Risk Factors Affecting the Postoperative Cerebrospinal Fluid Leak in Brain Surgery

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ABSTRACT

Introduction: During the brain surgeries, durotomy is the entering gate for the brain. The dural closure is important to prevent CSF leak, subgaleal collection and future infection. The aim of our study is to compare between different techniques of duroplasty in relation to postoperative complication rate.

Material and Methods: the patients' medical files were reviewed retrospectively for demographic data, diagnosis, comorbidities (diabetes mellitus, hypertension, dyslipidemia and smoking), location of pathology, type of surgery, type of closure and evidence of CSF leak. The risk for developing cerebrospinal fluid leak was calculated and the correlation with different parameters was done.

Results: 45 patients were included. The mean age was 36.4 ± 22 years. The mean follow up was 9 months. There were 18 (40%) males and 27 (60%) females. The different types of dural closures were not statistically significant for postoperative CSF leak. The pericranial flap showed statistically significant difference in preventing CSF OR 3.2, 95%CI [1.07, 9.54], *P*= 0.04.

Conclusion: Different dural closure and reinforcing techniques seem to have similar protective outcome with statistically significant superiority to the pericranial flap. Diabetes, hypertension, dyslipidemia or postoperative chemo- or radiotherapy do not seem to be a risk factor for post operative CSF leak.

Keywords: craniotomy, craniectomy, CSF leak, dural repair, pericranium

INTRODUCTION

The brain is protected mechanically by the meninges: Dura, arachnoid and Pia mater. The dura is the first layer to be encountered after bone flap removal in craniotomy surgeries. Microscopically the outer layer of the dura is composed of fibroblast and collagen. The inner most layer is formed by flattened cells with sinuous processes.[1] Previous studies revealed some important biologic function of the dura beside its protective function.[2,3]

During the brain surgeries, durotomy is the entering gate for the brain. The dural closure is important to prevent CSF leak, subgaleal collection and future infection. The dura can be closed by either primary closure or duraplasty. The duraplasty can be done by autologous or synthetic dural substitutes.

Dural substitute development began in the 1890's with the use of gold foil or rubber, which proved unsatisfactory.[4] Nowadays, many advances are made. Options for dural substitution materials include: Autograft (Pericranium and fascia lata), Allograft (Amniotic membrane, pericardium, lyophilized dura), Xenografts (bovine or porcine pericardium) and synthetic materials (polytetrafluoro ethylene, polyester urethane). However, each material had advantages and drawbacks that may limit their usage.[5,6]

Neurosurgeons used autologous pericranium, which is easy to harvest and heals well. However, it can be thin and fragile to the extent that may require some reinforcement with sealant.[7,8] On the other hand, KRH von Wild on 1999, examined prospectively the safety and efficacy of an absorbable dura mater substitute (Dura-Patch) on 101 patients, in normal applications in Neurosurgery. His results shows the suitability of Dura-patch.[9] Whereas, when Malliti et al compares retrospectively the synthetic dural substitute (Neuro-Patch) (among 61 patients) and pericranium graft (in 63 patients) with regards to deep wound infection and CSF leak for one year. They report the raised risk of complications with the synthetic (Neuro-Patch) graft as a foreign body.[10]

A recent monocentric prospective study from Italy, is conducted by G. Sabatiro et al, which compared the galea pericranium dura plasty with non-autologous dural surrogates. The only difference was the cost, while the other clinical variables didn't show any significant statistical difference.[11]

Several reports have described the duraplasty method by each particular synthetic substitutes[10,11] specially in cases like extensive meningioma resection (simpson 1 or 2)[4,10,11] or decompressive craniectomy.[12] But still the ideal substitute has not yet been well established.

So, the aim of our study is to compare between different techniques of duroplasty in view of postoperative complication; also to compare different reinforcing techniques at King Abdulaziz University Hospital (KAUH)-Jeddah.

MATERIAL AND METHODS

This was a retrospective study and ethical approval was obtained from institutional ethical board. The patients' medical files were reviewed. Any patient who underwent crainiotomy or craniectomy with dural closure was included. Exclusion criteria were: deficient files for any parameter of the study and extracranial surgeries. The parameters reviewed were: patient demographic data, diagnosis,

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comorbidities (diabetes mellitus, hypertension, dyslipidemia and smoking), location of pathology, type of surgery, type of closure and evidence of CSF leak.

STATISTICAL ANALYSIS

The data was analyzed using SPSS 21 software. The parametric data were presented by mean ± standard deviation. The odd ratio (OR) was calculated to find out the risk of CSF leak in correlatin with dural closure type. The nonparametric correlation was calculated using Pearson's correlation.
P-value of < 0.05 was considered significant. This study was approved by the Biomedical Ethics Research Committee at King Abdulaziz University, Jeddah (HA-02-J-008).

