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Original Article

Surgery Section

Cerebrospinal Fluid Leak in Base of Skull Fractures- Incidence and Complications

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ABSTRACT

Introduction: Cerebrospinal Fluid (CSF) leak is a serious complication in base of skull fractures with high probability of complications like meningitis.

Aim: To find out incidence and duration of CSF leak, occurrence of meningitis, type of organism and antibiotic sensitivity and incidence of those requiring surgery among the head injury patients with base of skull fracture.

Materials and Methods: A prospective cohort study was conducted in the Neurosurgery and General Surgery Ward, Government Medical College, Kozhikode, Kerala, India. All patients with clinically evident CSF leak in base of skull fracture from 15th April 2017 to 30th November 2018 were included in the study. Incidence of CSF leak, incidence of meningitis and patients requiring surgery were noted. Results were expressed in terms of frequency and percentages.

Results: A total of 167 patients were included in the study. Total 81 (48.49%) patients was between 21-40 age group (years). The most common mode of injury was road traffic accidents, accounting to 83.23%. Of the total 167 patients, 35 patients (20.95%) developed post traumatic CSF leak. Of these 30 (85.71%) had CSF rhinorrhea and 6 (17.14%) had CSF otorrhea. Duration of CSF leak was 1 day in 18 patients (51.42%), 2-10 days in 10 patients (28.57%), more than 10 days in 7 patients (20.00%). Meningitis occurred in 9 out of 35 (25.7%) patients. Most common organism was *Streptococcus*, found in 2 patients (22.2%), followed by resistant *Klebsiella*. Cultures were sterile. Two *Streptococcus* infected patients were found to be sensitive to penicillin. Of the total 35 only 7 patients (20%) needed surgical interventions.

Conclusion: The incidence of CSF leak in patients with base of skull fractures is approximately 20%. Most of the cases resolve spontaneously. With persistent leak, there is significant morbidity and mortality in the form of meningitis and requirement of surgery for repair of defect.

Keywords: Anterior cranial fossa repair, Meningitis, Rhinorrhoea

INTRODUCTION

The history of traumatic Cerebrospinal Fluid (CSF) leak can be traced back to second century AD when Galen described the leakage of CSF after cranial trauma [1]. In 1826 Miller had noticed the nasal flow of spinal fluid in a child and he reported it [2]. Years later the term CSF rhinorrhea was coined by St. Clair Thompson in 1899 [3]. During next several years, broad attempts were made to make the diagnosis of CSF leak which included instilling dyes into meningeal space; but was found to be neurotoxic and no longer recommended [4]. In 1950s, the development of nuclear medicine introduced the use of radioactive isotope injection into space for diagnostic purpose [5].

Base of skull fractures can occur with only high energy trauma. Usually, a force more than 1000 lb in 1 ms is required to produce a fracture [6]. Due to the adherence of dura to the bone in the region of anterior skull base, fracture in this region often result in dural tear. Hence, a communication occurs between the subarachnoid space and the sinuses, resulting in CSF rhinorrhoea. Middle Cranial Fossa (MCF) and the posterior cranial fossa fractures involving the clivus can cause CSF rhinorrhoea via the sphenoid sinus [7]. Fractures passing through the petrous bone, especially the longitudinal ones can also cause CSF leak due to its proximity to the middle ear. Almost eighty per cent of the traumatic CSF leaks are those involving the nasal pathways while twenty percent involves the aural pathways [8].

Traumatic CSF leak is a complication seen in 2% of all head injuries. And it occurs in 12-30% of the cases of basilar skull fractures. Out of the basilar skull fractures, those involving the frontal and ethmoidal sinuses ranks first followed by longitudinal temporal bone fractures causing CSF leaks [9].

In about 60% of the cases, CSF leak occurs within first few days after trauma and the diagnosis occurs within first 3 months in almost 95% of the patients [10]. The delayed onset of CSF leak is usually due to cerebral oedema, Lysis of blood clot or necrosis of tissue overlying a dural defect.

The linear fractures in the base of the skull carry a high risk of intracranial infection. The overall incidence of bacterial meningitis among post-traumatic CSF leak varies between 7-30% and the rate increased with increases with increase in duration of CSF leak. The objective of the study was to find out incidence and duration of CSF leak, occurrence of meningitis, type of organism and antibiotic sensitivity and incidence of those requiring surgery among the head injury patients with base of skull fracture.

MATERIALS AND METHODS

A hospital based prospective cohort study was conducted in the Department of Neurosurgery and General Surgery Ward, Government Medical College, Kozhikode, Kerala, India, from 15th April 2017 to 30th November 2018. Ethical Committee approval (GMCKKD/RP 2017/IEC/103) and consent form from the subjects was obtained.

Inclusion and Exclusion criteria: Inpatients of the Department of Neurosurgery and General Surgery Ward, with clinically evident CSF leak in base of skull fracture were included in the study. Patients with non traumatic CSF leak, Patients not willing to give consent and patient lost to follow-up were excluded from study.

