Extended extradural anterior skull base approach for management of post-traumatic cerebrospinal fluid rhinorrhea

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Abstract

Background: Cerebrospinal fluid rhinorrhea is a serious and potentially fatal condition that still presents a major challenge in terms of its diagnosis and management.
It is estimated that meningitis develops in approximately 10%–25% of patients with this disorder, and 10% of them die as a result. Approximately 80% of all cases of CSF rhinorrhea are caused by head injuries that are associated with cranial fractures.

Objective: To evaluate the technique and perioperative management for cerebrospinal fluid (CSF) leak following anterior skull base fracture via extradural anterior skull base approach.

Methods: This study was conducted at the department of Neurosurgery of Benha University hospitals, Egypt from June 2024 to December 2024. Patients with post-traumatic CSF rhinorrhea occurred after extensive anterior skull base fracture managed surgically via extended extradural anterior skull base approach were included in this study. The data of medical and radiological records, surgical approaches, repair techniques, perioperative management, surgical outcome and postoperative follow up were analyzed. Patients were followed up for the outcome of CSF leak and postoperative complications. Data were presented as frequency and percent.

Results: Twenty-five patients were included in this study. The patients' mean age was 41.5 years (range 30-53 years). Seven patients were operated within 2 weeks; while the remaining 18 patients, with prolonged or recurrent CSF rhinorrhea, received the repair surgery at 2 weeks to 3 weeks after the initial trauma. The mean overall length of follow-up was 6 months. All the patients suffered from anterior skull base multiple fractures. The main surgical repair aimed to achieve watertight seal of the dura. The frontal peri-cranial flap alone was used in 14 patients, combined with temporalis muscle and/or its fascia in 8 patients. Free fascia Lata graft was used instead in the rest 3 patients. No CSF leak was found in all the patients at discharge. There was no mortality in this series. Bilateral anosmia was the most common complication. At follow-up, recurrent CSF leak occurred in 3 cases or postoperative infection occurred in 2 cases.

Conclusion: Traumatic CSF rhinorrhea with extensive anterior skull base fractures often

needs aggressive treatment via extended intracranial extradural approach. Vascularized tissue flaps are good grafts for anterior cranial base reconstruction, either alone or in combination with temporalis muscle and its fascia, also fascia Lata sometimes can be used as free autologous graft. The approach is usually reserved for patients with post-traumatic CSF rhinorrhea in anterior skull base injuries.

Keywords: Rhinorrhea, anterior skull base, post-traumatic, CSF leak, extradural.

Background

Cerebrospinal fluid rhinorrhea is a serious and potentially fatal condition that still presents a major challenge in terms of its diagnosis and management. [1-2]

It is estimated that meningitis develops in approximately 10%–25% of patients with this disorder, and 10% of them die as a result. Approximately 80% of all cases of CSF rhinorrhea are caused by head injuries that are associated with cranial fractures. [3-4]

The estimated incidence of basilar skull fracture from no penetrating head trauma varies between 7% and 15.8% of all skull fractures, with associated CSF leakage occurring in 10%–30% of these patients. [5-6]

Because of the firm adherence of the dura to the skull base, dura tears and subsequent cerebrospinal fluid (CSF) leak are common. The leak can occur wherever the dura mater is lacerated during injury and there is a communication between the intracranial and nasal cavities. [7-8]

Despite many advances, it is still difficult to critically interpret the literature with regard to the optimal management of CSF leakage following craniomaxillofacial trauma. [9-10]

In addition, no authors have consistently analyzed the success of nonsurgical treatment modalities, such as bed rest and CSF diversion, and still little is known about the incidence and natural history of this disease entity, the need for antibiotics, and the surgical indications for and timing of intervention.[11]

Furthermore, the issues related to CSF leak caused by traumatic injury are complex and multiple. Having conducted a thorough review of existing literature, we discuss here the diagnosis and management of CSF rhinorrhea relevant to traumatic anterior skull base injuries and attempt to identify areas in which further research is needed. [12-13]

Objective

The aim of this study is to evaluate the technique and perioperative management for cerebrospinal fluid (CSF) leak following anterior skull base fracture via extradural anterior skull base approach.