RESULTS

Total of 45 patients were included. The mean age was 36.4 ± 22 years. The mean follow up was 9 months. There were 18 (40%) males and 27 (60%) females (table-1).
Among different pathologies included in this study, the most common one was the intra-axial tumors 22(48.9%) figure-1). 9 (20%) of patients had CSF collection/leak. Of those 5 were males, and 4 were females. Factors associated with high CSF leak (table-2) were:

1. Postoperative radiotherapy: there was no statistically significant association between radiotherapy and CSF leak OR 1.4, 95% CI [1.13, 1.8], *P*=0.18.
2. Postoperative chemotherapy: there was no significant association between chemotherapy and CSF collection/ leak, OR 1.4, 95% CI [1.12, 1.76], *P*=0.24.
3. Diabetes was not a risk factor for CSF. leak OR 0.86, 95% CI [0.06 - 12.22], *P*=0.4.
4. Hypertension was not a risk factor for CSF leak OR 0.69, 95% CI [0.09 - 5.26], *P*=0.8.
5. Smoking was not a risk factor for CSF leak OR 1.28, 95% CI [1.08 - 1.5], *P*=0.3.
6. Dyslipidemia was not significantly associated with CSF leak OR 1.27, 95% CI [1.08 - 1.49], *P*=0.3.

Comparison of different closure techniques and CSF leak
Different dural closure techniques were reviewed and a correlation was calculated with CSF leak risk. The results showed no statistical difference for most of the techniques including primary closure, use of povine pericardium (Dura - Guard®), use of regenerative matrix (DuraGen Plus®) except for the pericranium were it showed statistically significant difference in preventing CSF OR 3.2, 95%CI [1.07, 9.54], *P*= 0.04.
The reinforcing material that were used in some patients (fat graft, fibrin sealant or cyanoacrylate glue) were tested for correlation with CSF leak and showed no statistical difference (table-3).

Risk of developing complications, infection or seizure
In this study we reviewed the possibilities of developing complications (at the surgery site such as wound dehesince or systematic such as allergic reaction), infection or seizure in relation with the dural closure technique. There was no statistically significant correlation (table-4)

Length of stay and outcome versus the type of dural closure
The length of stay showed no statistical difference between the different dural closure techniques. The outcome was divided into four different categories: no symptoms, no disability with symptoms, disability and death. Accordingly, the analysis did not show a statistical difference between different dural closure techniques (table-4).

Socio-demographics	Number (%)
Age (mean) Mean ± SD	36.4 ± 22.6
Gender	
Male	18 (40.0)
Female	27 (60.0)
Nationality	
Saudi	11 (24.4)
Non-Saudi	34 (75.6)
Smoking	
Yes	4 (8.9)
No	41 (91.1)
Diabetes	
Yes	9 (20.0)
No	36 (80.0)
Hypertension	
Yes	11 (24.4)
No	34 (75.6)

Table-1: Socio-demographic characteristics of the participants (n=45)

Variable	Pearson Chi-Square value	p-value
Gender	1.134	.287
Diabetes	.556	.456
Hypertension	.030	.862
Dyslipidemia	.804	.370
Steroids > 7 days	3.021	.388
Smoking	1.098	.295
Pathology	5.411	.248
Location	3.640	.056
Surgery type	4.606	.100
Reoperation	.108	.742
Radiotherapy	5.625	.18
Chemotherapy	5.081	.24

Table-2: CSF leak correlation with different factors

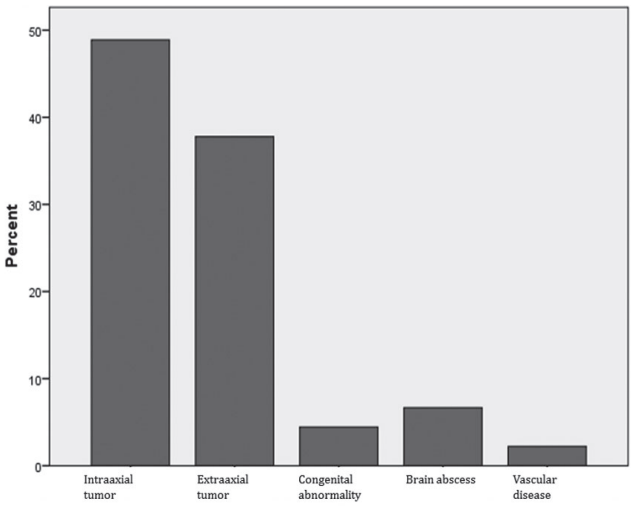

Figure-1: Types and percentage of pathologies included

DISCUSSION

Cerebrospinal fluid leakage is not uncommon complication after most types of neurosurgical procedures, provided that watertight dural closure sometimes is not achievable. Known methods for repairing dural defects may involve direct primary suture, but frequently the gaps may not be amenable to closure primarily. As well, watertight primary closure of the dura sometimes cannot be achieved due to dural shrinkage secondary to dural dissecation after a prolonged procedure.[13] The problem of CSF leakage wither it is collected under the scalp or dripping out of the skin is the high risk of developing an infection that can lead to serious morbidities and possible mortality.

