocephalus were readmitted for definitive surgery. Twenty patients were lost to followup.

FOLLOW UP (6 WEEKS)	
1. No improvement	2
2. Clinical improvement	70
3. CT improvement	-
4. Both	10
5. 1 but not 2	1
6. 2 but not 1	-
7. Failure of endoscopy. (Shunt/surgery)	6
8. Static	3
9. Deteriorated but improved with conservative	1
10. Developed SDH	1
11. Readmitted for definitive surgery	4
12. lost to follow up	20
Total	118

FOLLOW UP (6 MONTHS)	
1. No improvement	-
2. Clinical improvement	59
3. CT improvement	-
4. Both	23
5. 1 but not 2	3
6. 2 but not 1	-
7. Failure of endoscopy. (Shunt/surgery)	-
8. Static	2
9. Deteriorated but improved with conservative	-
10. Developed SDH	-
11. Readmitted for definitive surgery	1
12. lost to follow up	30

FOLLOW UP (1 YEAR)	
1. No improvement	-
2. Clinical improvement	43
3. CT improvement	-
4. Both	6
5. 1 but not 2	-
6. 2 but not 1	-
7. Failure of endoscopy. (Shunt/surgery)	-
8. Static	1
9. Deteriorated but improved with conservative	-
10. Developed SDH	-
11. Readmitted for definitive surgery	-
12. Lost to follow up	68
Total	118

HOSPITAL STAY

The average hospital stay of patients undergoing third ventriculostomy was found to be 6 days. If the patients undergoing third ventriuclostomy for uncomplicated aqueduct stenosis only were taken into consideration their average hospital stay was found to be only 4 days.

AQUEDUCTOPLASTY

The procedure of dilating the stenosed aqueduct using a Fogarty balloon catheter introduced through the endoscope (aqueductoplasty) was attempted in 8 patients with congenital uncomplicated aqueduct stenosis along with third ventriculostomy. All the patients in this group had good clinical as well as radiological outcome.

No. of cases	8
+ ETV	8
Relief of presenting complaint	8
Post op CT	7
Reduction in ventricular size	5
Static ventricular size	2

FORAMINOPLASTY

Dilatation of the stenosed Foramen of Munro was attempted in 4 patients with asymmetric hydrocephalus. All patients revealed satisfactory post operative clinical outcome and Post operative CT scans done in 3 patients showed reduction in ventricular size giving clinicoradiological correlation.

No. of foraminoplasty	4
Clinical improvement	4
Radiological improvement	3
No post op CT	1

FENESTRATION

Endoscopic fenestration of intracranial arachnoid cysts to establish communication with subarachnoid spaces to relieve mass effect was done in 22 cases. 17 patients revealed immediate post operative relief. The remaining 5 patients were on kept on followup and showed improvement during the followup period.

No. of cases	22
Relief of presenting complaint (imm. postop)	17
Symptomatic at first followup	Nil

ENDOSCOPIC ASSISTED VP SHUNTS

Shunt insertion assisted by the endoscope was done in 21 patients for various indications, the most common one being in suprasellar tumors where a third ventriculostomy couldnot be performed. The endoscope was used for the accurate placement of the ventricular tip and also for performing septostomies to avoid the use of biventricular shunts. 16 patients had relief of their raised intracranial pressure symptoms. 3 patients improved during followup with conservative measures and 2 patients expired due to unrelenting tumor progression.

1 patient in this group underwent endoscopic aspiration of a recurrent cystic craniopharyngioma (3 times operated) along with a septostomy and assisted shunt insertion owing to the morbid status of the patient which precluded any major surgical procedure for him.

None of the patients experienced malfunction or shunt related complications and post op CT scans in 13 patients showed satisfactory placement of the ventricular catheters with reduction in ventricular size.

ENDOSCOPIC BIOPSY

Neuroendoscopy was used to obtain biopsy pf intraventricular as well as paraventricular lesions in 12 cases. The majority included pineal lesions who present with hydrocephalus and raised ICP symptoms underwent a third ventriculostomy with a tumor biopsy based on which firthertreatment plan was decided. The histopathology was obtained in 11 of these patients.

