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The usefulness of surgical drains on short term outcomes among patients undergoing craniotomy at the Bugando Medical Centre, Mwanza Tanzania

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1. Background

Craniotomy is basically a neurosurgical procedure in which a part of the skull is temporarily removed to access the intracranial space with the purpose of treatment of underlying pathologies such as traumatic hematomas, brain tumors, aneurysms, arterio-venous malformations, skull fractures.[1] Historically, since Hippocrates times, the use of surgical drains have been reported in a wide variety of surgical procedures throughout the body although their efficacy and safety has been a question of debate in different disciplines[2–6] Similarly, regarding post craniotomy drains, some neurosurgeons use them post craniotomy, others do not and there exists no concensus on the use of the drains.[7,8] The necessity of post craniotomy drains on post-operative outcomes such as surgical site infection, prolonged hospital stay and subgaleal fluid collection has been studied by several groups with inconsistent results with some reporting advantages,[9–12] other groups paradoxically reported surgical complications[13–16] and the neutral arm which found no difference with the use of drains[17–19]

However, despite the contribution offered by these studies to understanding the efficacy and safety of post craniotomy drainages, there are still some gaps, hence more evidence is still needed to define more precisely the pros and cons. Therefore, it is the purpose of this single-center observational study to report our experiences of post craniotomy drains, utilized upon discretion of the individual treating surgeon, where we hypothesized that patients in the drainage group had a lesser risk of surgical site infection (SSI), shorter hospital stay and lesser occurrence of subgaleal fluid collection (SFC) compared to the non-drainage group.

2. Methodology

2.1. Study design, setting and objectives

A prospective observational study was carried out in a 1000-bed university hospital in Mwanza, Tanzania, which admits average of 1200 patients to the neurosurgery ward annually. Between 1st January 2022 to June 2022, patients who underwent a craniotomy for various conditions including trauma, tumour resection among others were enrolled consecutively in the study using non-probability purposive sampling method to obtain sufficient number of surgical procedures. Referred patients who had already undergone craniotomy before arriving to our institution and those with underlying SSI before the craniotomy were excluded.

Patients were divided into a drainage group (DG) and a non-drainage group (NDG) according to surgeons's preference with intention to treat and were followed up prospectively up to one-month post operatively. and data regarding the following items was collected in an Excel database This study's objectives included; a) determine the occurrence of subgaleal fluid collection among patients undergoing craniotomy. b) To determine the incidence of surgical site infection. c). To determine the

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duration of hospital stay.

All patients underwent the same protocol regarding preparation for surgery, Pre-operative skin preparation involved standardized application of at least three swabs, soaked with povidone-iodine solution. Antibiotic prophylaxis involved pre-operative intravenous ceftriaxone 1 g 30–60 min prior to incision and re-administration every 3 h during the operation and during the closure, the surgeon decided whether or not insert the drainage. The drain technique utilised in this study, once described by Bonfield et al[20] included a sterile IV-tubing which was shortened, tunneled through the skin and was inserted either in the subdural or subperiosteal space based on the individual surgeon's preference, and the other end of the intravenous fluid tubing was attached to the emptied transparent intravenous fluid bottle to achieve a modified closed drain system as illustrated Fig. 1 below (Consent for this image was acquired from the patient).

The skin was closed using nylon sutures and the head was washed with povidone-iodine solution. Post-operatively, the surgical wound was draped with a sterile impermeable towel for the first 24 h post-surgery. Afterwards, a head wash was performed every 12 h with povidone-iodine soaked gauze the first 72 h and surgical wound-care was carried out every 24 h under strict aseptic conditions.

2.1.1. Main outcome, variables, and data analysis

Basic demographic data were recorded, along with the following information on patient comorbidities and surgical procedure: Socio-demographic data (age, sex, education and occupation), alcohol intake, smoking cormorbidity: Diabetes mellitus, anemia; serology-status, Chronic kidney disease; Mechanism of injury; indication for surgery, radiologyfindings; Preoperative length of stay; ASA score Surgical characteristics: Level of the surgeon, Skin preparation:Hair removal or shaving; Iodine/chlorhexidine/alcohol/spirit; Location;, length of scalp incision and shape; Duration of the surgery; Ventricle opening; Dural closure technique. Other parameters included Drain insertion:Type of drain, Placement technique:stab/straight tract or subperiosteal tunneling, drain location Drain location, number and duration in place. SSI classification was in accordance to Centers for Disease Control and Prevention (CDC) criteria[21]

Follow up was conducted daily by monitoring general patient condition, temperature chart, pulse rate, conjunctival and palmar pallour, any surgical site discharge, state of the wound, dressing material on the wound for SSI, examination for scalp fluctuancy, approximation of SFC by subjective quantification by the trained clinician, monitoring the drain output, duration of compressive bandage application until patient is discharged home. Further follow up within 30days was done at the outpatient clinic which was scheduled on the day of discharge. For the SFC, detection was based on clinical examination while the SSI was superficial and presented with wound dehiscence and pus discharge.

