Is dural hitching necessary to prevent post-operative extradural haemorrhage in craniotomies and craniectomies

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Key words: Dural tenting sutures; post-op surgically significant extra-dural haemorrhage (EDH); craniotomy, craniectomy; Asian hospital environment

Abstract

Object

The goal of this study was to determine the necessity of dural tenting sutures in preventing post-op extra-dural haematomas (EDH) in craniotomies and craniectomies at a premier Neurosurgical unit in Sri Lanka.

Methods

Data was collected prospectively from 785 cranial operations of patients between the ages of 12 to 75 years. Dural hitching was considered as the control according to current Sri Lankan practices and not performing the dural hitch was considered the intervention. Sample allocation into each group was done alternatively with dura hitching being carried out on the first patient. Data was collected from 403 patients in the control group and 382 patients from the intervention group. The main outcome measure was the indication of significant post-operative EDH with evidence of neurological deficit or a post-operative CT scan with evidence of >30ml collection or midline shift >5mm.

Results

Dural hitching as a prophylactic technique proved no benefit in decreasing the occurrence of post-operative surgically significant extradural collections even in the context of an Asian hospital environment. It however remains as an important neurosurgical technique invaluable in other circumstances.

Introduction

The National Hospital of Sri Lanka (NHSL), Colombo, the premier hospital in Sri Lanka, houses 3300 beds and consists of a specialized Neurotrauma Centre (NTC) functioning 24 hours a day and 365 days a year. There are seven well trained middle grade medical officers supervised by a Consultant Neurosurgeon around the clock. More than 1500 major neurosurgical procedures are carried out yearly, of which 90% compose of trauma related procedures. Of these major surgeries, about 800 craniotomies and craniectomies are performed. This unprecedented neurosurgical exposure brings forth the ideal environment for research into innovation techniques, and allows for the re-evaluation of neurosurgical procedures.

A craniotomy is a surgical operation in which a bone flap is temporarily removed from the skull to access the brain and subsequently it is replaced to heal and mend like any broken bone, sometimes with the aid of metal plates when available. A craniectomy is a procedure which is similar to the former, but avoids bone flap replacement. Reasons include trauma to the bone, excessive cerebral swelling, or the surgeon's decision in the patient's best interest. A major complication of the above is post-operative extra-dural haemorrhages. This secondary EDH may be the result of damaged vessels of the dura, venous sinuses and bones associated with inadequate haemostasis. Traditionally to prevent this, a procedure called “dural hitching” or “tenting”, was adopted.

Achieving haemostasis was one of the major challenges encountered across the early years of neurosurgical development. Cushing's silver clips, and electro-cauterization and Horsley's wax were significant contributions to prevent haemorrhage [1]. However, the former had limited value against postoperative EDH which, according to Dandy, complicated almost 25% of all intracranial operations. Death or major neurological impairment was a common sequel. The main reason being attributed to low blood pressure caused by hypovolemia from intra-operative loss of blood, an extremely common phenomenon which then rendered the apparent haemostasis at the time of closure predictably unreliable [1].

Walter Edward Dandy, M.D. (April 6, 1886 – April 19, 1946) reported in 1932 that a number of permanent silk sutures tightly drawn between the Dura and the Galea or subaponeurotic tissue will hold the Dura firmly against the bone and make postoperative EDH from this source impossible [1]. Although often not cited among Dandy's great achievements, this technical innovation may be regarded as his greatest contribution, and compares favourably to

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Horsley's wax and Cushing's use of electrocautery.

Since its' introduction the incidence of postoperative EDH almost completely disappeared from neurosurgical literature. Various names have been assigned to this technique including Dural hitching, tenting sutures, Dural periosteal sutures, tacking sutures, tack-up sutures, stay sutures, suspension sutures, and sleeper sutures. The last term being derived from the neurosurgical mantra, "sleeper sutures help the neurosurgeon sleep at night". However, the prophylactic use of multiple Dural hitching sutures today, is a perpetuation of a tradition introduced 67 years ago.

