A 7-Year Study of 1,278 Patients with Maxillofacial Trauma and Cerebrospinal Fluid Leak

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Abstract

Background A number of patients with facial fractures have cerebrospinal fluid (CSF) leak that may result in meningitis and other central nervous system complications. Commonly, CSF leak occurs following trauma, but the etiology and pattern of this disorder are different from region to region. This study aims to evaluate the distribution of CSF leak in patients with maxillofacial fractures in Isfahan province, Iran.

Patients and Methods In this retrospective cross-sectional study, 1,287 medical files of patients admitted to a medical center with head and face injuries were evaluated during a 7-year period (2004–2010). Data was obtained using descriptive analysis.

Results Of the 1,278 patients with head and maxillofacial fractures, 16 (1.25 %) males and one (0.07 %) female had

CSF leak; all these cases had skull base fracture. Of these, 52.9 % had maxillary fracture, 23.5 % nasal fracture, 41.1 % orbital fracture, 11.7 % mandibular fracture, 23.5 % frontal fracture, and 41.1 % had more than one site of fracture. 58.8 % had rhinorrhea and 41.2 % otorrhea. Of all these patients with CSF leak, 8 (47 %), 2 (11.8 %), and 7 (41.2 %) cases were treated spontaneously, using lumbar drain placement, and by surgical intervention, respectively.

Conclusions Cerebrospinal fluid leak was observed most frequently in patients with fracture in the zygomatic and maxillary bone, and mostly exhibited itself as rhinorrhea and/or otorrhea. All cases with CSF leak had skull base fracture as well. However, post-traumatic CSF leaks are uncommon and are generally treated without surgical intervention (59 %). Distribution of CSF leak varies from one region to another and knowing this fact helps to manage the injury and prevent the complications.

Keywords Cerebrospinal fluid leakage · Cranial base · Facial bones · Cerebrospinal fluid rhinorrhea · Cerebrospinal fluid otorrhea

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Introduction

Cerebrospinal fluid (CSF) is one major component of the central nervous system (CNS) and serves as a shock absorber to protect the brain, cerebellum, and meninx. CSF, a transparent fluid, encloses the brain and meninx. It is produced daily by the ventriculocisternal portion of the nervous system [1]. Any fistula leading to CSF leak is a pathological condition and can be life threatening [1]. This can be caused by trauma to the base of skull, skull surgery, etc. [2–6]. Generally, CSF leak occurs following trauma.

The etiology and pattern of CSF leak vary in different countries. The most causative factors are different in each country [7]. It has been reported that CSF leak is caused by direct trauma in 80 % of cases, surgery in 16 %, and spontaneous in 4 % of patients [8, 9]. CSF fistula is the most frequent complication after the skull base, nose and adjacent structures surgeries [9, 10]. In general, traumatic CSF leak is generally caused by skull base fracture, while it could also be a result of middle and upper facial fractures. The correlation among head injury, skull base fracture, and consequently CSF leak is reported to be 2–30 % [11–16].

Cerebrospinal fluid leak could directly occur from the anterior cranial fossa or indirectly from the middle or posterior cranial fossa via the eustachian tube. The most common condition is direct anterior cranial fossa leak due to the firm attachment of the lamina dura to the thin cribriform plate and ethmoid bone [13].

Treatment of patients with CSF leak is still debatable and challenging [17]. The treatment of these patients, after confirmation of CSF leak, is achieved by using either conservative therapies or surgical interventions [11–16]. In case of conservative treatment failure, the lumbar subarachnoid drain will be used, and if this method is not effective, surgical operation should be carried out after 8 days [13, 14]. To date, there is little information about the occurrence rate of rhinorrhea and otorrhea following trauma, antibiotic therapy, successful lumbar subarachnoid drain placement, and surgeries. In 2004, Bell et al. published a report in which 33 of 734 traumatic patients had CSF leak. The study showed higher incidence of facial fracture in males and a higher percentage of CSF leak amongst injured females [18]. Consequently in 2006, Pappachan and Alexander stated that motorcyclists without helmets comprised 77.5 % of the maxillary and skull base fractures [19].

Head injuries have very serious implications due to the undeniable role of CNS in one's lifetime. Considering the conjunction and connection of facial bones to skeletal anatomy of the skull base and cranium, it could not be absolutely possible to treat facial fractures without a full comprehension and recognition of skull injuries [20].

To sum up, we attempted to assess CSF leak in patients with head and face injuries admitted to Department of Maxillofacial Surgery of a medical center, to increase public and professional awareness in order to prevent more injuries and complications.

