

EFFECTIVENESS OF TRANSCRANIAL DURAL REPAIR FOR EARLY POST-TRAUMATIC CEREBROSPINAL FLUID LEAKS

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 Date Received: September 12, 2017
 Date Revised: May 14, 2018
 Date Accepted: May 22, 2018

ABSTRACT

Objective: To determine the effectiveness of transcranial dural repair in the management of early traumatic cerebrospinal fluid (CSF) rhinorrhea.

Methodology: This study was conducted at Department of Neurosurgery, Hayatabad Medical Complex, Peshawar, from March 2015 to February 2017. Cases of traumatic CSF rhinorrhea of less than 7 days' duration, from both genders without age discrimination were included. Patients with chronic, spontaneous and iatrogenic CSF leaks were excluded. CSF rhinorrhea was diagnosed on clinical as well as radiological studies.

Results: Total 60 patients were studied. Age range was 7 to 57 years with mean age of 29 ± 1.2 years. There were 46 (76.6%) males and 14 (23.3%) were females. The causes of head trauma were road traffic accident in 36 (60%), fall from height in 14 (23.3%) and miscellaneous were noted in 10 (16.67%). Overall, postoperative complications were observed in a total of 13 (21.7%) patients. The success rate as denoted by closure of the CSF leak was 90%. Complications of surgery included recurrent CSF leak in 6 (10%) patients, 4 (6.67%) patients had meningitis, 10 (16.67%) patients developed pneumocephalus while 06 (10%) patients were complaining of loss of smell after surgery.

Conclusion: Transcranial dural repair is the safe and effective way to treat post-traumatic CSF rhinorrhea and prevent its complications.

Key Words: Head trauma, Cerebrospinal fluid leak, Transcranial dural repair, management outcome

This article may be cited as: Rahman ZU, Khan MM. Effectiveness of transcranial dural repair for early post-traumatic cerebrospinal fluid leaks. *J Postgrad Med Inst* 2018; 32(2): 206-10.

INTRODUCTION

Leakage of cerebrospinal fluid (CSF) from the intracranial space through the nasal passages is a serious condition because it provides a corridor to the bacteria and other organisms to get into intracranial CSF spaces and cause meningitis¹. CSF rhinorrhea may be early i.e. within one week or delayed i.e. beyond one week up to years². Thin cut (1–3 mm) contrast enhanced CT scan is the investigation of choice which can also be supplanted by contrast enhanced MRI of brain in prone position for the detection of underlying bony and dural defect³.

In majority of cases, CSF leak is due to trauma. In patients with closed head injury, 3% of patients present with CSF leaks, mostly through the nose, ear, or orbit. In 30% of cases, there is a skull base fracture^{4,5}. In majority of cases, the leak is resolved spontaneously and no further treatment is required. However, those with persistent leak for more than two weeks or leaks which recur after initial resolution, usually require surgical repair

of the dural defect^{6,7}. It has been reported that delaying surgical closure may increase the chances of ascending meningitis, therefore, these authors have favoured early surgical repair of CSF leak to reduce the incidence of meningitis and its attendant risks⁸.

Management of CSF rhinorrhea is a challenging situation for neurosurgeons. Conservative as well as surgical treatment options are available and vary from patient to patient, depending on etiology, anatomic site, patient age and underlying intracranial pressure⁹. The transcranial repair of dural tears in traumatic CSF leaks is a classic approach. It is straightforward and easy to learn. However, some studies have shown high complication rate, higher failure rate in resolution of the CSF leak and too traumatic as compared to its endoscopic variant. The endoscopic variant, though less invasive has a very steep learning curve with a need for advanced equipment which are not easily available⁷. The commonly used reconstructive material are fascia-lata graft or pericranium^{7,10,11}.

We, therefore aimed to determine whether early transcranial surgical repair of traumatic CSF leak is effective in terms of success rate and postoperative complications. This technique is simple, straightforward and the learning of this procedure is easy as compared to the endoscopic repair of the leak. This will enhance the evidence base for early surgical intervention and hence improve patient outcomes in neurosurgical care.

METHODOLOGY

This was a prospective observational case series conducted at Department of Neurosurgery, Hayatabad Medical Complex, Peshawar, from 1st March, 2015 to 30th February, 2017. Approval was obtained from the institutional ethical committee. All patients provided written informed consent before undergoing any invasive procedure and for inclusion in the study. We included patients with traumatic CSF rhinorrhea within first 7 days of onset from both genders and from all age groups using the consecutive sampling technique. Patients with delayed (CSF leak starting > 7 days after injury), chronic, spontaneous and iatrogenic CSF leaks as well as those who were lost to follow-up, were excluded.

Clinical diagnosis of traumatic CSF rhinorrhea was made by typical history of closed head injury followed by clear watery discharge with salty taste. Clinically it was confirmed by a positive reservoir sign, which is accentuation of rhinorrhea when the patient sits up with head bent down. Thin cut contrast enhanced CT with sagittal and coronal reformation or MRI Brain with contrast in prone position were done to determine the site of bony or dural defect by observing a contrast enhancing area at the base of skull.