Methods

This study was conducted at the department of Neurosurgery of Benha University hospitals, Egypt from June 2024 to December 2024. Patients with post-traumatic CSF rhinorrhea occurred after extensive anterior skull base fracture managed surgically via extended extradural anterior skull base approach were included in this study. The data of medical and radiological records, surgical approaches, repair techniques, perioperative management, surgical outcome and postoperative follow up were analyzed. Patients were followed up for the outcome of CSF leak and postoperative complications. Data were presented as frequency and percent.

Inclusion criteria:

1- Patients with extensive anterior skull base fracture.

2- Patients with CSF rhinorrhea.

Exclusion criteria:

- Patients with spontaneous CSF rhinorrhea.

Pre-operative assessment:

All patients underwent complete general and neurological examination. Presenting symptoms, Glasgow Coma Scale (GCS), Sex as regards male

to female ratio, Age, blood pressure, and blood glucose level were observed. Presenting symptoms like headache, bleeding per nose or disturbed conscious level were assessed.

Also occurrence of meningitis was assessed in early days after trauma and also in the following 4 weeks after trauma.

Nasal leak was examined by a simple test to determine the presence of CSF

by visualization of a ring or halo sign on a piece of gauze.

Clinical and radiological records of the included patients, generally clinical status and findings on admission, initial imaging data including assembled fracture location, fracture characteristics and associated intracranial lesions, surgical techniques, and treatment outcomes were reviewed.

Neuro-radiological assessment:

All the included patients underwent high-resolution and thin slice (1 mm) CT scan upon admission. Post processing with coronal and sagittal reconstructions was utilized to identify the skull base fracture defects.

MRI was performed in patients who were tolerable for the procedure. Besides enhancement MR image to rule out possibility of cerebral abscess, heavily T2-weighted images and a fast spin-echo sequence with fat saturation were utilized to localize the fistula. The “reservoir sign,” which was the ability of a patient to leak CSF by flexing the head, was taken to add the opportunity for detecting an occult fistula.

Indications for extradural anterior skull base approach:

Extradural anterior skull base approach is commonly reserved for CSF rhinorrhea resulting from complex frontobasal injuries or refractory

rhinorrhea. The existence of multiple comminuting bony fractures or defects at the anterior skull base, uncertain fistular localization, evidence of multiple fistulae, concomitant cerebrocranial injuries, and failure of previous surgical attempt are major concerns incorporating into the considerations of extradural approach.

Surgical approach

All patients were operated by anterior skull base approach using bifrontal coronal incision from the zygomatic level to the contralateral counterpart that allows harvest of sufficient pericranium. Following an extended bifrontal coronal incision and subgaleal dissection, the pericranial flap can be designed and a standard pedicled pericranial flap may be prepared. If the patients had a history of prior operation or the traumatic injury damaged the pericranium in this area, in which the pericranial flap was unavailable or insufficient, a vascular-pedicled flap, usually from the temporalis muscle with or without the overlying fascia was mostly prepared for the repair. If there was no sufficient pedicled graft, a free autologous fascia lata graft could be harvested from the lateral side of the thigh.

After the tissue flaps had been dissected, a bifrontal craniotomy was performed. The inferior border of bone window should be made as close as possible to the rim of the orbital to improve the working angles. With the assistance of the operative microscope, the dura of the anterior cranial base was dissected free from the underlying bone. Via a bilateral extradural subfrontal approach, the entire anterior cranial base was inspected to visualize possible dura tears and do necessary repair, either directly by suturing whenever possible or indirectly by packing the pericranium or other graft with the aid of fibrin glue.

A pedicled flap of pericranial tissue is spread to cover the entire anterior cranial base and then folded over to cover the repaired subfrontal dura. Then fibrin glue was used to reinforce the graft in place. The anterior skull base and dura were reconstituted extradurally. We usually open the dura when there is concurrent intradural lesion needing evacuation or release of the CSF to relax brain tissue and

facilitate retraction, or to test watertight suture of the repaired dura.