In the early days of the 20th century due to severe hypotension at the time of closure owing to lack of blood transfusions, poor anaesthesia, cardiovascular and haemodynamic status monitoring, dural hitching greatly minimized, but did not completely stop, as Dandy hoped, the risk of delayed EDH.

Delayed EDH occurred due to open or poorly secured dural blood vessels not identified at the time of closure as bleeding only starts several hours after surgery once perfusion is restored as the normal systemic blood pressure is re-established. Some surgeons prefer to completely excise the exposed dura and either leave it out or suture it back in place. The circumferential incision ensured that all dural vessels in the line of incision were dealt with at the time of opening. Other methods include leaving the dependent portion of the scalp wound open (Horsley) or place horse hair within the scalp wounds (Keen), to facilitate drainage of accumulated blood. Often wounds were routinely re-explored after a time lapse to remove the predictable extra-dural haematoma.

At the NTC, traditionally for all the craniotomies and craniectomies, dural hitching/tenting is performed.

This procedure is time consuming, owing to about 30 to 40 minutes depending on the size of the craniotomy and craniectomy. Expensive suture material including 4/0 Vicryl or proline (5-6 stitches depending on the size of the opening) is utilized. There is a possible complication of damaging cortical veins adherent to the inner surface of the Dura causing acute subdural haemorrhage if the procedure is performed without direct visualization. Additionally, prior to closure a suction drain is inserted into the subgaleal space and the wound is closed once the patient's baseline blood pressure is restored. Dura hitching is at present readily performed across most of the neurosurgical centres in Sri Lanka. Research into this area must be carried out in Sri Lanka to reconsider its' efficacy. Knowledge of this will greatly reduce the resources spent unnecessarily and spare the time of the surgeons and staff.

Literature for this topic dates back over a decade and is mainly case control studies without randomisation reaching only level 4 in the hierarchy of evidence for interventional research. In 1998, Ken and Winston in his prospective analysis of craniotomies concluded that dural hitch sutures on a selection basis, 8.9% of the study population vs. no dural hitch sutures in the remaining 90.1%, resulted in no significant extradural collections and thus no reopenings were required. This showed that there was no necessity for prophylactic dural hitch sutures, however the selection criteria was based on the surgeon's experience and required standardization [2]. On repeating the study in a paediatric population, the same conclusion was drawn [3].

A case control study conducted at the Royal Free Hospital in London comparing craniotomies between two surgeons, one that routinely used dural hitch sutures and the other that did not, concluded that there was no significant difference between the outcome measures of median EDH volume or midline shift. This reiterated that this was an obsolete technique that was not prophylactically required [4]. However, it must be mentioned that use of this technique in other areas of neurosurgery like in the prevention of subgaleal collections is gaining prominence [5].

Prior to disregarding this once highly reputed neurosurgical technique in the neurosurgical forums of Sri Lanka, it was deemed necessary to perform a case control study in our home environment.

Clinical methods and techniques

Study population

This report is based on data inclusive of all patients over 12 years of age that underwent a craniotomy or craniectomy during the study period at Operating Theatre T, at National Hospital of Sri Lanka, Neurotrauma Unit. Patients undergoing surgeries for EDH, burr hole surgeries, surgeries for ventricular peritoneal shunts and patients with an abnormal INR (>1.3) or platelet counts (less than 100,000/mm3) were excluded.

Study design

An interventional study was designed with the patients allocated into two groups. The current standard practice involved prophylactic dural hitching and was considered the control, whilst the intervention group had no dural hitching performed. The intervention group and control group was calculated using statistical method for quantitative outcome [6]. Since we could not find research where a proper randomization was carried out, to calculate sample size, we assumed that bleeding occurred in 50% of the surgeries where tenting was not performed.

The sample size calculation was done using the following formula:

$$n = \frac{2p \times (100 - p) \times f(\alpha,\beta)}{d^2}$$

n = Required number of patients on each treatment

p = Dura not hitching produces bleeding in 50% of patients

d = 10%

$\alpha = 0.05$

$\beta = 0.2$

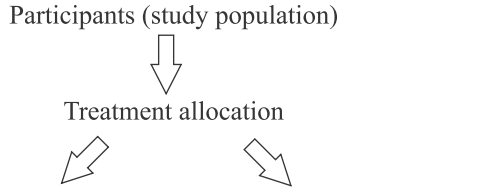
$f(\alpha,\beta) = 7.9$

$n = \frac{2 \times 50 \times 50 \times 7.9}{10^2} = 395.0$

5% will be added for surgeries wasted (due to death or transfer).

