

Frontal Sinus Obliteration During Surgical Management of its Fractures. A Comparative Pilot Study of Possible Used Autogenous Grafts

MOHAMED F.M. ALSAWY, M.D. and MOHAMED ELMALLAWANY, M.D.

The Department of of Neurosurgery, Faculty of Medicine, Cairo University

Abstract

Background: Frontal sinus fractures can result as sequelae of head trauma with mismanagement can lead to structural complication and serious infections sometimes with nasofrontal outflow tract obstructions, if the surgical management was decided, then it should apply control of associated CSF leakage with prevention of late frontal sinus complications, it should also provide a good correction of aesthetic deformity.

Aim of Study: The aim of this study is to address the efficacy of 3 common autogenous grafts (pericranium, muscle and fat grafts), used in obliteration of frontal sinus in cases of frontal sinus fracture with CSF rhinorrhea, and assess their success rate in sealing the nasofrontal duct and cessation of CSF leak.

Patients and Methods: This study was done prospectively in the Cairo University Hospitals, on patients suffering from traumatic frontal sinus fracture with CSF rhinorrhea treated surgically including 30 patients treated between July 2017 and December 2018, Patients were randomized into 3 groups each containing 10 patients according to the autogenous material used in the closure of the sinus outflow whether muscle, pericranium or fat.

Results: In our series, we had 25 males, 5 females with male to female ratio 5:1.

Age ranged between 19 and 45, with mean age 32 years. Mechanisms of injury was variable, Motor vehicle accident in 8 patients (27%), Motor cycle accidents 11 (37%), Fall from height 6 patients (20%), Blunt facial injuries (e.g assault) 5 (16%). Associated injuries in the form of frontal contusion in 14 cases (47%), extradural hematomas in 11 cases (37%).

Nasofrontal duct fractures or obliteration was detected in (50%) of cases in the preoperative CT.

None of the operated cases developed mucocele formation or delayed abscess formation, frontal bone osteomyelitis, hematomas, gross contour deformities, or fatalities.

With fat graft, only one case (10%) had transient leakage for one day stopped spontaneously, while 4 (40%) out of 10 cases packed with temporalis muscle developed CSF leak that was managed conservatively, then one of them required redo

surgery after late CSF recurrent leak, two cases (20%) out of 10 packed with pericranial graft developed early postoperative CSF leak stopped by conservative treatment.

Conclusion: Despite the wide variation in the plugging materials usage which is mostly attributed to the surgeon preference, we found a relative advantage and superiority of fat graft as a plugging material over both muscular and pericranial grafts. Careful handling during fat graft harvest can guard against wound complications eventhough it has a separate abdominal wound.

Early surgical intervention is highly recommended as it eliminates any potential sources of infection and was associated with good outcome and minimizing infection rate to the least.

Key Words: CSF (cerebrospinal fluid) – Nasofrontal duct – Rhinorrhea.

Introduction

FRONTAL sinus fractures can result as sequelae of head trauma with various mechanisms. Mismanagement of these types of fractures can lead to structural complication and serious infections sometimes with nasofrontal outflow tract obstructions [1].

Many treatment algorithms correlating the variable combinations of injuries in frontal sinus injury management have been proposed. However, if the surgical management was decided, then it should apply control of associated CSF leakage with prevention of late frontal sinus complications, it should also provide a good correction of aesthetic deformity if present, and each case should be managed on an individual basis according to the associated injuries [2].

A debate do exist about the best management of the nasofrontal involvement whether reconstruction or obliteration, and even if the obliteration option was decided, various materials can be used to seal the duct including autogenous grafts as

Correspondence to: Dr. Mohamed F.M. Alsawy,
The Department of of Neurosurgery, Faculty of Medicine,
Cairo University

bone, fat, muscles, and also synthetic materials like methyl methacrylate calcium phosphate bone cement and hydroxyapatite bone cement [3,4].

In this pilot study, we present our experience with the use of 3 autogenous grafts which are pericranium, muscle and fat grafts. We assessed their success rate in accomplishing adequate sealing of the nasofrontal duct together with the drawbacks of each graft type.

Patients and Methods

Thirty patients were included in this study who were operated upon in our institute between July 2017 and December 2018. All patients had traumatic frontal sinus fractures with CSF rhinorrhea that were treated surgically. Patients who performed frontal sinus repair secondary to non traumatic etiology & those who was managed conservatively were excluded from our study. All the patients had been evaluated clinically upon arrival to the emergency room. After stabilization of the general condition. A CT brain with bone window was done to all patients together with the rest of investigations that might be needed in the trauma survey. If the patient had frontal sinus fractures with CSF rhinorrhea then the patient was operated upon. Patients were randomized into 3 groups each containing 10 patients according to the autogenous material used in the closure of the sinus outflow whether muscle, pericranium or fat.