Study Procedure

All patients admitted in Government Medical College Hospital Kozhikode with base of skull fractures during study period form the sample population. Patients with Computed Tomography (CT)

scan evidence of base of skull fracture were evaluated with detailed history and repeated clinical examination, during their period of stay in hospital for the evidence of CSF leak. Data was collected by direct interview and questionnaire method. If the patient was alert, history of a salty postnasal drip, complaints of clear and watery discharge from nose and ear, or discharge mixed with blood were looked for. However this was further confirmed bedside by a 'double ring' or 'halo sign'. 'Reservoir sign' was looked for. If there was a suspicion of CSF leak from the history and clinical examination, High Resolution Computed Tomography (HRCT) was done.

In patients with clinical evidence of meningitis, lumbar puncture was done and the CSF sample sent to microbiology department to look for the type of organism and pattern of antibiotic sensitivity. Since the most common organisms involved in causing meningitis in cases of post-traumatic CSF leak are *Streptococcus* and *H.influenza* [11], these patients were started on empirical antibiotics to cover these organisms. Antibiotics like ceftriaxone and penicillin was the first choice. Patients with penetrating injury, intracranial haematoma, large intracranial aerocoel, herniation of brain tissue from nose and ear, low probability of natural dural repair, were considered for early surgery. Initial conservative management was done for upto 10 days. Persistent CSF leak after 10 days, recurrence after 10 days of conservative management, recurrent aerocoele after conservative management, meningitis was considered for surgery.

Surgery involved craniotomy and repair of base of skull with bone pieces if defect was large, intradural and extradural reinforcement of dura with fascia lata graft was done. Abgel was placed and fibrin sealant glue applied for extra protection. Postoperative antibiotics were given.

STATISTICAL ANALYSIS

The data was collected in the proforma. Data analysis was done with the help of Microsoft Excel 2010. Results were expressed in proportions, means and standard deviation.

RESULTS

There were a total of 167 subjects who had head injury as well as CT scan evidence of base of skull fracture. Maximum number of patients was in the age group 21-30 years (44 patients). Mean age of the patients was 41.47 and standard deviation was 15.79. There were a total of 131 (78.44%) males and 36 (21.55%) females [Table/Fig-1].

Age distribution (years)	Males	Females	n (%)
13-20	8	2	10,5.98%
21-30	38	6	44,26.34%
31-40	24	13	37,22.15%
41-50	17	8	25,14.97%
51-60	21	3	24,14.37%
61-70	18	2	20,11.97%
71-80	5	2	7,4.19%
Total	131	36	167,100%

[Table/Fig-1]: Age and sex distribution in patients.

While assessing the mode of injury among the study subjects, road traffic accidents was the most common mode of injury, which occurred in 139 (83.33%) patients. A total of 18 (10.77%) patients had history of fall from height and assault accounted for 10 (5.98%) patients [Table/Fig-2].

Among the total 167 patients, 103 (61.6%) patients had loss of consciousness soon after trauma. There were 108 (64.67%) patients who had raccoon eye. Of the 167 patients only

Mode of injury	n (%)
Road traffic accident	139,83.23%
Fall from height	18,10.77%
Assault	10,5.98%
Total	167,100%

[Table/Fig-2]: Mode of injury.

Clinical feature	Number	Percentage
Ear or nose bleed	133	79.64%
Loss of consciousness	103	61.67%
Subconjunctival haemorrhage	65	38.92%
Raccoon eye	108	64.67%
Postauricular haemorrhage	46	27.54%
CSF leak	35	20.95%

[Table/Fig-3]: Clinical presentation of base of skull fracture patients.

46 (27.54%) patients had postauricular haemorrhage (Battle sign) [Table/Fig-3].

Among the total 35 patients with CSF leak, 29 of them had CSF rhinorrhea only, 5 patients had CSF otorrhoea only and 1 (2.85%) patient had both CSF rhinorrhea and otorrhoea.

An 84 (50.29%) patients had Anterior Cranial Fossa (ACF) fracture alone which was the most common among all the base of skull fractures in the study subjects. A combination of anterior and MCF fracture was seen in 44 (26.34%) patients. Fracture site in different patients in the study group identified from CT is given in [Table/Fig-4].

CT scan	Frequency	Percentage
ACF	84	50.29
MCF	15	8.98
PCF	2	1.19
ACF+MCF	44	26.34
ACF+MCF+PCF	10	5.98
ACF+PCF	8	4.79
MCF+PCF	4	2.39
Total	167	100

[Table/Fig-4]: CT scan finding of basilar skull fracture among the patients.
ACF: Anterior cranial fossa; MCF: Middle cranial fossa; PCF: Posterior cranial fossa

Patients were categorised into three groups depending on the duration of CSF leak. There were 18 patients who had only one day of CSF leak which came to 51.4% of the patients with CSF leak. In the study group, 10 patients had CSF leak with duration between 2-10 days which is 28.5% of those with CSF leak. A prolonged duration of CSF leak in spite of conservative management was noted in seven patients which is 20% of the total among those with CSF leak.