395.0 + 5% = 414.75 ~ **415**

Dura hitching was carried out on the first patient that came at the beginning of the study. From then onwards every other patient was selected for Dura hitching and Dura not hitching if within the selection criteria.



Data collection

Data collection was carried out by the principal investigators, the Consultant Neurosurgeon and three other Grade II medical officers, who worked as neurosurgical registrars at the study setting between the period of January 2012 to June 2014, using the two instruments listed below.

Instrument I - An interviewer administered questionnaire was used to collect data on socio-demographic factors and the signs, symptoms and the cause of the injury, which was collected from a guardian of the patient pre-operatively.

Instrument II - Record sheet information on diagnosis and investigations relevant to the surgery in pre- and post-operative stages. Clinical and radiological assessment of the patient before surgery and 48 hours after surgery was carried out.

Clinical assessment: Glasgow coma scale was used

Radiological: Thickness of the haematoma if present was assessed by post-operative CT scan which is routinely performed in our unit in all patients following a craniotomy or craniectomy (measurement scale in CT allows to measure the volume of haematoma; more than 5mm thickness considered as significant here).

Ethical and administrative considerations

Informed verbal consent was obtained from the guardian of the patient. Ethical clearance was obtained from the ethical review committee at the National Hospital of Sri Lanka. Permission to carry out the study was also obtained from the Director, National Hospital of Sri Lanka. The principal investigators handled the data and they were not divulged to any other person.

Data analysis

The principal investigators coded the data manually and analysis was done using personnel computers. SPSS 13.0 statistical package was used for this purpose. Chi squared test was used with the level of significance at 0.05. Two sample t-test were carried out where appropriate.

Data was completed collected from 785 patients, 403 from the control group where dural hitch technique was performed and 382 from the intervention group where it was avoided which was 97.1% and 92.0% of the required sample size of 415. Inability to reach the required target to complete data collection was due to transfer or death of a patient before the end of the 48 hour post-operative period. However, as the rate of participation was more than 95% for the control group and nearly 95% for the intervention group it was deemed sufficient for valid analysis of data. Listed below are the results of the analysis of the data fields mentioned earlier.

(Study participants were usually unconscious and without a bystander at the time of admission. During such time our main concern was how to revive these patients and therefore, the ethnicity, religion and occupation were not enquired and age was also sometimes assumed. Therefore, although recruited to the study, ethical issues prevented us from resorting only to post-operative demographic characteristics of the patients. Missing data analysis was done separately.)

	CG		IG		Significance
Sex composition	N=415	%	N-415	%	
Male	345	83.1	349	84.1	$\chi^2 = 0.14$
					df = 1
					p = 0.71
Female	70	16.9	66	15.9	

Table 1. Sex composition of patients in the study population in the control group (CG) and intervention group (IG). The sex compositions in the CG and IG have no statistically significant difference ($p > 0.05$).

More than 25% of patients in the control group (CG) were in the age group 45 to 54 years, whereas in the intervention group (IG) it was the 35 – 44 years. About 47% of patients were in the combined age group of 35-54 years in both the CG and IG. Mean age of patients was 48 years in the CG and 42 years in the IG.

Nearly 80% of patients were in the ethnic group Sinhala in the CG and greater than 80% in the IG. When occupation is considered (assessed according to ISCO-08 structure; see annexure 1), about 40% in the CG and 30% in the IG were either unemployed or housewives, and about 25% were in an elementary occupation (labourer) in both CG and IG.