Postoperative management

Postoperatively the patients were admitted to the intensive care unit for monitoring. The patients were kept in a supine position for about 7 days. Care was taken not to disrupt the graft by avoiding strenuous activity or straining or nose blowing for approximately 6 weeks following the surgery. As dissection occurs through a contaminated operative field, we chose to use postoperative prophylactic intravenous antibiotics. For patients with preoperative definite meningitis, the duration of postoperative antibiotics administration was prolonged. Postoperative lumbar CSF draining catheter was not routinely used. CSF drainage was utilized for those with definite intracranial infection or those intraoperative watertight dura seal not reliably achieved. CSF was sampled repeatedly for laboratory test either from lumbar draining or serial lumbar puncture to monitor the presence of postoperative meningitis.

Follow-up

The patients were followed up through outpatient clinic with patients themselves or their families. The data of the follow-up included nasal discharge, manifestation of meningitis, healing of wound or incision and condition of anosmia. Follow up was for 6 months.

Illustrative case

A 53-years-old man had head trauma after falling from a height in home.

His forehead hit the ground. Multiple lacerations were observed on the forehead, and the frontal skull bone was exposed and depressed. Continuous CSF rhinorrhea was observed.

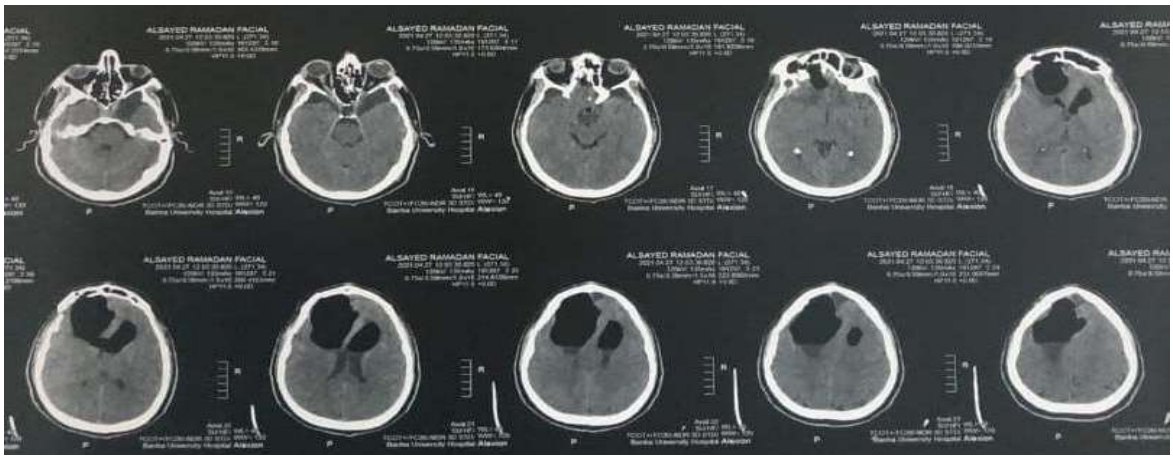
Urgent CT brain was done showing fracture of the frontal sinus and anterior base of the skull with pneumocephaly. Figure (1)

No other injury was observed in the body. The patient was alert and the pupils were regular and reactive. An urgent surgery was planned to reduce the infection from the open wound and reduce the depressed fractures. He was transferred to the operating room and was put under general anesthesia. After saline irrigation and aseptic scalp washing, the frontal bone was exposed using an extended incision of the forehead lacerations. A frontal craniotomy was performed along the margin of the fracture, and the dura was exposed. A dural defect was detected in the bone of the right frontal base.

The dural defect was primarily repaired using the graft of the frontal pericranium. Figure (2)

The bony fragments removed from the anterior cranial fossa were repositioned using stitching-up. The craniotomy and comminuted frontal bones were fixed. The scalp was carefully closed considering the cosmetic aspect. No infection or CSF leakage was observed following surgery.

Post-operative CT brain was done to assess for postoperative bleeding and the pneumocephaly. Figure (3)