All procedures were performed by a consultant neurosurgeon under general anaesthesia (GA). The patient was put in supine position with neck extension and chest elevation. Pre-operative ceftriaxone 1 g was administered intravenously. The procedure length was recorded from endotracheal intubation to extubation. A bicoronal/sutar incision was used which was placed behind the hair line and 1 cm anterior to the tragus of the ear. At the time of scalp flap elevation, the pericranium was saved for utilization as onlay graft. After bone flap elevation, linear incision was made in dura, brain retracted, CSF aspirated, defect was identified and graft was put over the defect. After stabilization of the graft by suturing, we used fibrin glue if the graft closure was not complete or if the defects were multiple. Hemostasis was meticulously secured. Dura was closed in water and air tight fashion. Hitch stitches were applied to dura and bone flap was replaced. Skin closure was followed by antiseptic dressing.

Postoperatively, broad spectrum intravenous antibiotics cover was given for the initial 72 hours. In routine

the patient was kept in ward for 72 hours or longer if the patient condition required so.

For the purpose of our study, early CSF leak was defined as those leaks which starts within the first 7 days after admission. A favourable outcome was defined as cases in which dural repair was not followed by recurrent CSF leak and absence of other postoperative complications such as wound infection and meningitis.

Patients who presented with recurrent CSF leak were treated with insertion of a lumbar drain and followed-up for at least 72 hours. Once the scalp wound epithelialization was complete, we removed the lumbar drain. Patients with postoperative meningitis or wound infection were admitted to the ward and treatment was guided by wound/CSF culture and sensitivity reports.

Data was collected about patient demographics such as age and gender as well as clinical data such as injury mechanism, CT findings, length of procedure, postoperative complications, length of stay and final categorization into favourable and unfavourable groups. All patients were followed-up for 2 weeks postoperatively. Data was entered and analysed using SPSS version 22.0. A chi-square test was run to determine any association between various clinical and demographic variables to final outcome. An independent t-test was run to determine significant mean differences for continuous variables such as age, length of the procedure and length of stay for the two outcome groups. Statistical significance was kept at <0.05.

RESULTS

A total of 60 patients who completed the follow-up were studied in two years. The minimum age was 7 years and the maximum age was 57 years with a mean age of 34.3 ± 10.7 years. There were 46 (76.7%) males and 14 (23.3%) females in a ratio of 3.3 to 1.

There were 36 (60%) cases due to road traffic accidents, 14 (23.3%) cases of fall from height, 8 (13.3%) cases of assault and 2 (3.3%) cases of sports injury.

The surgical approach was intradural in all of the 60 (100%) patients. Fascia lata graft was placed in 56 (93.33%) patients and pericranium in 4 (6.67%) patients to cover the defect properly. Lumbar CSF drainage was not done in any patient pre-operatively while 4 (13.3%) patients had undergone post-operative CSF drainage. The mean procedure length was 124.5 ± 17.9 minutes.

In 26 (43.33%) patients bicoronal craniotomy was performed where wide exposure was needed and in 34 (56.67%) unilateral subfrontal approach was adopted. Among intraoperative findings, all the 60 patients had a defect in the dura. Operative findings and their frequency distribution is shown in Table 1.

Postoperatively, the mean length of stay was 4.2 ± 1.5 days. Overall, postoperative complications were observed in a total of 13 (21.7%) patients. The success rate as denoted by closure of the CSF leak was 90%, since we observed recurrent CSF leak only in 6 (10%) of patients. All leaks were identified as recurrent rhinorrhea. These leaks were identified within 2 weeks postoperatively. Four of the cases resolved with lumbar drainage while 2 of the cases resolved with bed rest and head elevation. The mean length of lumbar drain insertion was 3.7 ± 1.4 days.

Other postoperative complications were meningitis which occurred in 4 (6.7%) patients and 10 (16.67%) patients developed pneumocephalus. Pneumocephalus resolved spontaneously within 5 days of surgery while the meningitis cases responded to intravenous broad

spectrum antibiotics. There were five wound infections postoperatively. One wound culture showed staphylococcus aureus while the other 4 did not show growth of microorganisms. Postoperative complications and their frequency distribution in 02 outcome groups is shown in Table 2.

A chi-squared test was run to determine association between final outcome and various clinical variables. It was observed that unfavourable outcome was strongly associated with the concomitant occurrence of recurrent CSF leak ($p < 0.0001$) and meningitis (<0.0001). On independent samples t-test, there was statistically significant mean difference for total length of stay in the hospital according to the final outcome group (mean difference: 3.5, 95% CI: 2.5 to 4.4, $p < 0.0001$), as shown in Table 3.