Fig. 1.

2.1.2. Data analysis

Data were collected using a standardized, pre-tested and coded questionnaire. Data collected were entered into a computer using Epidata version 3.1 (CDC, Atlanta, USA) and analyzed using STATA version 15 (College Station, Texas, USA). Demographic characteristics were analysed using descriptive approach. The quantitative variable were summarized appropriately using mean and standard deviation (SD) or median with the interquartile range depending on the distribution. Categorical variables were summarized using absolute frequency and proportions (percent). The Chi-square test was used to measure the associations between variables. The level of significance to be considered was *p*-value <0.05.

2.1.3. Ethical consideration

Permission to conduct the study was obtained from the institutional ethical review board with approval number CREC/538/2022. This paper was written in accordance with the STROBE statement[22]

3. Results

3.1. Enrollment procedure

Between January 2022 to June 2022, a total of 82 patients who underwent craniotomy were evaluated for eligibility criteria, 5 refused to consent, therefore a total of 77 patients were enrolled in the study.

3.2. Patient characteristics

Among 77 enrolled patients, the median patient age (IOR) was 33 (18–55) years, and 55% of patients were males, giving male to female ratio of 2:1. Majority were from the rural area (74%)0.43% of the patients attained primary education.52% were self employed. Majority had no comorbidity, and 91% respectively.

3.3. Clinical characteristics

3.3.1. Preoperative characteristics

The majority of patients had trauma as a aetilogy for surgery 68% n = 52, had mild admission GCS at 77% n = 59.The most common clinical presentation was headache 70% n = 54.51% of the patients had a ASA score of 2 n = 39 The most common diagnosis was Subdural hematoma 35% n = 27.All the surgeries were done under general anesthesia and most patients scored ASA II/III (50.65%/42.86) The preop LOS <24hrs 57.14% n = 44.

3.3.2. Patients surgical variables

The surgical variables are summarized in Table 1 below.

3.4. Short term outcomes

In this study, 36.4% n = 28 had a drain inserted. The most common drain utilised was SPD 68.29% n = 18 as compared to SDD 35.7% n = 10. SSI 4 (5.19%) p = 0.538, SFC 11 (14.28%) p = 0.624 and LOS 11 (14.28%) p = 0.486 for those above 7 days as summarized in Table 2.

In the event that there was no significance in the short term outcomes following univariate analysis, we further performed a bivariate analysis to seek for any association of drainage use and other patient factors. Of the patient's factors that were analyzed we found that dural closure **(P value = <0.001)**, skin closure **(P value = <0.001)** and Comorbidities **(P value = 0.013)** to be associated with Length of Drain usage as shown in Table 3 below.

Table 1
Summary of patients surgical variables.

Variables	No.	%
Surgical Procedure		
Craniotomy + evacuation	22	28.57
Craniectomy + evacuation	10	12.99
Craniotomy + skull elevation	19	24.68
Craniotomy + tumor excision	4	3.90
Burr hole Craniotomy	23	29.87
Craniotomy + Biopsy	6	7.79
Decompressive Craniectomy	1	1.30
Type of incision		
Linear	12	15.58
Curved	17	22.08
Curvilinear	34	44.16
Vertical	10	12.99
Traumatic flap	4	5.19
Location		
Frontal	8	10.39
Frontalparietal	6	7.79
Frontalparietaltemporal	1	1.30
Parietal	34	44.16
Parietaltemporal	10	12.99
Parietaloccipital	1	1.30
Temporal	13	16.88
Occipital	4	5.19
Length		
<5 cm	4	5.19
5–10 cm	63	81.82
>10 cm	10	12.99
Technique of dural closure		
No closure	26	33.77
Water tight	37	48.05
Incomplete	14	18.18
Skin closure		
Continuous	33	42.86
Interrupted	44	57.14
Duration of surgery (hrs)		
< 1	22	28.57
1- 3	53	68.83
> 3	2	2.60
Drain use		
Yes	28	36.36
No	59	63.64
Type		
SDD	10	35.71
SPD	18	68.29
Location		
Frontal	3	10.71
Parietal	16	57.14
Temporal	9	32.14
Duration drain (days)		
≤ 2	5	17.86
3 -5	19	67.86
> 5	4	14.28
Amount (mls)		
< 10	3	10.71
10 20	14	50.00
> 20	11	39.29