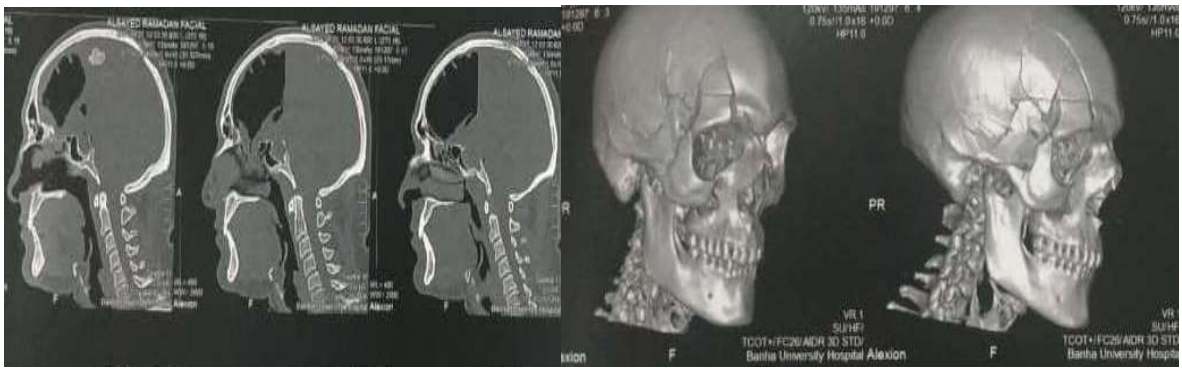


Fig (1): Preoperative CT brain soft window axial view, bone window sagittal view and 3D reconstruction. (**Benha university hospital, neurosurgery department**)

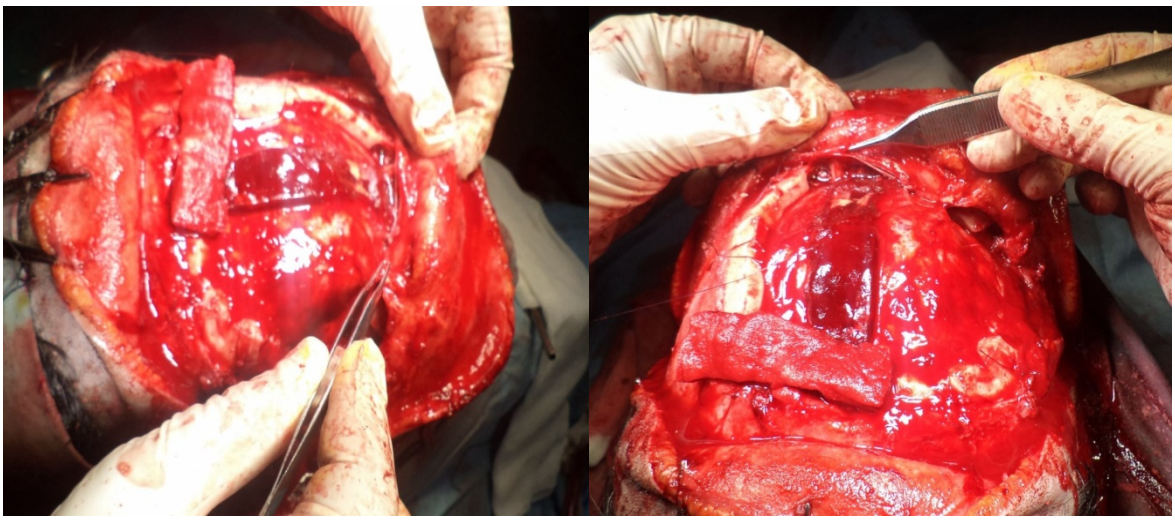
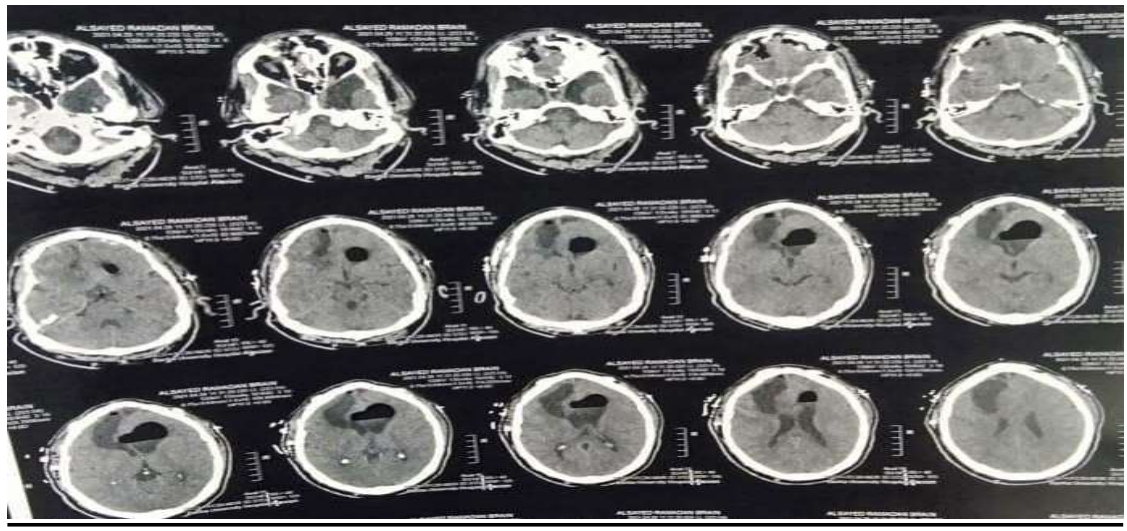