Patients and Methods

This retrospective cross-sectional study was conducted by surveying medical files of 1,278 patients admitted to the Department of Maxillofacial Surgery, Al-Zahra Hospital,

Table 1 Distribution of fractures in all patients and those with CSF leak based on site of fracture

Site of fracture	Fractures in all the patients		Fractures in patients with CSF leakage	
	N	%	N	%
Maxilla and zygoma	428	33.5	9	52.9
Nasal bone	377	29.5	4	23.5
Orbit	180	14.1	7	41.1
Mandible	484	37.9	2	11.7
Frontal bone	4	0.3	4	23.5
>1 site of fracture	196	15.3	7	41.1

Table 2 Distribution of rhinorrhea and otorrhea in patients with CSF leak based on the fracture site

Site of fracture	Rhinorrhea		Otorrhea	
	N	%	N	%
Maxilla and zygoma	3	33.3	6	66.7
Nasal bone	3	75	1	25
Orbit	4	57.2	3	42.8
Mandible	2	100	0	0
Frontal bone	3	75	1	25
>1 site of fracture	4	57.2	3	42.8

Isfahan, Iran due to head and face injuries occurred between 2004 and 2010.

Distribution of all fractures was determined. In addition, the frequency of fractured sites based on gender was determined. Afterwards, distribution of CSF leak based on the site of trauma, gender, and cause of trauma was measured. Symptoms of leak (rhinorrhea and otorrhea) were evaluated. The recovery procedure in patients with CSF leak was considered as well. Meanwhile, the medical files with insufficient information were excluded from the study. Eventually, the data was entered into SPSS software; (version of 11.5, Illinois, USA), and analyzed using descriptive statistical analysis.

Results

According to the results of this study, 17 (1.3 %) of a total of 1,278 traumatic patients had CSF leak. Age of the patients with SCF leak ranged between 6 and 63 years with a mean age of 31.8 years. Table 1 shows the distribution of fractures in all the patients and those with CSF leak based on the site of fracture. 2.1 % of maxillary and zygomatic fractures, 1.06 % of nasal bone, 3.8 % of orbital, 0.4 % of mandibular, and all of frontal bone fractures were accompanied by CSF leak.

Fig. 1 Distribution of patients with facial fracture and those with CSF leak based on gender

Fig. 2 Recovery procedure in patients with CSF leak

Table 2 indicates the distribution of rhinorrhea and otorrhea based on the site of fracture (some of patients had more than one site of fracture). Amongst patients with CSF leak, 10 (58.8 %) cases with rhinorrhea and 7 (41.2 %) cases with otorrhea were observed, of which, one (5.8 %) patient exhibited rhinorrhea and otorrhea simultaneously.

Figure 1 shows the distribution of patients with facial fracture and those with CSF leak based on gender. The male/female ratio was 1,048:230 in patients with facial fractures, and 16:1 in patients with CSF leak. It was not possible to evaluate the mean time of CSF leak due to the absence of verification in the medical files of the maxillofacial ward of the hospital. Unfortunately, only the causative agent of 194 traumatic cases was recorded (84.8 % of the medical files were not completed), of whom,

188 (96.9 %) traumatic cases were caused by traffic accidents and 6 (3.1 %) by falling. Among the 17 cases with CSF leak, 15 (88.2 %) were caused by traffic accidents and 2 (11.8 %) by falling.

Figure 2 shows the recovery procedure in patients with CSF leak.

Discussion

Head and facial fractures following head injury are very common. Vulnerable sites of head and face include the orbit, zygomatic arch, maxilla, and mandible. Compared with similar studies, it is clearly shown that mandible fracture is the most frequent type of injury [21, 22]. However, in another study in Yazd city, the most vulnerable site of fracture was nasal bone (79 %) [23]. Table 1 indicates that as the fracture occurs in sites closer to the CNS, the chance of CSF leak is higher. CSF leak can be expressed as rhinorrhea or otorrhea [1, 2, 5, 6], which is due to the connection between the skull and nasal cavity or eustachian tube [24, 25]. The formation of this fistula can be life threatening and could also make a connection between the nasal cavity and paranasal sinuses with cranium, which can lead to meningitis, encephalitis or an infection inside the skull [2, 26]. According to our study, the incidence of rhinorrhea and otorrhea in patients with CSF leak was 58.8 and 41.2 %, respectively that was in accordance with the study of Conforti et al. [10] who reported rhinorrhea and otorrhea incidences of 68 and 25 %, respectively. However, the number of patients with CSF otorrhea compared to rhinorrhea was reported higher in the study by Bell et al. [18] (72 and 28 %, respectively). The reason for this difference is unclear.