At KAUH different dural closure techniques have been used, so the sit up is suitable to compare between those different techniques.

In the current study we show that postoperative chemotherapy is not associated with a CSF leak, this finding is different than what is reported in the literature before on a limited number of patients.[14-16] However, the difference is that we studied the post operative chemotherapy administration risk while the other articles study the preoperative risk. So, we may conclude that the postoperative chemotherapy administration of chemotherapy is less risky in developing CSF leak than preoperative administration.

The postoperative radiotherapy, as well, is not a risk factor for developing CSF leak. The preoperative radiotherapy has been reported as a risk factor for CSF leak before.[17,18] Again, the postoperative radiotherapy does not seem to be a risk for CSF leak.

Boudreaux,B et.al. advocates for the use of vascularized graft for repair of CSF leak in high risk patients, his recommendation is in line with our finding of using the pericranial flap that has better sealant effect.[19]

Different available materials for closure of the dura (such as; fascia lata, pericranium, dural adhesion barrier matrix or pericardial graft) seem to be similar with a little superiority to the pericranial flap.

Huter et.al. article showed that the CSF leak rate increased with diabetes, increased CRP and the need for dural patch. In our study there is no statistical difference between diabetics and non-diabetics as well there is no difference between the primary dural closure and the use of patch closure. The exact reason for this contradicting results is unclear, however, it may be related to the additional use of "tachosil" in Huter's study, different pathologies or immune compromise in diabetics that need a tight control, or possible presence of the infections as suggested by elevated CRP.[20]

A recent study shows that Infratentorial surgery and > 8 days of postoperative corticosteroid were significant predictors for the development of CSF leak. In our study, that is not the case with unclear reason, further studies are needed to explore this issue further.[21]

The use of reinforcing closure material (i.e. fat graft, fibrin sealant or cyanoacrylate glue) does not show any statistical difference regarding the superiority of one over the other. Keeping in mind that fat graft is cheaper and readily available, however, it requires a separate surgery for harvesting the graft. Fibrin sealant is a natural extract, but the cost is sometimes a limiting factor. Finally, the cyanoacrylate glue is a synthetic material, cheaper than the fibrin glue but it can lead to inflammatory reaction, gliosis or meningeal irritation.[22,23]

The limitations of this study are the retrospective design, limited number of patients, single center experience, different pathologies and not addressing the cost effectiveness. So, we recommend to conduct a prospective multicentric study with a larger number of patients and a unified type of pathology to limit the confounder in the study.

Variable	Pearson Chi-Square value	p-value
Water tight closure	1.177	.278
Fascia lata	.256	.613
Pericranium	4.201	.040
Dura guard	.804	.370
Duragen	.523	.469
Fat graft	.523	.469
Fibrin glue	.069	.793
Gluebran	.523	.469

Table-3: CSF leak correlation with different dural repair techniques

CONCLUSION

Different dural closure and reinforcing techniques seem to have similar protective outcome with statistically significant superiority to the pericranial flap. Diabetes, hypertension, dyslipidemia or postoperative chemo- or radiotherapy do not seem to be a risk factor for post operative CSF leak.

The authors report no conflict of interest involved in this study.

	Primary d/closure (n=16)	Pericranium (n=9)	Dura guard (n=19)	Duragen (n=1)	
Post-operative complication	5 (31.3)	3 (33.3)	12 (63.2)	0	N.S.
Post-operative infection	7 (43.8)	4 (44.4)	8 (42.1)	0	N.S.
Post-operative seizure	4 (25.0)	2 (22.2)	7 (36.8)	0	N.S.
Length of hospital stay (days)	47.5±90.6	19.6±16.9	36.6±84.3	8.0	N.S.
Follow-up (months)	3.3±3.7	14.2±25.9	12.1±20.7	2.0	N.S.
Outcomes	No symptom - 3 (18.8) No disability - 7 (43.8) Disability - 4 (25.0) Dead - 2 (12.5)	No disability - 8 (88.9) Disability - 1(11.1)	No symptom - 1 (5.3) No disability - 7 (36.8) Disability - 9 (47.4) Dead - 2 (10.5)	No disability - 1 (100.0)	N.S.

N.S. - Not significant

Table-4: Comparison of different procedures for dural repair (n=45)

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