Table 2
Showing Univariate analysis of Drainage use vs Short Term Outcomes.

Variable	DG n (%)	NDG n (%)	P value
SSI			
Yes	1 (3.57)	3 (6.12)	
No	27 (96.43)	46 (93.88)	0.538
SFC			
Yes	4 (14.29)	7 (14.29)	
No	24 (85.71)	42 (85.71)	0.624
LOS (days)			
≤ 7	23 (82.14)	43 (87.76)	
> 7	5 (17.86)	6 (12.24)	0.498

Table 3
Association of Patients factors and Drain usage.

Factors	DG n (%)	NDG n (%)	P value
Comorbidities			
Yes	17 (60.71)	42 (85.71)	
No	11 (39.29)	14 (14.29)	**0.013**
Mechanism of injury			
Trauma	17 (60.71)	35 (71.43)	
Non trauma	11 (39.29)	14 (28.57)	0.334
ASA Score			
II	14 (50.00)	25 (51.02)	
III	14 (50.00)	19 (38.78)	
IV	0 (0.00)	5 (10.20)	0.216
Length			
< 5 cm	2 (7.14)	2 (4.08)	
5 – 10 cm	23 (82.14)	40 (81.63)	
> 10 cm	3 (10.71)	7 (14.29)	0.803
Location			
Frontal	2 (7.14)	6 (12.77)	
Frontalparietal	3 (10.71)	3 (6.38)	
Frontalparietaltemporal	0 (0.00)	1 (2.13)	
Parietal	14 (50.00)	20 (42.55)	
Parietaltemporal	2 (7.14)	8 (17.02	
Parietaloccipital	0 (0.00)	1 (2.13)	
Temporal	6 (21.43)	5 (10.64	
Occipital	1 (3.57)	3 (6.38	0.705
Dural Closure			
No closure	1 (3.57)	25 (51.02)	
water tight	15 (53.57)	22 (44.90)	
Incomplete	12 (42.86)	2 (4.08)	**<0.001**
Duration of surgery (hrs)			
< 1	12 (42.86)	10 (20.41)	
1- 3	16 (57.14)	37 (75.51)	
> 3	0 (0.00)	2 (4.08)	0.093
Skin Closure			
Continuous	5 (17.86)	28 (57.14)	
Interrupted	23 (82.14)	21 (42.86)	**<0.001**

After subjecting the factors found to be statistically significant on bivariate analysis to further multivariate logistic regression, only dural closure remained statistically significant $p = 0.015$ OR 14.15 [1.67–119.92] as shown in Table 4.

4. Discussion

Craniotomy for different neurosurgical conditions is among the common procedures performed in several neurosurgical institutions within Tanzania[23–25] and the safe use of post craniotomy drainages has been previously described locally and others neurosurgical centers[20]

An extensive literature review was undertaken with the purpose to define and compare efficacy of post surgical drains among patients undergoing craniotomy and although these studies differed in sample size, substantial variations in the inclusion criteria, and differences in patients clinical and surgical characteristics and indications for craniotomy, mixed findings were reported hence a clear recommendation

Table 4
Multivariate logistic regression showing the effect on drainage use vs patient factors.

Factors	Drain (DG) n (%)	No Drain (NDG) n (%)	OR [95CI%]	P value
Comorbidities				
Yes	17 (60.71)	42 (85.71)		
No	11 (39.29)	14 (14.29)	1.99 [0.50–7.91]	0.328
Dural Closure				
No closure	1 (3.57)	25 (51.02)		
water tight	15 (53.57)	22 (44.90)	14.15 [1.67–119.92]	**0.015**
Incomplete	12 (42.86)	2 (4.08)	73 [5.64–959.80]	**0.001**
Skin Closure				
Continuous	5 (17.86)	28 (57.14)		
Interrupted	23 (82.14)	21 (42.86)	3.51 [0.94–13.16]	0.062

remained elusive. Accordingly, we undertook this study to further contribute to the literature regarding this subject matter.