Biopsy only	2
Biopsy + ETV	8
Biopsy + VP shunt	2

ENDOSCOPE ASSISTED SURGICAL PROCEDURES

The endoscope was used along with the microscope in 8 patients, 3 tumor resections, 1 colloid cyst excision and 4 aneurysm clippings. It aided in superior visualization of the important neighbouring neurovascular structures and in ensuring correct clip application including the entire neck and excluding any closely related perforators or other small branches.

DISCUSSION

DISCUSSION

The analysis of the intracranial endoscopic procedures in our institute from its inception over a three and a half year period reveals one its most important indications, mainly in the management of obstructive hydrocephalus due to various causes. The other important indications included its use in the management of symptomatic intracranial cysts by fenestration, in obtaining biopsies of intra and paraventricular lesions and in endoscope assisted procedures like in shunt placements and in other microneurosurgical procedures.

The other indications mentioned in literature are in transsphenoidal procedures like repair of CSF fistulas and in decompression of pituitary adenomas. The cases from our institute were not included in the present study as they have been started in the last year of the study so that an adequate followup period has not been reached for satisfactory analysis.

Endoscopic third Ventriculostomy (ETV) – Outcome:

Presently ETV is thought to be one of the best techniques in tackling the problem of hydrocephalus because it combines a minimally invasive approach with brilliant visual control of manipulations.

The favorable outcome of approximately 85.6% overall and 88.9% for adult aqueduct stenosis compares with that reported for patients with aqueduct stenosis. Significantly better outcomes have been noted in hydrocephalus due to benign space occupying lesions (SOL) rather than progressive tumorous conditions[3]. The complication rate was also comparable at 4.3% to 6% with one death occurring in the postoperative period due to intraventricular hemorrhage (IVH) which was directly linked to the procedure.

The reported complication rates for ventricular endoscopic procedures ranges from less than 2% to 7%[2]. They include wound infection, CSF leaks and subgaleal collections (pseudomeningocoele).

Other complications reported like direct injury to caudate or internal capsule when cannulating the lateral ventricle, traction injury to fornix or hypothalamus while cannulating the foramen of Munroe were not seen in the present series. Most symptoms are self-limited and improve over time.

Ventriculitis & meningitis (both infectious & aseptic) have been treated successfully with intravenous antibiotics. In addition, the subsequent inflammation & scarring can cause or potentiate hydrocephalus & ventricular loculations.

The present series had only 2 proven cases of meningitis though postoperative pyrexia was a common finding noted in nearly 40% of our patients with majority of them not showing any focus of infection. The presence of blood within the ventricular system is postulated as a cause for this postoperative pyrexia in patients undergoing intracranial endoscopic procedures.

Radiological outcome:

67% of the patients who underwent postoperative CT scans showed radiological improvement and this showed good clinical correlation also. Radiological documentation of successful ETV is seen in 76% of cases and a clinicoradiological correlation of 96% has been reported in series with postoperative MRI studies[3]. However only 86% of pts with patent stoma as revealed by T 2 MRI, improved clinically.

However our findings of absent signs of radiological improvement in the presence of documented clinical improvement is consistent with Fukuhara et al[9] observation that ventricular sizes do not consistently change after ETV & does not appear to correlate with clinical outcome. In his series, the ventricular size remained unchanged for 75% on the next day, 57.4% after 3 months, for 48.2% after 6 months and for 41.8% after 1 year.

Most authors have stressed on the absence of reduction in ventricular size even in clinically improved ETV patients[3,11,12], and even in the above series, also only 48% of patients among the clinically successful cases reported a decrease in ventricular size[11].

Our finding of decreased PVL especially in patients who had good clinical outcome with no apparent reduction in ventricular size seems to indicate a early predictor of procedure success. But its reliability cannot be recommended partly due to the lack of a measuring scale with good inter observer reliability in such variables.

