A SHUNT DEPENDENCY OUTCOME OF ENDOSCOPIC THIRD VENTRICULOSTOMY IN THE MANAGEMENT OF OBSTRUCTIVE HYDROCEPHALUS

BY

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Abstract:

Background: Endoscopic third ventriculostomy (ETV) is an accepted alternative to cerebro-spinal fluid(CSF) shunting in cases of obstructive hydrocephalus. The aim of this study is to evaluate the shunt dependency following ETV in obstructive hydrocephalus patients and factors influencing it.

Methods: This was a cross-sectional study of which a total of 206 patients presenting with obstructive hydrocephalus that underwent ETV from 3 major centres ;. Kuala Lumpur General Hospital, Hospital Universiti Sains Malaysia and Sarawak General Hospital were studied. Successful ETV is taken as clinically no symptoms of raised intracranial pressure and imaging evidence of resolution of hydrocephalus[(1)].

Results: Mean age of patients was 21.1 ± 22.6 years with 98 (47.6%) being paediatrics (<12 years) and 108 (52.4%) adults (≥12 years). 63 (30.6%) were of congenital causes, 90 (43.7%) tumoral related, 40 (19.4%) due to hemorrhage and 13 (6.3%) post-infective. Shunt free outcome at one month was 179 (86.9%) and 177 (85.9%) at six months. Chi-square test showed no statistical significance in outcome with age groups (p value = 0.629) or outcome with diagnosis (p value = 0.057). Univariate analysis via logistic regression showed significance of Liliequist membrane with odds ratio 4.375 ; 95% CI (1.188 - 16.115), p value 0.027 ; of which patients with Liliequist membrane present are 4-fold risk of failure and ending up with a shunt after 1month following ETV. Also noted the nature of fenestration with the outcome where at one month odds ratio 17.969 ; 95% CI (2.077 - 5.957), p value 0.009 and at six months odds ratio 19.154 ; 95% CI (2.11,173.868), p value 0.009 signifies a large fenestra with well flapping floor of the third ventricle has a 17-fold chance of being shunt free at one month and 19-fold chance at six months. Multivariate logistic regression analysis showed significance of nature of fenestration with the outcome where at one month adjusted ratio 0.231 ; 95% CI (0.091-0.518), p value 0.005 and at six months adjusted ratio 0.241 ; 95% CI (0.092 - 0.535), p value 0.006 signifies a large fenestra with well flapping floor of the third ventricle has a 0.2-fold chance of being shunt free at one month and six months respectively. Also noted was 6 months outcome based on age group with adjusted ratio 0.202 ; 95% CI (0.109 - 0.206), p value 0.006 ; of which adult patients have 0.2-fold chance of being shunt free at six month following endoscopic third ventriculostomy.

Survival analysis using Cox regression to generate Hazard ratio showed ETV failure at any point of time in this study for tumoral causes are 0.322 times less likely to fail compared to congenital causes (HR 0.322 ; 95% CI 0.122 - 0.847 ; p value 0.022).

Conclusion: ETV is a safe and effective procedure in patients with obstructive hydrocephalus. Patients with presence of Liliequist membrane has a higher chance of ETV failure and nature of the fenestra plays a vital role in outcome of ETV. Paediatric age group has a slightly higher chance of ETV failure. Patients with tumors predominantly pineal and posterior fossa tumors has a higher chance of success compared to congenital cases.

Keywords: endoscopic third ventriculostomy, hydrocephalus, shunt dependency, Liliequist membrane

Abstrak:

“Endoscopic third Ventriculostomy” (ETV) merupakan satu procedur untuk merawat masalah air otak yang bertakung yang disebabkan oleh sekatan saluran air otak. Prosedur ini adalah alternatif kepada prosedur shunt. Tujuan utama penyelidikan ini adalah untuk menganalisa kegagalan ETV and factor-faktor yang mempengaruhinya. Seramai 206 pesakit dari 3 buah hospital dianalisa, iaitu dari Hospital Besar Kuala Lumpur, Hospital Universiti Sains Malaysia and Hospital Umum Sarawak. Mean umur pesakit 21.1 ± 22.6 tahun dengan 47.6% pediatrik (<12 tahun) dan 52.4% dewasa (≥12 years). 30.6% berpunca dari masalah kelahiran, 43.7% berkaitan dengan barah, 19.4% oleh pendarahan dan 6.3% post-infeksi. Kadar kejayaan ETV pada satu bulan adalah 86.9% manakala85.9% pada enam bulan. Analisa univariate menggunakan “logistic regression” menunjukkan pesakit yang mempunyai membran Liliequist adalah 4 kali lebih kerap untuk gagal ETV dalam satu bulan selepas procedur itu. Pesakit dengan lubang ETV yang besar dan mengepak dengan baik adalah 17 kali pada satu bulan dan 19 kali pada enam bulan lebih kerap untuk mengubati penakungan air otak dan tidak perlu menjalani prosedur yang lain. Manakala Analisa multivariate menunjukkan pesakit dengan lubang ETV yang besar dan mengepak dengan baik adalah 0.2 kali pada satu and enam bulan untuk mengubati penakungan air otak Kesimpulannya ETV merupakan satu prosedur yang selamat dan efektif dalam mengubati masalah penakungan air otak disebabkan oleh sekatan aliran air otak. Pesakit yang memiliki membran “Liliequist” mempunyai kebarangkalian yang lebih tinggi untuk gagal prosedur ETV manakala sifat lubang yang dibuat dalam prosedur ETV memainkan peranan yang penting dalam kejayaan prosedur ETV. Pesakit kanak-kanak mempunyai kebarangkalian

yang lebih tinggi berbanding dewasa untuk gagal prosedur ETV. Pesakit dengan barah bahagian pineal and juga pangkal otak didapat mempunyai kebarangkalian yang lebih tinggi untuk manafaat dari ETV berbanding kes-kes masalah kelahiran.

Introduction – literature review and rationale for the study:

Sir Walter E. Dandy is still considered as the father of neurosurgical endoscopy as he first described ventricular anatomy via ventriculoscopy in the early 1920s. He then went on to describe methods of performing third ventriculostomy first transcranially via subfrontal and subtemporal approaches and subsequently endoscopically along with choroid plexotomy [(2)]. However it was William Mixter who first successfully performed a third ventriculostomy on a child using a urethroscope in 1923 [(2)]. Scopes were then modified and redeveloped to modern ventriculoscopes which are used today. Treating non-communicationg hydrocephalus via third ventriculostomy has picked up over the recent years with the advancement of scopes and was not preferred in the olden days due to the high levels of morbidity and mortalities with cenventional scopes and instruments.

Indications and role for endoscopic third ventriculostomy is fairly clear and is done in cases of obstructive hydrocephalus with imaging evidence of dilated ventricles[(3)]. Endoscopic third ventriculostomy has been attempted in cases of communicating hydrocephalus such as idiopathic normal pressure hydrocephalus[(4, 5)].

The procedure itself is fairly a straight forward procedure but requires a lot of care and caution. Burr hole is made over Kocher’s point either on the right or left side, dura is then cut and cauterised. The endoscope is introduced into the anterior horn of the lateral ventricle. Endoscope is then gently navigated through the foramen of Monro to visualise the floor of the third ventricle. The floor of the third ventricle is then fenestrated using cautery and this fenestra is then enlarged using a Fogarty balloon catheter. Some choose to cauterize the choroid plexus especially in paediatric obstructive hydrocephalus patients[(6)].

Multiple studies analysing the outcome of endoscopic third ventriculostomy has been done however no such study has been done in the Malaysian population. Most of the large series studies published are from developed countries[7]. Sacko, Oumar, et al [7] reported a large series 368 cases of endoscopic third ventriculostomies in France with a success rate of 68.5%. Predorminant cause of obstructive hydrocephalus was tumors (53%), aqueductal stenosis (18%) and hemorrhage related (13%). Another study done in Britain, Waqar, Mueez, et al.[8] studied 190 cases of endoscopic third ventriculostomy for hydrocephalus with a success rate of 73%. The largest series publish from developing countries was the studies done by Benjamin Warf in Uganda[9, 10] amongst paediatric population. Total 403 patients underwent endoscopic third ventriculostomy with a success rate of 57% mainly failures were seen under the age of 6 months with cisternal scarring following hemorrhage or infection.

The main aim of this study the shunt dependency outcome of endoscopic third ventriculostomy in managing obstructive hydrocephalus. Cases that end up with a shunt would be taken as failed endoscopic third ventriculostomy. We would like to delianate the main factors causing failure of the procedure amongst the Malaysian population. Would also like to evaluate shunt dependency in adults and paedatric age groups separately.