4.1. Drainage usage and short term outcomes

4.1.1. Subgaleal collection and drainage usage

Subgaleal fluid collections encompassing either tissue breakdown hematomas or hemorrhagic CSF occur frequently after cranial surgery and as such thought to increase both the patients discomfort as well as the overall postoperative complication rate.

In a univariate analysis, we found no difference in outcomes between the DG vs NDG ($p = 0.624$). Our findings were similar to a prospective study by Hamou and colleagues[26] which evaluated the efficacy of subgaleal drains among 150 consecutive patients undergoing supratentorial craniotomy similarly found that presence of drainage posed no influence on the outcome, although their study further reported that curved incisions, bigger craniotomy, and tumor size, were related with higher occurrence of subgaleal fluid collection ($p < 0.0001$, $p = 0.001$, $p < 0.01$ respectively). More supporting findings were reported by Choi and group who noted that utility of post craniotomy drains did not appear to be important for prevention of post craniotomy SFC as well as for promotion of surgical site healing in pterional craniotomy[27]

Li et al reported contrasting findings where they found an incidence of SFC DG 11.5% (3/23) and NDG 54.1% (20/23) ($p < 0.006$) which was statistically significant hence supporting the usage of drains in helping reduce SFC(28).

A possible explanation of the disparity in findings may lie on the fact that despite the few number of cases in our cohort due to limited time, the natural healing course takes effect where the healing process within surgical site is immediately initiated in a physiological response absorbing a significant amount of post craniotomy SFC, equally with supportive routine utility of meticulous intraoperative achievement of hemostasis offering a controlled environment for which the surgeons are confidently guided on whether to use the post-operative drain.

4.1.2. SSIs and drainage use

Although drains are placed commonly in the craniotomy field to prevent hematoma collection, in some studies, they have been hypothesized to lead to SSI as they are thought to act as a conduit to retrograde bacterial migration and the expose to external environment,[29] this controversy remains unresolved in neurosurgery since there is limited literature supporting this finding in the neurosurgery field.

In our study, the rate of SSI was 5.2% (4/77) with DG vs NDG was 3.6% vs 6.1 % respectively. The SSI rate is within the range with other neurosurgical series such as those by Bokop et al 4.2%,[30] Adeleye et al 4.5%,[31] although Buang et al reported a slightly higher rate at 7.7%.[32] Contrastingly lower rates were reported by Buchanan et al 2.2%.[33] The low SSI in this study could be attributed to the routine meticulous pre-operative aseptic preparation, use of pre and post-operative antibiotics and daily dressing of wound in the early postoperative window as per institutional protocol, a finding supported by Korinek and group[34] who unsurprisingly reported that antibiotic prophylaxis was found to be effective in preventing SSI in a much larger series of 4578 craniotomies.

Univariate anaylsis analyzing the initial hypothesis revealed no difference in the rate of SSI between the DG and NDG groups ($p = 0.538$) in contrast to our initial hypothesis, similar findings witth Hamou and group.[26] Interestingly, Spake and colleagues showed a decreased rate of infection with drain usage among patients who underwent cranioplasty.[35]

Noteworthy mentioning, the average drainage duration in this cohort was 3–5 days and there was no association with the risk of SSI. This was in contrast to Cassir et al reported that duration of drainage ≥3 days was an independent risk (OR = 5.7; 95% CI, 1.5–22) of SSI in postcranial surgery patients.[36] which they attributed it to the shorter period of bacterial colonization since the drain acts as a conduit to the external environment hence the lowered risk. On the contrary, Yu et al found no significant increased risk of SSI with prolonged duration of drainage.[37]

However, a local study by Mawala et al at this institution showed that drainage use among patients undergoing major abdominal surgery was associated with SSI (OR = 15.3) among other factors.[38]

4.1.3. Length of hospital stay and drainage use

In this study, the average LOS of <7days, there was no association noted between drain use with LOS ($p = 0.498$).This finding was in contrast to Bonney and colleagues who reported that use of surgical drains was associated with decreased intensive care unit length of stay in a cases series of 52 patients with supratentorial hematoma.[39]

One possible explanations could be the low incidence of SSI in this study, given that SSI is a known independent risk factor for lengthened hospital stay[40,41]