ETV in shunt malfunction

The success rate of 75% in cases of shunt malfunction coupled with the use of the endoscope in assisted shunt placement of this subgroup of patients indicate the role of ETV in reducing the morbidity and improving the quality of life in these cases. This corroborates well with series reports of 77%, 67% and 63% favorable outcomes following ETV in patients with meningitis, shunt infections & IVH respectively[3]. Though 6 out of our 17 failed ETVs had a history of shunt malfunction, the above finding underlines the changing management trend of patients with shunt malfunction in that even a small chance to remain or to become shunt free renders offering ETV to these patients worthwhile.

ETV is a viable and effective option for patients who present with shunt malfunction and can lead to a shunt free state of existence. Krause et al reports a 82% shunt free success rate for ETV in shunt malfunction[26], which compares with the 76% rate quoted by Cinnalli et al[27]. But they also have concluded that predictors of failure of ETV in shunt malfunction included a history of meningitis or shunt infection or multiple shunt revisions[26].

ETV in pediatrics:

Pediatric patients benefit the most from ETV, but the best time to perform ETV is not yet clear.

Our findings of 4 out of 17 failures belonging to the infant age group (less than 1 year old) though may not seem significant, considering the fact that a total of only 13 patients in the study group belonged to this age group makes the success rate in this group of patients to be around 68%.

Most authors think ETV is significantly more effective in pediatric patients, older than 2years of age[3,16].

Fukuhara et al has advocated the use of ETV in congenital hydrocephalus with less than 6 months age, but has pointed out the high chance of failure owing to the poor CSF absorption abilities of newborn infants[9].

Brockmeyer et al reports a 26% procedure abandonce rate, due to unfavorable anatomy or technical reasons, which included 36% of hydrocephalus with myelomeningocoele (MMC)[18]. There were no cases of procedure abandonce in our series.

In the series reported by Fukuhara et al, 89 infants who underwent ETV has been analyzed. He reports an overall success rate of 61.7% at 5.3yrs follow-up period. Identifying possible risk factors for failure of ETV, he has identified a history of CNS infection or intraventricular hemorrhage as an important indicator of failure with statistical significance. He has advocated the use of ETV in congenital hydrocephalus with less than 6 months age, but has pointed out the high chance of failure owing to the poor CSF absorption abilities of newborn infants.

Predictors of ETV failure:

The possible pointers to likely failure of procedure included:

- History of multiple shunt revisions
- Patients age less than 1 year
- Post meningitic or other causes of hydrocephalus
- A combination of any of the above factors.

In the epic study conducted by Cinnalli et al[17] to identify the ETV failures in aqueduct stenosis (AS) in children (213 cases) he states about the issue of increased failure rate among children less than 6 months of age and concludes that though the risk of secondary stomal closure and impaired CSF absorption are quite high in the younger age group, ETV should be attempted, as failures that occur in this age group occur early and hence can be picked up for planned secondary intervention by close follow up for the first year.

He also presents the life table analysis of patients which shows that all treatments failures were seen within 5 yrs and no patient required repeat intervention after 5 years. Long term cine PC MRI Imaging studies ensures satisfactory intracranial CSF shunt upto 17 years post operatively, indicating that ETV is a long term & definitive cure for obstructive hydrocephalus in the majority of patients. His overall success rate was more than 70%.

Hospital stay

The average hospital stay of patients undergoing third ventriculostomy was found to be 6 days. If the patients undergoing third ventriuclostomy for uncomplicated aqueduct stenosis only were taken into consideration their average hospital stay was found to be only 4 days.

Gupta et al[25] reporting on his series of neuroendoscopic procedures from India, concludes that it cuts down on the operative time as well as hospital stay, thereby reducing cost and resulting in faster turnover of patients and so is especially useful in busy neurosurgical centers of developing countries.

Neuroendoscopy in intracranial cysts:

76.6% of our patients with intracranial cysts who underwent endoscopic fenestration became symptom free in the immediate post operative period with short operative time, minimal hospital stay and zero morbidity. All the patients in this group became symptom free by first followup period.