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Tarikh : 4hb September 2015

Manvinder Singh Mangat
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Tuan/Puan,

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A SHUNT DEPENDENCY OUTCOME OF ENDOSCOPIC THIRD VENTRICULOSTOMY IN THE MANAGEMENT OF OBSTRUCTIVE HYDROCEPHALUS

Lokasi Kajian: Hospital Universiti Sains Malaysia (HUSM)
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Pusat Penyelidikan Klinikal, Hospital Raja Permaisuri Bainun
Pusat Penyelidikan Klinikal, Hospital Umum Sarawak
Pusat Penyelidikan Klinikal, Hospital Sultanah Aminah

Dengan hormatnya perkara di atas adalah dirujuk.

2. Jawatankuasa Etika & Penyelidikan Perubatan (JEPP), Kementerian Kesihatan Malaysia (KKM) tiada halangan, dari segi etika, ke atas pelaksanaan kajian tersebut. JEPP mengambil maklum bahawa kajian tersebut tidak mempunyai intervensi klinikal ke atas subjek dan hanya melibatkan pengumpulan data melalui rekod perubatan sahaja.

3. Segala rekod dan data subjek adalah **SULIT** dan hanya digunakan untuk tujuan kajian ini dan semua isu serta prosedur mengenai *data confidentiality* mesti dipatuhi. Kebenaran daripada Pegawai Kesihatan Daerah/Pengarah Hospital dan Ketua-Ketua Jabatan atau pegawai yang bertanggung jawab disetiap lokasi kajian di mana kajian akan dijalankan mesti diperolehi sebelum kajian dijalankan. Tuan/Puan perlu akur dan mematuhi keputusan tersebut.

4. Adalah dimaklumkan bahawa kelulusan ini adalah sah sehingga **4hb September 2016.** Tuan/Puan perlu menghantar dokumen-dokumen seperi berikut selepas mendapat kelulusan etika . Borang-borang berkaitan boleh dimuat turun daripada laman web MREC (http://www.nih.gov.my/mrec).

I. *'Continuing Review Form'* selewat-lewatnya 2 bulan sebelum tamat tempoh kelulusan ini bagi memperbaharui kelulusan etika.
II. Laporan tamat kajian pada penghujung kajian.
III. Laporan mengenai *"All adverse events, both serious and unexpected"/Protocol Deviation* atau *Violation* kepada Jawatankuasa Etika & Penyelidikan Perubatan, KKM jika berkenaan.
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5. Sila ambil maklum bahawa sebarang urusan surat-menyurat berkaitan dengan penyelidikan ini haruslah dinyatakan nombor rujukan surat ini untuk melicinkan urusan yang berkaitan.

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Saya yang menurut perintah,

(DATO' DR CHANG KIAN MENG)
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A SHUNT DEPENDENCY OUTCOME OF ENDOSCOPIC THIRD VENTRICULOSTOMY IN THE MANAGEMENT OF OBSTRUCTIVE HYDROCEPHALUS

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Abstract

Background: Endoscopic third ventriculostomy (ETV) is an accepted alternative to cerebro-spinal fluid(CSF) shunting in cases of obstructive hydrocephalus. The aim of this study is to evaluate the shunt dependency following ETV in obstructive hydrocephalus patients and factors influencing it.

Methods: This was a cross-sectional study studying the shunt dependency outcome of ETV in the management of obstructive hydrocephalus. Total 206 patients presenting with obstructive hydrocephalus that underwent ETV from 3 major centres ; Kuala Lumpur General Hospital, Hospital Universiti Sains Malaysia and Sarawak General Hospital were studied. Successful ETV is taken as clinically no symptoms of raised intracranial pressure and imaging evidence of resolution of dilated ventricles(1).

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17-fold chance of being shunt free at 1 month and 19-fold chance at 6 months respectively. Multivariate logistic regression analysis showed significance of nature of fenestration with the outcome where at one month adjusted ratio 0.231 ; 95% CI (0.091-0.518), p value 0.005 and at six months adjusted ratio 0.241 ; 95% CI (0.092 - 0.535), p value 0.006 signifies a large fenestra with well flapping floor of the third ventricle has a 0.2-fold chance of being shunt free at one month and six months respectively. Also noted was 6 months outcome based on age group with adjusted ratio 0.202 ; 95% CI (0.109 - 0.206), p value 0.006 ; of which adult patients have 0.2-fold chance of being shunt free at six month following endoscopic third ventriculostomy.