4.1.4. Drainage use and other patient factors

On multivariate analysis, we found that a watertight dura closure significantly reduced the occurrence of SFC 14 times ($p = 0.015$ 14.15 [1.67–119.92]) and incomplete dura closure profoundly increased the likelihood of SFC and drainage use ($p = 0.001$ 73 [5.64–959.80]). This was in disagreement with Li et al [28] who showed that among 63 patients who underwent craniotomy near the parietal site, there was significantly reduced SFC, infection, and control epilepsy with the prophylactic use of drainages and a non-watertight dura suture, findings contrary to Hamou et al.[26] However, our findings were contrary to a study by Hamou and group in which they reported that despite watertight dural closure in patients who underwent supratentorial craniotomies there was no difference in the occurance rate of SFC.

In practice, post craniotomy drains can either be placed in the subdural (SDD) or subperiosteal space (SPD) depending on the surgeons preference. In this study the overall drain usage was 36% (28/77), whereby SPD was preferred 64% (18/28) as compared to SDD (32%)

To further validate the implication of drainage utility on the short outcomes in our study, we performed a separate bivariate analysis on the drainage type (SDD vs SPD) solely within the drainage group against the outcomes Table 5.

Sub analysis within the drainage group showed that there was an association between the use of SPD and less occurrence of SFC($p = 0.037$) and shorter hospital stay ($p = 0.041$) as compared to patients with SDD. Greuter et al[42] and Kaliaperumal[43] also showed superiority of SPD in patients with chronic subdural hematoma post burr-hole drainage posting lower rates of recurrence, drain misplacements and parenchymal injuries as compared to those with SPDs.

It was found none of the two drainage types had an impact on the incidence of SSI ($p = 0.357$). However, in patients whom SDD was utilized, there was a prolonged length of hospital stay ($p = 0.047$) and higher occurrence of SFC ($p = 0.037$) than in the SPD group, findings which lend support to preference of SPD in our study.

In general, our findings were largely similar to those in other studies, and the judicious use of drains still remains at the expense of the surgeon's preference at our center.

Table 5
Bivariate analysis of Short term Outcomes and drainage type.

Variable	SDD n (%)	SPD n (%)	P value
SSI			
Yes	1 (10.00)	0 (0.00)	
No	9 (90.00)	19 (100.00)	0.357
SFC			
Yes	3 (30.00)	0 (0.00)	
No	7 (70.00)	18 (100.00)	**0.037**
LOS (days)			
≤ 7	6 (60.00)	17 (94.44)	
> 7	4 (40.00)	1 (5.56)	**0.041**

4.2. Study limitations

The sample size was relatively small due to the limited study period. Although the use of modified iv tubing drain has been alluded to be safe and efficient the lack of utility of the standard Jackson Pratt drainage systems could have impacted on the results.

5. Conclusion

In this single center observational study, we found that outcomes of patients with post-craniotomy drains were largely equivalent and non-inferior to those without drains who underwent craniotomy for similar neurosurgical conditions at our institution with no statistical significance in terms of occurrence of subgaleal fluid collection, incidence of surgical site infection and length of hospital stay. The use of watertight dura closure significantly reduces the occurrence of galeal collection. Larger well randomized control are recommended to further validate our findings.

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CRediT authorship contribution statement

Dennis Onsombi: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Gerald Mayaya:** Investigation, Methodology, Supervision. **Vladimir Herrera:** Investigation, Methodology, Supervision. **Anton Manyanga:** Investigation, Methodology, Writing – review & editing. **Washington Leonald:** Conceptualization, Data curation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Samuel Byabato:** Methodology, Supervision, Validation, Writing – review & editing. **James Lubuulwa:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviations

BMC: - Bugando Medical Centre
CRP: - C Reactive Protein
CSDH: Chronic Subdural hematoma
CSF: - Cerebrospinal fluid
DG: - Drain Group
ED: - Epidural hematoma
LOS: Length of hospital stay
NDG: - Non Drain Group
RCT: Randomized controlled trial
SDD: - Subdural Drain
SFC: Subgaleal Fluid collection
SOPD: - Surgical Outpatient Department
SPD: - Subperiosteal drain
SSI: Surgical Site Infection
STATA: South Texas Art Therapy Association
TBI: - Traumatic Brain Injury
USS: - Ultrasonography