According to Fig. 1, the occurrence of CSF leak in males was 16 times higher than in females. However, Clemenza et al. [8] reported that the incidence of CSF leak was three times higher in males. Hence, the differences confirm that the prevalence of CSF leak varies from one region to another. In addition, in this study the gender difference was similar to other studies in which they have reported a higher incidence of facial fractures in males than in females [7, 22, 27, 28]. This could be due to the fact that males are more involved in outdoor activities thus they are more prone to such accidents. Nevertheless, Bell et al. [18] reported a higher incidence of CSF leak amongst injured females. In this study, the male/female percentage was 4.55 %. This percentage, compared to neighboring cities, was slightly higher than Yazd city (2.22 %), and lower than Tehran city (8.09 %) [23, 28]. Such a comparison shows that maxillofacial injuries might be different even among neighboring cities.

It has been reported that the causative agent of 80 % of CSF leaks is direct trauma, and 16 % of which is caused by

surgical operation [8, 9]. In the present study, all cases with CSF leak were caused by head injury, of which 15 (88.2 %) cases were caused by traffic accidents and 2 (11.8 %) by falls. Of the 17 patients with CSF leak, 8 (47 %) cases recovered spontaneously, 2 (11.8 %) were treated after lumbar drainage, and 7 (41.2 %) were treated by surgical operation (Fig. 2). The spontaneous obstruction of CSF fistula was observed in 68 % of cases within the first 48 h and 85 % within the first week [17].

Quantitative comparison of glucose levels of the draining fluid with that of serum and nasal secretions is a time-honored method but carries with it a high false-positive rate and does not consistently differ between CSF and secretions of allergic rhinitis [29]. β 2-Transferrin has been found to be highly sensitive and specific for recognizing CSF, and is the laboratory test of choice [30, 31].

Patients with CSF leak were managed precisely. Once the diagnosis of CSF leak was confirmed, non-surgical therapy was performed. Non-surgical therapy began with bed rest, head elevation, and strict sinus precautions. In our study, the success rate of spontaneous closure of fistula was 47 %. Although this rate was lower than those reported by Mincy (85 %) [17], but spontaneous recovery was the most successful method same as the report of Mincy's study.

If non-surgical therapy failed to stop CSF leak, the next step was to place a lumbar drain for CSF diversion. Patients with CSF leaks were managed by lumbar drainage for 5–8 days. The success rate of this protocol was 11.8 % in our study. This rate was much lower than other studies reported elsewhere, ranging from 84 to 94 % [32–34]. Our findings had close similarity to Bell's et al. [18] study, who reported the successful treatment of 2 of 5 patients undergoing lumbar drainage. This conflict might be due the fact that the severity of the injuries or the size of the skull base defects varied in different studies. As the injuries or defects become more severe, the protocol tends toward surgical intervention.

If lumbar drainage failed to resolve the leak, surgical correction, including extra or intracranial procedures, would be performed. All the cases in our study underwent intracranial procedure. The decision to carry out the intracranial approach had two reasons: the large size of skull base defects, or the lack of endoscopic instruments in the medical center. However, Wax et al. [25] reported no difference between the success rate of extra and intracranial procedures. Up to present time, there is still little documentation regarding endoscopic management procedure of CSF leaks, and the intracranial approach remains as the golden standard for treatment of formal dural repair. Bell et al. [18] believe that the intracranial approach provides the most predictable repair procedure and should be the first-line of treatment for patients with large skull base fractures. Nachtigal and colleagues [35] treated 12 patients

with CSF rhinorrhea by endoscopic procedure, of which only two patients failed to respond to the treatment as they had outsized bony framework defects.

Compared with similar studies reported elsewhere, the main cause of maxillofacial fractures in the Middle East was motor vehicle accidents, same as our study [7, 23, 27, 28, 36]. Causes might involve various factors, such as high-speed driving, poor road conditions, reduced safety standards of motor vehicles, and inadequate stress on traffic rules and regulations. Thus, these factors should be taken into account for future policies of relevant countries to reduce the rate of traffic accidents.

Conclusions

The findings of our study indicate that head and facial fractures are observed more frequently in males, which leads to further CSF leaks. Most cases with CSF leak were caused by head and face trauma. The majority of these were caused by traffic accidents, and only a few were as a result of falls. CSF leak was observed most frequently in patients with fracture in the zygomatic and maxillary bones, and exhibited as rhinorrhea and/or otorrhea. All cases with CSF leak had skull base fracture as well. However, post-traumatic CSF leaks are uncommon and most cases were treated without surgical interventions (59 %). The distribution of CSF leak varies from one region to another and knowing this fact helps to manage the injury and to prevent the complications.

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