Survival analysis using Cox regression to generate Hazard ratio showed ETV failure at any point of time in this study for tumoral causes are 0.322 times less likely to fail compared to congenital causes (HR 0.322 ; 95% CI 0.122 - 0.847 ; p value 0.022).

Conclusion: ETV is a safe and effective procedure in patients with obstructive hydrocephalus. Patients with presence of Liliequist membrane has a higher chance of ETV failure and nature of the fenestra plays a vital role in outcome of ETV. Paediatric age group has a slightly higher chance of ETV failure. Patients with tumors predominantly pineal and posterior fossa tumors has a higher chance of success compared to congenital cases.

Survival analysis using cox regression to generate Hazard ratio showed endoscopic third ventriculostomy failure at any point of time in this study for tumoral causes are 0.322 times less likely compared to congenital causes (HR 0.322 ; 95% CI 0.122 - 0.847 ; p value 0.022).

Keywords: endoscopic third ventriculostomy, obstructive hydrocephalus, shunt dependency

1 Introduction

Ventriculo-peritoneal shunting has been the gold standard treatment for obstructive hydrocephalus since it was developed by Nulsen and Spitz in 1951. Sir Walter E. Dandy pioneered ventricular visualisation in the early 1920s using a cystoscope. He then went on to describe methods of performing third ventriculostomy first transcranially via subfrontal and subtemporal approaches and subsequently endoscopically along with choroid plexotomy. However William Mixter was the first to successfully fenestrate the floor of the third ventricle endoscopically in attempt to treat obstructive hydrocephalus in 1923[(2)]. Shunts then superseded ventriculotomies as the morbidity and mortality rates were much higher back then with the conventional scopes. Only over the recent decade that endoscopic third ventriculostomy has started to pick up. Mainly due to the advances in endoscopes and also extensive trials and studies have been carried out on the role of endoscopic third ventriculostomy in the management of obstructive hydrocephalus. However in developing countries endoscopic third ventriculostomy is very slowly picking up and way outnumbered in comparison to shunts. Majority of the data published so far are mainly from developed countries and very few from developing countries. No such data has been published from Malaysia so far.

Indications and role for endoscopic third ventriculostomy is fairly clear and is done in cases of obstructive hydrocephalus with imaging evidence of dilated ventricles[(3)]. Endoscopic third ventriculostomy has been attempted in cases of communicating hydrocephalus such as idiopathic normal pressure hydrocephalus[(4, 5)].

The procedure itself is fairly a straight forward procedure but requires a lot of care and caution. Burr hole is made over Kocher's point either on the right or left side, dura is then cut and cauterised. The endoscope is introduced into the anterior horn of the lateral ventricle. Endoscope is then gently navigated through the foramen of Monro to visualise the floor of the third ventricle. The floor of the third ventricle is then fenestrated using cautery (monopolar, bipolar or laser) and this fenestra is then enlarged using a Fogarty balloon catheter (3 or 4 Fr). In some cases there is the presence of an extra membrane known as the Liliequist membrane which has to fenestrated also. A good flapping floor of the third ventricle indicates a good fenestration. Care is to be taken not damage vital surrounding structures such as hypothalamus, mamillary body and vascular structures such as anterior septal vein, thalamostriate vein and basilar artery.

2 Materials and Methods

2.1 Patients

This was a cross-sectional study studying the shunt dependency outcome of endoscopic third ventriculostomy in the management of obstructive hydrocephalus. All patients presenting with obstructive hydrocephalus that underwent endoscopic third ventriculostomy was included in this study and patients who had previous cerebro-spinal fluid (CSF) diversions or prior endoscopic third ventriculostomies were excluded. All causes of obstructive hydrocephalus were taken into account. Diagnosis of obstructive hydrocephalus is confirmed with computed tomography and magnetic resonance imaging evidence of dilated ventricles. For purposes of this study the causes of obstructive hydrocephalus was broadly put into 4 different groups ie. congenital, tumoral, hemorrhage and post-infective causes. All patients were evaluated clinically and with imaging immediate post-operatively, at one month and six months post- endoscopic third ventriculostomy. Successful endoscopic third ventriculostomy is taken as clinically no symptoms of raised intracranial pressure and imaging evidence of resolution of dilated ventricles[1]. Data was collected from 3 major centres; Kuala Lumpur General Hospital, Hospital Universiti Sains Malaysia and Sarawak General Hospital.