Fig (2): Intraoperative images for repairing of the skull base dura by pericranium. (**Benha university hospital, neurosurgery department**)



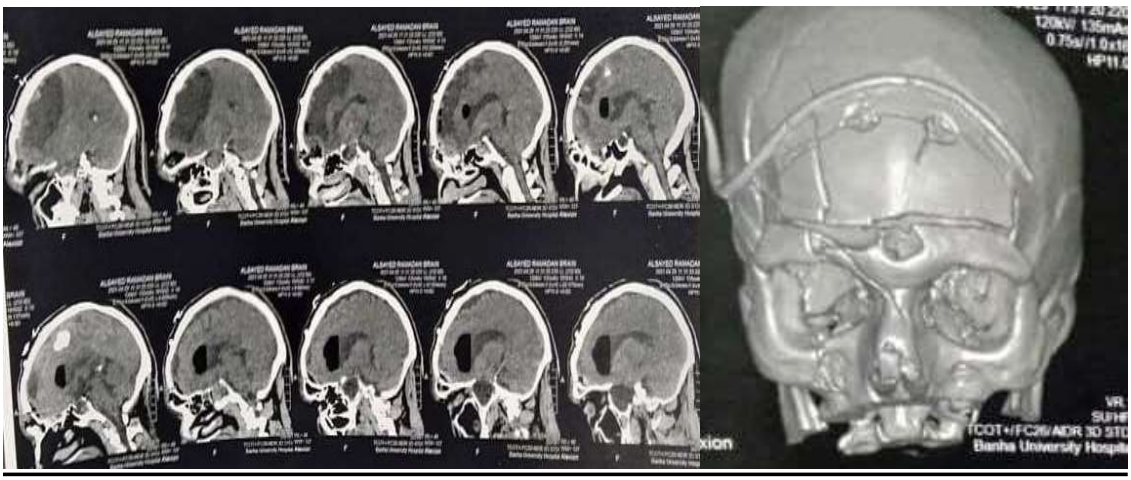


Fig (3): Postoperative CT brain soft window axial view, soft window sagittal view and 3D reconstruction. (**Benha university hospital, neurosurgery department**)

Results:

Our study was conducted prospectively in the Benha University Hospitals on 25 cases suffering from post-traumatic CSF rhinorrhea occurred after extensive anterior skull base fracture whom were

operated in Neurosurgery department.

Age:

The age of the patients ranged between (30 and 53years) with a mean of 41.5 years.

Sex:

In our study there was male predominance as there were 18 males and 7 females. Table (1)

No statistically significant difference was detected between the sex of patients and the outcome.

Sex	Number Of Patients
Male	18(72%)
Female	7(28%)

Table (1) Sex of patients

Mode of trauma:

According to the mode of trauma we had 14 patients presented after road traffic accident, 6 patients after falling from a height and 5 patients after motorcycle accident. Table (2)

Mode of trauma	Number of patients
Road traffic accident	14(56%)
Falling from a height	6(24%)
Motorcycle accident	5(20%)

Table (2): Mode of trauma and number of patients.