Perneczky et al[28] in his series of 36 patients with intracranial cystic lesions either arachnoid cysts or intraventricular cysts reports overall clinical improvement was seen in 70%. The best results were obtained in intraventricular cysts with 89% clinical improvement and radiological improvement was seen in 72% of cases. The overall complication rate was 14% including subdural hematomas or hygromas, meningitis etc.

The selection of the endoscopic technique for intra cranial cysts should be based on the individual characteristic of the cyst, the equipment available & the surgeon's experience which may account for our good results as all the patients had uncomplicated but symptomatic arachnoid cysts.

ETV in congenital malformations:

Though our series of 6 patients who underwent ETV for hydrocephalus associated with Chiari malformation showed good postoperative improvement, literature has shown the limited effectiveness of ETV in patients with Chiari malformation or Myelomeningocoele or other forms of spinal dysraphism[3,15,29,30]. The lower success rate of ETV in relieving hydrocephalus in such situations is related to the structural immaturity of the subaracnoid space or occurrence of sub clinical adhesive inflammation in this space, which precludes adequate CSF absorption[3,15,31,32].

However there are studies showing efficacy of third ventriculostomy in fourth ventricular outlet obstruction associated with Chiari malformation[17,29,33,34]. In a case report from Kyushu university Japan, Fukui et al presents the successful use of ETV in a case of Chiari malformation with fourth ventricular outlet obstruction, hydrocephalus and syringomyelia, leading to complete resolution of clinical symptoms & radiological improvement too[29].

Endoscopy in intraventricular tumors:

Neuroendoscopy was used to obtain biopsy pf intraventricular as well as paraventricular lesions in 12 cases. In 2 cases without hydrocephalus only biopsy was done whereas in the remaining 10 cases, 8 underwent ETV and 2 had endoscope assisted VP shunts. All patients had relief of raised intracranial pressure symptoms and biopsy was obtained in all but one patient which turned out to be an astrocytoma.

This is in line with reported series of 34 patients with pineal region tumors who underwent endoscopic third ventriculostomy with tumor biopsy, where the diagnosis rate was 94%[35]. There was only one case of ETV failure, with no operative mortality or major procedure related complications.

Cohen et al[43] has also concluded, on a report of his series of pineal tumors where ETV and biopsy was instituted as the initial management, that neuroendoscopy contributes to the safe & minimally invasive initial management of patients with intraventricular tumors especially pineal region neoplasms and symptomatic hydrocephalus that can guide further definitive management.

CONCLUSION

Conclusion

Neuroendoscopy has etched for itself a prominent place with specific indications and advantages. It is undoubtedly the procedure of choice for adult aqueduct stenosis and other causes of obstructive hydrocephalus, especially due to benign space occupying lesion, with high success rate approaching 90% in experienced hands. The low complication rates ofapproximately 5% is another factor in favour of neuroendoscopy being used in these conditions.

Neuroendoscopic third ventriculostomy should be attempted in the management of paediatric Aqueduct stenosis, though an age of 6 months or less should caution the surgeon to a high likelihood of failure approaching 30 to 40 %. This is also true in the case of patients with hydrocephalus associated with congenital malformations, meningitis or subarachnoid hemorrhage. But the chance of remaining shunt free renders offering ETV to these high risk groups worthwhile.

Conditions like neonatal intraventricular hemorrhage associated hydrocephalus and infant postmeningitic hydrocephalus have a very low success rate with ETV. Another prominent predictor identified by the study is a history of multiple shunt revisions with shunt malfunction. These are conditions which should provoke extreme caution in the endoscopic neurosurgeon and involvement of the patient in all management issues is a must for planning treatment strategy. The endoscopic assistance offered to

microneurosurgery in various procedures makes the surgeon more confident in avoiding iatrogenic complications. On the whole neuroendoscopy has gained an irreplaceable position for itself with expanding but specific indications & advantages in this era of modern microneurosurgery.

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