2.2 Statistical methods

The data was analyzed using commercially available IBM Statistical Packages for Social Sciences (SPSS) statistics for windows version 20. All variables were expressed as mean ± standard deviation (X ± SD). Chi-square, logistic regression univariate and multivariate analysis and survival analysis using Cox regression to generate Hazard ratio; analysis was used to study correlations of the investigated parameters (significance was assumed at a level of p-value < 0.05). [National Medical Research Register (NMRR), www.nmrr.gov.my, Identifier: NMRR-15-1145-24949].

3 Results

Total 206 patients with obstructive hydrocephalus undergoing ETV only once were studied. Mean age of patients was 21.1 ± 22.6 years with 98 (47.6%) being paediatrics (<12 years) and 108 (52.4%) adults (≥12 years). 63 (30.6%) were of congenital causes, 90 (43.7%)

tumoral related, 40 (19.4%) due to hemorrhage and 13 (6.3%) post-infective. Shunt free outcome at one month was 179 (86.9%) and 177 (85.9%) at six months (Table 1).

Chi-square test showed no statistical significance in outcome with age groups (p value = 0.629) or outcome with diagnosis (p value = 0.057).

Univariate analysis via logistic regression showed significance of Liliequist membrane with odds ratio 4.375 ; 95% CI (1.188 - 16.115), p value 0.027 ; of which patients with Liliequist membrane present are 4-fold risk of failure and ending up with a shunt after 1month following endoscopic third ventriculostomy. Also noted the nature of fenestration with the outcome where at one month odds ratio 17.969 ; 95% CI (2.077 - 5.957), p value 0.009 and at six months odds ratio 19.154 ; 95% CI (2.11,173.868), p value 0.009 signifies a large fenestra with well flapping floor of the third ventricle has a 17-fold chance of being shunt free at one month and 19-fold chance at six months respectively. (Table 2).

Multivariate logistic regression analysis showed significance of nature of fenestration with the outcome where at one month adjusted ratio 0.231 ; 95% CI (0.091-0.518), p value 0.005 and at six months adjusted ratio 0.241 ; 95% CI (0.092 - 0.535), p value 0.006 signifies a large fenestra with well flapping floor of the third ventricle has a 0.2-fold chance of being shunt free at one month and six months respectively. Also noted was age at 6 months with adjusted ratio 0.202 ; 95% CI (0.109 - 0.206), p value 0.006 ; of which adults patients have 0.2-fold chance of being shunt free at six month following endoscopic third ventriculostomy. (Table 3).

Survival analysis using cox regression to generate Hazard ratio (Table 4) showed endoscopic third ventriculostomy failure at any point of time in this study for tumoral causes are 0.322 times less likely compared to congenital causes (HR 0.322 ; 95% CI 0.122 - 0.847 ; p value 0.022).