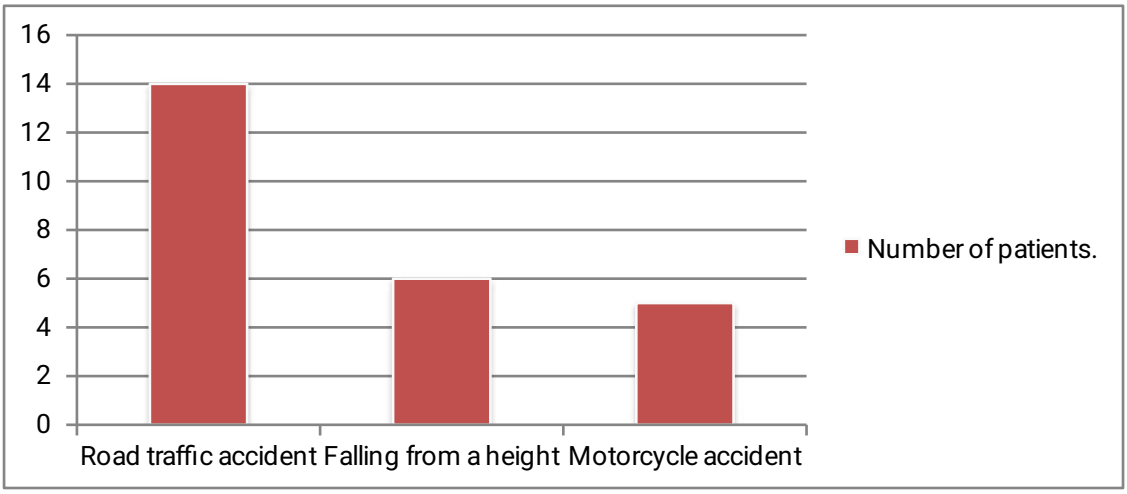


Diagram (1): Mode of trauma and number of patients.

Presenting symptoms:

At the time of presentation in the emergency room we had 12 patients complaining of headache only after trauma, also 7 patients complained of bleeding per nose and the remaining 6 patients had disturbed conscious level.

Presenting symptoms	Number of patients
Headache	12(48%)
Bleeding per nose	7(28%)
Disturbed conscious level	6(24%)

Table (3): Presenting symptoms.

In our study we had 6 cases with history of meningitis for one attack and 8 cases with recurrent attacks while the remaining 11 case had no history of meningitis.

Onset of CSF rhinorrhea after trauma:

In our study all patients included had CSF rhinorrhea but the onset of rhinorrhea was different; 6 patients had CSF leak in the 1st day after trauma, 9 patients had CSF leak at the 3rd day and 10 cases had CSF leak at the 7th day.

Onset of CSF rhinorrhea	Number of patients
1st day	6(24%)
3rd day	9(36%)
7th day	10(40%)

Table (4) Onset of CSF rhinorrhea after trauma.

Preoperative CT brain findings:

In the preoperative CT brain we had 18 cases with frontal sinus fracture and 20 cases with intracranial pathology like brain contusions or intracranial hemorrhage.

Preoperative CT brain	Number of patients
Frontal sinus fracture	18(72%)
Intracranial pathology	20(80%)

Table (5) Pre-operative CT brain findings

In our study all cases with frontal sinus fracture had intracranial pathology like brain contusion, subdural hemorrhage or epidural hematoma.

Time of operation after trauma:

In our study we followed up for conservative treatment at first by medical treatment and good positioning for the patients for at least one week.

We had 7 patients operated in the 2nd week after trauma, 11 cases

operated after 2 weeks and 7 cases after 3 weeks from the time of trauma.

Time of operation after trauma	Number of patients
In the 2nd week after trauma	7(28%)
After 2 weeks	11(44%)
After 3 weeks	7(28%)

Table (6) Time of operation after trauma.

Graft used in surgery:

In all cases we used an allograft to repair the site of leak in the anterior cranial fossa.

We used pericranium in 14 cases, Temporalis fascia in 4 cases, Temporalis muscle in 4 cases and Fascia Lata in 3 cases.

Graft used in surgery	Number of patients
Pericranium	14(56%)
Temporalis fascia	4(16%)
Temporalis muscle	4(16%)
Fascia Lata	3(12%)

Table (7) Graft used in surgery

Postoperative complications:

In the follow up after surgery we had some postoperative complications.

The most common complication was anosmia that occurred in 16 patients that improved in follow-up in only 9 cases.

Postoperative CSF leak happened in 3 cases that managed by insertion

of lumbar drain in one case and redoing the surgery in 2 cases. Postoperative wound infection occurred in 2 cases and treated by medical treatment by antibiotics.