Variable	CG		IG		Significance
	N=403	%	N-382	%	
Age of patients (in years)					
					$\chi^2 = 42.6$
					df = 5
					p < 0.05
					t=5.69; df=783
					p<0.0001
=12 – 24	33	8.2	68	17.8	
25 – 34	88	21.8	48	12.6	
35 – 44	88	21.8	102	26.7	
45 – 54	102	25.3	80	20.9	
55 – 64	46	11.4	47	12.3	
=65	46	11.4	37	9.7	
Mean (SD) Range	**48.4 (15.8) 12 - 75**		**41.7 (17.2)12 - 78**		
Ethnicity					
Sinhala	315	78.2	316	82.7	$\chi^2 = 14.23$
					df = 4
					p = 0.007
Tamil	21	5.2	33	8.6	
Muslim	47	11.7	23	6.0	
Bhurger	07	1.7	05	1.3	
Malay	13	3.2	05	1.3	
Religion					
Buddhist	312	77.4	310	81.2	$\chi^2 = 13.36$
					df = 3
					p = 0.004
Christian	13	3.2	19	5.0	
Hindu	18	4.5	25	6.5	
Islam	60	14.9	28	7.3	
Occupation					
Managers	10	2.5	10	2.6	$\chi^2 = 24.9$
					df = 10
					p = 0.005
Professionals	8	2.0	11	2.9	
Technicians	20	5.0	15	3.9	
Clerical	15	3.7	17	4.5	
Service & sales workers	18	4.5	9	2.4	
Agricultural/ Fisheries	13	3.2	7	1.8	
Crafts & related trade	26	6.5	7	1.8	
Plant & machine operators	40	9.9	29	7.6	
Elementary occupation (labourer)	105	26.1	92	24.1	
Armed forces	65	16.1	68	17.8	
Unemployed/Housewives	83	41.5	117	30.6	

Table 2. Socio-demographic and socioeconomic distribution of the study participants in CG and IG.

Although there doesn't seem to be a difference between CG and IG patients there is a statistically significant difference between CG and IG in age, ethnicity, religion and occupation ($p < 0.05$) in the two groups. Since there are more than two components in comparison the direction of significance cannot be stated using chi squared statistics [7].

Cause of injury	CG N=403	%	IG N=382	%	Significance
Road traffic accident	223	55.3	191	50.0	$\chi^2 = 8.524$
					df = 4
					p = 0.074
Home accident	31	7.7	38	9.9	
Assault/ fight	33	8.2	53	13.9	
Fall from height	102	25.3	89	23.3	
Other	14	3.5	11	2.9	

Table 3. Cause of injury distribution amongst patients in the CG and IG in the study.

Surgery indication	CG N=403	%	IG N=382	%	Significance
ASDH	115	28.5	108	28.3	$\chi^2 = 10.422$
					df = 13
					p = 0.659
CSDH	9	2.2	8	2.1	
ASDH & CSDH	11	2.7	13	3.4	
Cerebral oedema	40	9.9	43	11.3	
Compound fracture	26	6.5	33	8.6	
Depressed fracture	56	13.9	35	9.2	
Depressed fracture & ICH	18	4.5	14	3.7	
Depressed fracture & SAH	19	4.7	22	5.8	
ICH	25	6.2	26	6.8	
ICH & IVH	14	3.5	11	2.9	
Increased ICP	19	4.7	22	5.8	
SAH	16	4.0	10	2.6	
Haemorrhagic contusion	20	5.0	27	7.1	
Tumour, osteomyelitis & others	15	3.7	10	2.6	

Table 4. Distribution of the indication for surgery amongst patients in the CG and IG of the study.

The highest indication for surgery was for Acute SDH (nearly 30%) in both the CG and IG .The second highest in the CG was for depressed skull fractures (>10%), whilst it was cerebral oedema (>10%) in the IG. Other indications for surgery included tumours, osteomyelitis, aneurysms and abscesses, and was collectively regarded as 'others' as each contained less than five cases. There is no statistically significant difference in the indication for surgery in the CG and the IG ($p > 0.05$).

Type of Surgery	CG N=403	%	IG N=382	%	Significance
Craniotomy	78	19.4	70	18.3	$\chi^2 = 0.136$
					df = 1
					p = 0.712
Craniectomy	325	80.6	312	81.7	

Table 5. Distribution of the type of surgery carried out for the CG and IG patients.