Table 1 Demographic variables with outcome at one and six month intervals

Variables	No of patients (%)	Success (%)		Failure (%)	
		1 month	6 months	1 month	6 months
Mean age in years	21.1 (Paediatric 2.4 years and Adults 37.1)				
Paediatric (< 12yrs)	98(47.6%)	83(84.7%)	83(84.7%)	15(15.3%)	15(15.3%)
Adults (≥12 yrs)	108(52.4%)	96(88.9%)	94(87.0%)	12(11.1%)	14(13.0%)
Sex					
Male	117(56.8%)	102(57.0%)	102(57.6%)	15(55.6%)	15(51.7%)
Female	89(43.2%)	77(43.0%)	75(42.4%)	12(44.4%)	14(48.3%)
Diagnosis					
Congenital	63(30.6%)	50(27.9%)	50(28.2%)	13(48.1%)	13(44.8%)
Tumoral	90(43.7%)	86(48.0%)	84(47.5%)	4(14.8%)	6(20.7%)
Hemorrhage	40(19.4%)	32(17.9%)	32(18.1%)	8(29.6%)	8(27.6%)
Infection	13(6.3%)	11(6.1%)	11(6.2%)	2(7.4%)	2(6.9%)
Operation done					
ETV	96(46.6%)	82(45.8%)	80(45.2%)	14(51.9%)	16(55.2%)
ETV & biopsy	61(29.6%)	57(31.8%)	57(32.2%)	4(14.8%)	4(13.8%)
ETV & washout	41(19.9%)	32(17.9%)	32(18.1%)	9(33.3%	9(31.0%)
ETV & fenestration	8(3.9%)	8(4.5%)	8(4.5%)	0	0
Scope degree					
Zero degree	169(82.0%)	147(82.1%)	145(81.9%)	22(81.5%)	24(82.8%)
Thirty degree	37(18.0%)	32(17.9%)	32(18.1%)	5(18.5%)	5(17.2%)
CSF nature					
Clear	158(76.7%)	143(79.9%)	141(79.7%)	15(55.6%)	17(58.6%)
Blood stained	38(18.4%)	30(16.8%)	30(16.9%)	8(29.6%)	8(27.6%)
Turbid	2(1.0%)	0	0	2(7.4%)	2(6.9%)
Xanthochromic	8(3.9%)	6(3.4%)	6(3.4%)	2(7.4%)	2(6.9%)

Table 1 continued

Variables	No of patients (%)	Success (%)		Failure (%)	
		1 month	6 months	1 month	6 months
Choroid plexus					
Normal	201(97.6%)	174(97.2%)	172(97.2%)	27(100%)	29(100%)
Abnormal	5(2.4%)	5(2.8%)	5(2.8%)	0	0
Anterior Septal Vein					
Normal	205(99.5%)	178(99.4%)	176(99.4%)	27(100%)	27(100%)
Abnormal	1(0.5%)	1(0.6%)	1(0.6%)	0	0
Thalamostriate Vein					
Normal	205(99.5%)	178(99.4%)	176(99.4%)	27(100%)	29(100%)
Abnormal	1(0.5%)	1(0.6%)	1(0.6%)	0	0
Third Ventricle Floor					
Thin & Bulging	140(68.0%)	122(68.2%)	120(67.8%)	18(66.7%)	20(69.0%)
Thick & Bulging	15(7.3%)	12(6.7%)	12(6.8%)	3(11.1%)	3(10.3%)
Thin & not bulging	47(22.8%)	41(22.9%)	41(23.2%)	6(22.2%)	6(20.7%)
Thick & not bulging	4(1.9%)	4(2.2%)	4(2.3%)	0	0
Infundibular recess					
Normal	200(97.1%)	173(96.6%)	171(96.6%)	27(100%)	29(100%)
Abnormal	6(2.9%)	6(3.4%)	6(3.4%)	0	0
Mamillary body					
Normal	202(98.1%)	175(97.8%)	173(97.7%)	27(100%)	29(100%)
Abnormal	4(1.9%)	4(2.2%)	4(2.3%)	0	0
Fogarty catheter size					
3 Fr	178(86.4%)	155(86.6%)	153(86.4%)	23(85.2%)	25(86.2%)
4 Fr	28(13.6%)	24(13.4%)	24(13.6%)	4(14.8%)	4(13.8%)

Table 1 continued

Variables	No of patients (%)	Success (%)		Failure (%)	
		1 month	6 months	1 month	6 months
Cauterization					
Monopolar	44(21.4%)	39(21.8%)	39(22.0%)	5 (18.5%)	5(17.2%)
Bipolar	161(78.2%)	139(77.7%)	137(77.4%)	22(81.5%)	24(82.8%)
Laser	1(0.5%)	1(0.6%)	1(0.6%)	0	0
Fenestration attempts					
Once	180(87.4%)	157(87.7%)	155(87.6%)	23(85.2%)	25(86.2%)
More than once	26(12.6%)	22(12.3%)	22(12.4%)	4(14.8%)	4(13.8%)
Liliequist membrane					
Absent	118(57.3%)	108(60.3%)	106(59.9%)	10(37.0%)	12(41.4%)
Present	88(42.7%)	71(39.7%)	71(40.1%)	17(63.0%)	17(58.6%)
Nature of fenestration					
Flapping well with large stoma	198(96.1%)	175(97.8%)	173(97.7%)	23(85.2%)	25(86.2%)
Flapping well with small stoma	6(2.9%)	4(2.2%)	4(2.3%)	2(7.4%)	2(6.9%)
Flapping poorly	2(1.0%)	0	0	2(7.4%)	2(6.9%)
Outcome	206(100%)	179(86.9%)	177(85.9%)	27(13.1%)	29(14.1%)