Of the 35 patients who had CSF leak, nine patients (25.7%) developed meningitis. CSF culture was done in nine patients, of whom two of the samples grew *Streptococcus pneumonia*, one grew resistant *Klebsiella* and other samples were sterile. Those patients in whom CSF culture grew *Streptococcus pneumoniae*, both were sensitive to penicillin. One patient with the resistant *Klebsiella* and another one with sterile CSF study succumbed to death.

Among 35 patients with CSF Leak, 28 patients were managed conservatively and only seven patients had surgical interventions. Among 28 patients managed conservatively, three of them were managed with a lumbar drain. Only seven patients (20%) had a persistent leak lasting for more than 10 days. We couldn't put

lumbar drain in these patients as we were suspecting raised ICP at that point, and in our hospital, authors are not monitoring ICP in head injury patients due to technical limitations.

Craniotomy with both intradural and extradural repair with fascia lata graft was done in each patient. Intraoperatively, two patients had defect near the frontal sinus, one had a defect measuring 1 cm near the cribriform plate, two patients had multiple small defects near the cribriform and ethmoid, one patient was with a posterior ethmoid and frontal sinus defect; and one had defect near the ethmoid. All patients were treated with postoperative antibiotic for 7-10 days and discharged. There were no significant complications during postoperative period in any patient on an average follow-up of one month.

DISCUSSION

In the present study, maximum number of patients who had traumatic CSF leaks was between 21-30 years, which constituted 26.3% and it was followed by those between 31-40 years which was nearly 22.1%. This was comparable with the World Health Organization (WHO) statistics [12]. Hence in this study, comparatively younger individuals were victims for base of skull fractures. Road traffic accidents contributed to the major share of the base of skull fractures in our study and it contributed to the mode of injury in 83.23% of patients. Road traffic accidents were found to be the most common cause in a study conducted by Sivanandapanicker J et al., [13]. This tendency of predisposition in younger age group and road traffic accidents may be due to inexperience, tendency to take risks, and alcoholism.

In this study, ACF fractures were the most common basal skull fractures. This constituted 50.29% of cases. This was comparable with the results of studies by Waani AA et al., and Emejulu JK and Malomo O [14,15]. There are certain studies in which they found MCF fractures as the most common site of fracture in patients with head injury [16,17].

It was observed that 38.92% of the study subjects had subconjunctival haemorrhage and 64.67% of the patients had raccoon eyes. These are signs of ACF fracture. 46 patients (27.54%) had post auricular ecchymosis or battle sign, which is a manifestation of MCF fracture. Pretto FL et al., had clearly stated the importance of clinical signs to diagnose basal skull fractures in his study [18].

There were 35 patients who had CSF leak in the form of rhinorrhea or otorrhoea among the total study group. This accounted to about 20.9% of the total cases of basal skull fractures. Friedman JA et al., had reported 12-30% incidence of CSF leak among patients with base of skull fractures [19]. HRCT scan was done in all patients in the study group after basic clinical evaluation. According to Lloyd MN et al., the most common investigation done for diagnosis of basal skull fracture is HRCT [20].

The duration of CSF leak in each of the 35 patients were studied. There were 18 patients (51.42%) with duration of leak for 1 day and in them the leak resolved spontaneously. Of these 17 patients with duration of leak more than one day; nine patients developed clinical features of meningitis. CSF study was done in them and it was suggestive of meningitis. Hence, 25.7% of the total 35 patients with CSF leak had meningitis in this study. In a 12-year prospective study conducted by Daudia A et al., it was found that the incidence of meningitis in persistent CSF leak was 19% [21]. The relatively increased incidence in this study may be attributed to small sample size.

The CSF leak repair by intracranial intradural and intracranial extradural repair with fascia lata had a success rate of 100% with maximum follow-up period of 1 year and a minimum of 1 month. Similar results were obtained in study conducted by Lin DT and Lin AC [22].

Two (5.71%) patients out of 35 patients with CSF leak expired during course of treatment. In study by Liao KH et al., death occurred in 33 (10.91%) out of 302 patients with CSF leak [23]. It was a retrospective 15-year study conducted from 1993-2008 with 1773 patients. Better broad-spectrum antibiotics and improved intensive care over last decade might have helped in improving our result.

Limitation(s)

Many patients referred from peripheral hospitals with CT scans lacked bone window images and missed base of skull fractures, hence reduction in total number of cases. Lack of Intra Cranial Pressure (ICP) monitoring facility was also a limitation.

CONCLUSION(S)

Post-traumatic CSF leak following base of skull fractures is common in young adults. In most of the cases, post-traumatic CSF leaks resolve spontaneously. With persistent leak, there is significant morbidity and mortality in the form of meningitis and requirement of surgery for repair of defect. Early detection of CSF leak and starting of antibiotics according to culture and sensitivity and surgical repair in indicated patients can yield best results.

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