Nearly 20% and 80% of the operations were craniotomies and craniectomies respectively, which were carried out in the CG and IG with no statistically significant difference ($p > 0.05$) between the two groups.

Outcome measures

The outcome of the intervention was measured in terms of post-operative bleeding at 48 hours after surgery.

	CG		IG		Significance
Post – op view of CT scan	**N=403**	**%**	**N=382**	**%**	
No surgically sig. Haemorrhage	392	97.3	375	98.2	$\chi^2 = 0.704$ df = 1 p = 0.401
Surgically sig. Haemorrhage	11	2.7	07	1.8	

Table 6. Post-operative CT scan indication of surgically significant haemorrhage after 48 hours in the study population.

There was no post-op surgically significant haemorrhage (more than 5mm) in more than 95% of the patients in both the CG and IG. There was also no statistically significant difference in CG and IG ($p > 0.05$) post-operatively at 48 hours.

Losses to follow up data analysis

There were 45 patients (CG-12 and IG-33) that were lost to follow up due to either death or being transferred to the hospital they were sent prior to within 48 hours of surgery. Cause of injury, indication for surgery and type of surgery carried out was analysed to find out whether there was a difference between the missing and the completed data.

	CG		IG		Significance
Cause of injury	**N=12**	**%**	**N=33**	**%**	
Road traffic accident	4	33.3	18	54.5	$\chi^2 = 1.19^*$ df = 4 p = 0.88
Home accident	2	16.7	5	15.2	
Assault/ fight	3	25.0	5	15.2	
Fall from height	3	25.0	4	12.1	
Other	0	0.0	1	3.0	

*Yates continuity correction done

Table 7. Cause of injury distribution among lost to follow up patients in the CG and IG.

Similar to completed data, there was no statistically significant difference ($p > 0.05$) amongst the two groups which were lost to follow up, with regard to cause of injury.

Similar to completed data, there was no statistically significant difference in the indication for surgery in the CG and the IG ($p > 0.05$). Similar to completed data, there was no statistically significant difference in the type of surgery carried out in the CG and the IG ($p > 0.05$).

	CG		IG		Significance
Surgery indication	**N=12**	**%**	**N=33**	**%**	
ASDH	7	58.3	23	69.7	$\chi^2 = 0.51^*$ df = 4 p = 0.972
Cerebral oedema	2	16.7	4	12.1	
ICH	0	0.0	1	3.0	
Increased ICP	2	16.7	3	9.1	
Tumour, osteomyelitis & others	1	8.3	2	6.1	

*Yates continuity correction done

Table 8. Distribution of the indication for surgery among lost to follow up patients in the CG and IG of the study.

	CG		IG		Significance
Type of Surgery	**N=12**	**%**	**N=33**	**%**	
Craniotomy	1	8.3	8	24.2	$\chi^2 = 0.57^*$ df = 1 p = 0.448
Craniectomy	11	91.7	25	75.8	

*Yates continuity correction done

Table 9. Distribution of the type of surgery carried out among lost to follow up patients in the CG and IG patients.

Discussion

There was no benefit in prophylactic dural tenting compared to omission of this technique. 2.7% of patients in CG and 1.8% of patients in the IG presented with surgically significant EDH, however a statistically relevant difference was not observed between the two groups. Comparing the sample selection there was no statistical difference between the gender distribution, cause of injury, indication for surgery or the type of operation between the two groups. However, there was a stastically significant difference in the distribution of age, ethnicity, religion and occupation ($p < 0.05$). This was not considered as an issue since the objective of this study was based on the outcome measure of a physiological factor for which ethnicity, religion and occupation proved immaterial. Additionally, 55% of patients in both the CG and IG were below 44 years of age and thus the statistically different mean ages did not influence the comparisons.

Previous case control studies like that of Swayne and others [4] also revealed non-significant associations ($P = 0.74$ and 0.84) between Dural tenting and omission, consistent with our findings. It was also pointed out that the group using tenting sutures had larger median extradural haematoma volumes (2.5 vs. 2.0 ml) and midline shifts (3 vs. 0 mm) compared to the group omitting them. This study involved a different surgeon for each group and surgeon bias needs to be considered.