Table 2 Logistic regression (Odds ratio- OR) at one and six month intervals

	At One Month			At Six Months		
	ß(S.E.)	OR (95% CI)	P	ß(S.E.)	OR (95% CI)	P
Age	0.024(0.016)	1.025(0.994,1.057)	0.121	0.038(0.015)	1.039(1.008,1.07)	0.012
Sex	0.352(0.554)	1.422(0.48,4.212)	0.525	0.586(0.546)	1.796(0.615,5.242)	0.284
Diagnosis	-0.294(0.522)	0.745(0.268,2.072)	0.573	-0.296(0.524)	0.744(0.266,2.077)	0.572
Operation done	0.249(0.572)	1.283(0.418,3.935)	0.663	-0.058 (0.607)	0.944(0.287,3.104)	0.924
Scope Brand	2.114(1.734)	8.278(0.277,247.627)	0.223	2.231(1.697)	9.311(0.335,259.116)	0.189
Scope Degree	-0.627(1.125)	0.534(0.059,4.845)	0.577	-0.716(1.136)	0.489(0.053,4.527)	0.528
CSF nature	0.193(0.331)	1.212(0.633,2.321)	0.561	0.165(0.339)	1.179(0.606,2.294)	0.627
Choroid Plexus	-16.433(19995.745)	0	0.999	-16.291(19959.214)	0	0.999
Anterior Septal Vein	32.649(52052.415)	1.51×10^{14} (0)	0.999	32.877(52041.574)	1.90×10^{14} (0)	0.999
3rd Ventricular Floor	-0.339(0.312)	0.713(0.386,1.314)	0.278	-0.339(0.307)	0.712(0.391,1.299)	0.269
Infundibular Recess	-17.611(16717.365)	0	0.999	-17.869(16652.35)	0	0.999
Mamillary Body	-17.991(20363.8)	0	0.999	-18.461(20424.957)	0	0.999
Fogarty catheter size	-0.912(1.159)	0.402(0.041,3.898)	0.432	-1.17(1.207)	0.31(0.029,3.303)	0.332
Cauterization	1.715(1.466)	5.558(0.314,98.287)	0.242	1.895(1.443)	6.651(0.393,112.614)	0.189
Fenestration Attempts	0.608(1.059)	1.837(0.231,14.644)	0.566	0.519(1.061)	1.68(0.21,13.428)	0.625
Liliequist Membrane	1.476(0.665)	4.375(1.188,16.115)	0.027	1.174(0.63)	3.234(0.941,11.12)	0.063
Nature Of Fenestration	2.889(1.101)	17.969(2.077,5.957)	0.009	2.952(1.125)	19.154(2.11,173.868)	0.009

Table 3 Multivariate Logistic regression (Adjusted ratio- AR) at one and six month intervals

	At One Month			At Six Months		
	ß(S.E.)	AR (95% CI)	P	ß(S.E.)	AR (95% CI)	P
Age	0.002(0.001)	0.114(-0.001-0.116)	0.211	0.03(0.001)	0.202(0.109-0.206)	0.006
Cauterization	0.171(0.389)	0.035(-0.595-0.937)	0.708	0.160(0.403)	0.032(-0.635-0.954)	0.692
Liliequist Membrane	0.094(0.048)	0.138(0.000-0.188)	0.050	0.073(0.050)	0.104(-0.024-0.171)	0.141
Nature Of Fenestration	0.304(0.108)	0.231(0.091-0.518)	0.005	0.327(0.113)	0.241(0.092-0.535)	0.006

Table 4 Survival analysis using Cox regression to generate hazard ratio (HR)

	ß(S.E.)	HR (95% CI)	P
Congenital	0	1	0.114
Tumor	-1.134 (0.494)	0.322 (0.122 , 0.847)	0.022
Hemorrhage	-0.011 (0.449)	0.989 (0.410 , 2.387)	0.981
Infection	-0.232 (0.760)	0.793 (0.179 , 3.514)	0.760