Table 1: Operative findings and their frequency distribution

Operative Findings	Number	Percentage
Dural Defect	60	100%
Fracture of Cribriform Plate	28	46.67%
Olfactory Nerve Injury	20	33.33%

Table 2: Early postoperative complications according to outcome groups

Complications	Favorable Outcome		Unfavorable Outcome	
	n	%	n	%
Wound Infection	5	8.3%	0	0%
Persistent CSF Leak	0	0%	6	10%
Meningitis	0	0%	4	6.7%
Pneumocephalus	8	13.3%	3	5.0%
Loss of Smell	6	10.0%	0	0%

Table 3: Independent samples t-test for continuous variables

Variables	Final Outcome	n	Mean	SD	Mean Difference	95% Confidence Intervals	P values
Patient Age	Favourable	54	34.4	10.7	1.5	-7.7 to 10.9	0.794
	Unfavourable	6	32.8	11.6			
Procedure Time (minutes)	Favourable	54	125.0	17.4	4.7	-10.8 to 20.2	0.602
	Unfavourable	6	120.3	23.4			
Length of Stay	Favourable	54	3.9	1.1	3.5	-4.5 to -2.5	<0.0001
	Unfavourable	6	7.3	1.9			

DISCUSSION

The structure of the anterior fossa, skull base and paranasal sinuses is extremely complex. This complexity leads to complex results after traumatic forces cause fractures of these thin plates of bones. Anterior cranial base fractures frequently (30%-60%) associates with CSF leaks^{1,2,12}. Middle fossa CSF leaks are known for high rates of spontaneous closure while anterior cranial fossa leaks are notorious for lower rates of spontaneous closure. Continued leaks indicate an open passage way for microorganisms to travel into the brain and meninges, leading to devastating conditions such as acute pyogenic meningitis, cerebritis and brain abscess^{5,13}. It is well known that early closure of CSF leak is associated with lower rates of meningitis, therefore, the notion of early CSF leak closure was introduced; whereby instead of waiting for the CSF leak to continue for at least two weeks before surgical closure was decided, a proactive early closure of the dural defect was favored. Though data about the risks and benefits of this approach is scant, it has been shown to reduce the incidence of CSF leak related meningitis⁴.

Sakas & co-workers¹⁴ reported a very high rate of meningitis and other infective complications if the CSF leak persisted for longer than 8 days. This is associated with mortality rate of upto 25% which obviates the need for early identification and closure of dural fistula¹⁵. It is noted that although CSF leaks may close spontaneously, however, the rate of meningitis is up to 30% in those with spontaneous closure. This data and other studies have indicated the need for early closure of CSF fistulas¹⁶⁻¹⁸.

In our study, the success rate of CSF leaks were 90%. The 6 patients who failed in resolution of their CSF leaks, 4 of them had acute meningitis, while none had meningitis whose dural closure was successful. Similarly, there was no case of mortality in the acute period. This shows that transcranial repair is of utmost importance in treatment of these patients, as it reduces the higher rates of infective complications as well as mortality^{19,20}.

The objective of surgical intervention is not only to stop CSF leak but to repair the dural rent as well, as this reduces the risk of meningitis from 85-7%⁹. There are more than one way of repairing this dural defect. Transnasal endoscopic technique is practiced in selected cases especially where site of CSF leak can be precisely identified and dural defect of less than 3 cm can be managed with free mucoperichondrial on-lay graft endoscopically²¹.

As classified by Sakas et al¹⁴, the anterior skull base fractures are classified into 4 types where type I fractures which involves the cribriform plate, are associated with

60% infection while type II fractures which involve frontoethmoidal bones are associated with 43% infection. This is due to the fact that fractures in these regions are larger and complex, so spontaneous closure occur rarely. Similarly, they identified that fracture displacement >1 cm and rhinorrhea longer than 8 days increases the incidence of meningitis several folds.

In our study of 60 patients, there was no operative mortality which is comparable to those of international studies¹². CSF leakage stopped in 56 (93.33%) patients immediately. Aurangzeb et al¹⁸ conducted his study on 27 patients and noted that CSF leak stopped in 85% cases in immediate postoperative period while in 11% patients, lumbar punctures were required to stop post-operative persistent CSF leak. Moreover in the mentioned study, 3.7% cases developed meningitis and 4 (15%) cases developed anosmia. Our study results are slightly better than their observation due to the fact that we used microscope in all cases and generously used fibrin glue even if there was very little doubt about proper dural closure.

LIMITATIONS

Our study has got certain limitations as well. This study was confined to limited numbers of patients with a short follow-up period. However, important positive points are the higher success rate of CSF closure and lower rates of meningitis.

CONCLUSION

Early CSF rhinorrhea responds well to transcranial dural repair, the defects are easily identifiable in the early post-trauma period and the postoperative complications are lower. Transcranial dural repair is the safe and effective way to treat post-traumatic CSF rhinorrhea and prevent complications.

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CONTRIBUTORS

ZUR conceived the idea, planned the study, and drafted the manuscript. MMK helped acquisition of data, did literature search and statistical analysis. All authors contributed significantly to the submitted manuscript.