Other papers showed that selective Dural hitching demonstrated negligible haemorrhagic collections, denying the need for prophylactic use in both adults [2] and children [3]. However, the percentage of surgically significant

extradural haematomas in both above studies was 0% whilst this study concluded a percentage of 2.7% and 1.8% for the CG and IG respectively. Further looking into the series of operations published by Fukomashi, if under our selection criteria with all patients undergoing a Dural hitch the surgically significant number of collections accounted to 2.3% [5]. All studies in the literature were based in western countries and displayed fundamental differences in sample selection. In both our groups there was a greater percentage of males (83% in CG and 84% in IG), a much higher value than what was quoted in previous literature. This can be explained by the higher incidence of RTAs at this Level 1 trauma unit and as stated in previous literature (GBD-2005), males display an almost four times higher rate of non-fatal road injury incidence compared to women in Sri Lanka.

Majority of the injuries in this study were due to road traffic accidents (>50%) in tally with Sri Lanka's Annual Health Bulletin (2012) statistics [7], which claimed traumatic injuries as the leading cause of hospital admission with a proportionate morbidity of 17.0, whilst literature implicates elective surgeries e.g. neoplasia. This was an important contributing factor to the risk of extradural collections. Most operations were indicated for the evacuation of ASDH accounting for more than 25% in both CG and IG, followed by 10% for depressed fracture in the CG and more than 10% for cerebral oedema in the IG. There was no statistical difference in the percentage of craniotomies and craniectomies between the groups, but over four times more craniectomies were performed than craniotomies within each group. Owing to the differences highlighted above, it proved useful to conduct a similar study to fit the context of a Sri Lankan hospital environment before altering practice purely based on literature.

Despite the performance of about 1300 craniotomies and craniectomies during this study period (according to NHSL statistics), we recruited only 830 patients that suited the study inclusion criteria. According to previous research in Sri Lanka [8], the average number of major and minor neurosurgical procedures carried out at the NHSL per year is 2500 and 3000 respectively. Data collection was completed only in 403 patients (97.1) in the control group and 382 (92.0) in the intervention group. This was due to post-operative coagulation disorders resulting in death and also due to back-transfer after performing the surgery. The required sample size was calculated based on an assumption that bleeding occurred in 50% of the patients where tenting was not performed. The actual figure however was not found as the appropriate literature could not be retrieved.

There was also no data collection or analysis of the average platelet count and pre- and peri-operative blood pressure, but all the patients had a stable cardiovascular system and matched the inclusion criteria.

It can be confidently said that with the current advances in anaesthesiology and surgeon expertise, EDH have a far smaller occurrence than when Dandy first brought forth the dural tenting technique [1]. Four different surgeons and different anaesthetists were involved in this study, but this did not affect the technique as all surgeons were technically sound and competent. Analysis into the distribution of the surgeons in each group may be done in the future.

Even though no complications of dural hitching were recorded in this series it must be noted that it is not a risk free procedure and involves possible damage to the cortical matter or blood vessels, resulting in complications like AV fistulas and post-operative ischaemic regions in the brain. Additionally, it adds about 20 - 30 minutes to the operating time and incurs an additional cost.

Conclusions

The above results conclude that dural hitching as a prophylactic technique proved no benefit in decreasing the occurrence of post-operative surgically significant extradural collections even in the context of an Asian hospital environment where there is specifically an increase in the burden of traumatic injuries.

Recommendations

A randomized controlled trial with no surgeon bias is recommended to provide a higher level of evidence. It is also recommended to collect and analyze other outcome measures such as the post-operative GCS, volume of EDH and midline shift for better understanding of clinical parameters.

Limitations

As this was a hospital based study, surgeries could not be categorized according to age since every other eligible patient was taken for Dura hitching.

All authors disclose no conflict of interest. The study was conducted in accordance with the ethical standards of the relevant institutional or national ethics committee and the Helsinki Declaration of 1975, as revised in 2000.

Informed consent to be included in the study was obtained from all involved patients or their next of kin where applicable. No specific patient identifying details of any patient in particular were published within the course of this article.

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