Postoperative complications	Number of patients
anosmia	16(64%)
CSF leak	3(12%)
wound infection	2(8%)

Table (8) Postoperative complications

Discussion

In our study the age of the patients ranged between (30 and 53years) with a mean of 41.5 years. Also there was male predominance as there were 18 males and 7 females. No statistically significant difference was detected between the sex of patients and the outcome.

According to the mode of trauma we had 14 patients presented after road traffic accident (56%), 6 patients after falling from a height (24%) and 5 patients after motorcycle accident (20%).

In our study we had 12 patients complaining of headache only after trauma (48%), also 7 patients complained of bleeding per nose (28%) and the remaining 6 patients had disturbed conscious level (24%).

The initial evaluation of a patient presenting with CSF rhinorrhea starts with a good history and physical examination. The most common presenting symptom is that of clear, watery discharge from nose after a head trauma. There may be an increase in postnasal drip in the supine position. There is a high risk of developing meningitis.

In our study we had 6 cases with history of meningitis for one attack (24%) and 8 cases with recurrent attacks (32%) while the remaining 11 case had no history of meningitis (44%).

Schick et al. reported 61.9% patients had presented with meningitis, 7 (33.3%) with a single episode and 6 (28.6%) with recurrent episode, which is comparable to our study.[14]

In most cases, the physical examination is unremarkable except for CSF

rhinorrhea that occurs on forward bending or straining due to an

increase in intracranial tension. Simple test to determine the presence of CSF
is the visualization of a ring or halo sign. This test is not specific.

Dula et al. found that the ring sign occurred when blood was mixed with water, saline and other mucus.[15]

In our study all patients included had CSF rhinorrhea but the onset of rhinorrhea was different; 6 patients had CSF leak in the 1st day after trauma (24%), 9 patients had CSF leak at the 3rd day (36%) and 10 cases had CSF leak at the 7th day (40%).

Brijesh Kumar et al. an early onset rhinorrhea was present in 3 cases (7.3%), early onset rhinorrhea which improved on conservative management and again recurred and persisted was found in 12 cases (29.3%) and delayed onset rhinorrhea was present in 26 cases (63.9%).[16]

All cases of CSF rhinorrhea should be investigated by high resolution CT scan to detect bony defect. It can also detect pneumocephalus, soft tissue masses and hydrocephalus.

In the preoperative CT brain we had 18 cases with frontal sinus fracture (72%) and 20 cases with intracranial pathology like brain contusions or intracranial hemorrhage (80%). In our study all cases with frontal sinus fracture had intracranial pathology like brain contusion, subdural hemorrhage or epidural hematoma.

MR exam was performed in patients who were tolerable for the procedure. Besides enhancement MR image to rule out possibility of cerebral abscess, heavily T2-weighted images and a fast spin-echo sequence with fat saturation were utilized to localize the fistula and the presence of meningoencephalocele.

Wakhloo et al. were able to visualize three traumatic CSF fistulas and one meningoencephalocele in six patients of CSF rhinorrhea examined by MRI with T2 weighting. MRI is not as good as CT when it comes to detecting bony defects and is much more expensive. Precise location of the leak is prerequisite for surgical repair, without which the patients will continue to be at risk of potentially fatal meningitis. (17)

The treatment of CSF rhinorrhea can be divided into conservative management and surgical management. The majority of posttraumatic CSF leak responds well to conservative management. Persistence of a CSF leak increases the risk of meningitis about 10-fold.

Conservative management includes complete bed rest. The patient is placed on bed rest for 7 – 10 days with head of bed 15 to 30 degrees elevated with no straining, coughing or heavy lifting.

It is reported that with this type of management, 90 to 95% of all traumatic CSF leaks resolve spontaneously. In our study we follow up for conservative treatment at first by medical treatment and good positioning for the patients for at least one week.

We had 7 patients operated in the 2nd week after trauma (28%), 11 cases operated after 2 weeks (44%) and 7 cases after 3 weeks from the time of trauma (28%).

In our study we used the intracranial approach for direct visualization of a leak from above and allowing treatment of coexisting intracranial pathology.

In all cases we used an allograft to repair the site of leak in the anterior cranial fossa. We used pericranium in 14 cases (56%),

Temporalis fascia in 4 cases (16%), Temporalis muscle in 4 cases (16%) and Fascia Lata in 3 cases (12%).

In the follow up after surgery we had some postoperative complications. The most common complication was anosmia that occurred in 16 patients (64%) that improved in follow-up in only 9 cases.

Postoperative CSF leak happened in 3 cases (12%) that managed by insertion of lumbar drain in one case and redoing the surgery in 2 cases.

Brijesh Kumar et al. Postoperative CSF leak happened in 10 cases (24.4%) that managed by insertion of lumbar drain in 2 cases and redoing the surgery in 8 cases. [16]

Postoperative wound infection occurred in 2 cases (8%) and treated by medical treatment by antibiotics.

Conclusion

Posttraumatic CSF rhinorrhea requires special attention. Initial treatment is conservative, but persisting leak after 7 to 10 days requires surgical repair to avoid complication like meningitis. Localization of leak site can be done with preoperative imaging like CT or MR which is very important for successful surgical repair.

Traumatic CSF rhinorrhea with extensive anterior skull base fractures often needs aggressive treatment via extended intracranial extradural approach. Vascularized tissue flaps are good grafts for anterior cranial base reconstruction, either alone or in combination with temporalis muscle and its fascia, also fascia Lata sometimes can be used as free autologous graft. The approach is usually reserved for patients with post-traumatic CSF

rhinorrhea in anterior skull base injuries.

Ethics approval and consent to participate:
This study was approved by the Ethical Committee of Scientific Research, Faculty of Medicine, Benha University under the number (RC 14-5-2024).
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Conflicts of interest: There are no conflicts of interest.

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الملخص العربي

الخلفية: يعد سيلان السائل النخاعي من الأنف حالة خطيرة وربما مميتة ولا تزال تمثل تحديًا كبيرًا من حيث تشخيصها وإدارتها .

يتراوح معدل حدوث كسور الجمجمة القاعدية نتيجة عدم وجود صدمات نافذة في الرأس بين 7% و15.8% من جميع كسور الجمجمة، ويحدث تسرب السائل النخاعي الشوكي المصاحب في 10%-30% من هؤلاء المرضى. بسبب التصاق الأم الجافية بقوة بقاعدة الجمجمة، تكون تمزقات الجافية وتسرب السائل النخاعي اللاحق أمرًا شائعًا.

الهدف من الدراسة: لتقييم التقنية والإدارة المحيطة بالجراحة لتسريب السائل النخاعي (CSF) بعد كسر قاعدة الجمجمة الأمامية عبر نهج قاعدة الجمجمة الأمامية خارج الأم الجافية.

المرضي والطرق: تم إجراء هذه الدراسة في قسم جراحة المخ والأعصاب بمستشفيات جامعة بنها، مصر في الفترة من يونيو 2024 إلى ديسمبر 2024. وتم تضمين المرضى الذين يعانون من سيلان السائل النخاعي من ا لأنف بعد الصدمة بعد حدوث كسور واسعة النطاق في قاعدة الجمجمة الأ مامية جراحيًا عبر نهج ممتد لقاعدة الجمجمة الأمامية خارج الجافية

النتائج: كان إصابات الراس اكثر شيوعا في الرجال بنسبه (72%),وكان

إصابات حوادث الطرق الأكثر شيوعا بنسبه(56%), وكان عرض الصداع أكثرالاعراض تواجدا بالمرضي ,وتم تجربه العلاج التحفظي مع المرضي وتم الاجراء الجراحي للمرضي خلال 3 اسابيع في اكثر الحالات.

الخلاصه :غالبًا ما يحتاج سيلان الأنف من السائل الدماغي الشوكي مع كسور واسعة النطاق في قاعدة الجمجمة الأمامية إلى علاج قوي من خلال النهج خارج الجافية الممتد داخل الجمجمة. تعتبر اللوحات النسيجية الوعائية بمثابة ترقيع جيد لإعادة بناء قاعدة الجمجمة الأمامية.

يقتصر هذا النهج عادةً على المرضى الذين يعانون من سيلان الأنف في السائل الدماغي الشوكي بعد الصدمة في إصابات قاعدة الجمجمة الأمامية.