Surgical technique:

Under general anesthesia the patient is situated in a supine position with the head is in the neutral position with no tilting and head is elevated to 30 degrees. Bicoronal skin incision is then performed. A generous pericranial flap is harvested followed by bifrontal craniotomy. Elevation of bone flap is then done with exposure of the frontal sinus. Any fracture bony parts or foreign bodies are removed, and the dura is inspected to detect and fix any tears. The frontal sinus mucosa is removed and cauterized to avoid mucocele formation then obliteration of the sinus outflow is done using either muscle harvested from temporalis muscle or pericranial graft or a fat graft harvested from a 1-cm skin incision below the umbilicus. The previously harvested pericranial flap is then placed to cover the frontal sinus to add another barrier for CSF leak. Replacing bone flap is then carried out with closure of all layers over subgaleal drain. The drain is then removed after 2 days and the patient is then observed for 3 more days to detect any CSF rhinorrhea.

Postoperative instructions were given to patients to avoid valsalva maneuver as nose blowing, straining, closed mouth sneezing, heavy lifting, vigorous coughing. Medications of the patients included stool softeners and antibiotics with good CSF penetration.

If no CSF leak then the patient was discharged and was asked to follow-up after one week then after one month after discharge.

Results

In our series, we had 25 males, 5 females with male to female ratio 5:1.

Age ranged between 19 and 45, with mean age 32 years.

Mechanisms of injury was variable, Motor vehicle accident in 8 patients (27%), Motor cycle accidents 11 (37%), Fall from height 6 patients (20%), Blunt facial injuries (e.g assault) 5 (16%).

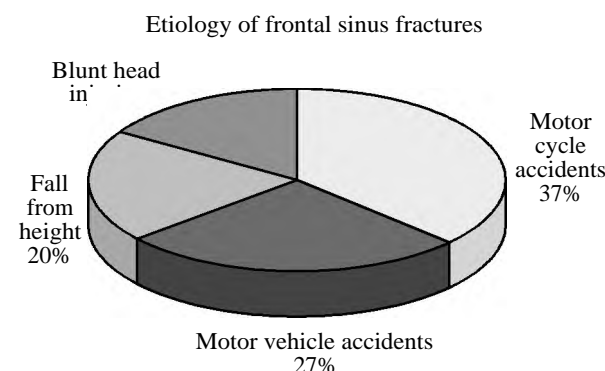


Fig. (1): Etiology of frontal sinus fracture.

All the patient had CT images confirming anterior and posterior table fracture, associated injuries in the form of frontal contusion in 14 cases (47%), extradural hematomas in 11 cases (37%).

Mean time between trauma to operative intervention was 13.8 hours, average operative timing was 76mins. average hospital stay was 6.7 days.

Nasofrontal duct fractures or obliteration was detected in (50%) of cases in the preoperative CT.

The materials was used for obliteration of the frontal air sinus was temporalis muscle, pericranial graft and fat graft.

None of the operated cases developed mucocele formation or delayed abscess formation, frontal bone osteomyelitis, hematomas, gross contour deformities, or fatalities.

Regarding the cases packed with fat graft in the postoperative follow-up, only one case had transient leakage for one day stopped spontaneously, while 4 out of 10 cases packed with temporalis muscle developed CSF leak that was managed conservatively, then one of them required redo surgery after late CSF recurrent leak, two cases out of 10 packed with pericranial graft developed early postoperative CSF leak stopped by conservative treatment.

Discussion

Frontal sinus fractures are challenging in management. Blunt facial trauma remains the commonest mechanism of injury, especially in motor cycle accident with lack of using of protective helmets, with involvement of multiple specialties as the plastic surgeon, maxillofacial surgery, ENT surgeon, ophthalmologist due to the complex trauma to the exposed face and surroundings, it is reported that half of the patient with injuries of frontal air sinus had associated mid-face fracture thus involvement of multi-specialties is of crucial importance for adequate and complete surgical interference [5].

In our study, 60% of cases had an associated injury either extradural, frontal contusion owing to the mechanism of injury and acceleration forces impacting the anterior skull region.

Precise physical examination is a cornerstone of the patient assessment, frontal sinus problem can be anticipated if a bony step could be detected in the glabella or in the supraorbital ridge. Also, frontal ecchymosis, laceration of the forehead or subcutaneous emphysema could be predictive signs of having frontal sinus injury. In addition, careful inspection should be carried out searching for active CSF leak through the nostril or the lacerated wound itself.

The time to operate upon frontal sinus fractures is dependent on many factors as the transfer from scene of injury, patient stabilization and associated injuries.

Although there is no definite recommendations for timing of the repair of the frontal sinus injuries, yet Bellamy et al., reported that the delayed operative intervention was associated with 4.03 fold increase in the risk of infection [6]. In our study the average operative timing to surgery was 13.8 hours, we did not encounter any case of meningitis or delayed abscess formation. Early surgical intervention helps to eliminate and cleans local infection of soft tissues which represents potential sources

of developing CNS infection and can increase the infection rate by 5 folds [6]. Lack of use of prophylactic antibiotics with good CNS penetration can account for more infection rate [7]. Early intervention together with the routine CNS penetrating antibiotic coverage perioperatively may account for our good results of having no infection in our cases.

The frontal sinus anatomical variations represent a key point of decision making especially those with hyperpneumatization, which predispose to CSF leak. Also, the status of nasofrontal duct is of utmost importance to implement the management plan [8]. Being in posteromedian position, the nasofrontal duct is susceptible to be fractured in frontal sinus injury jeopardizing the sinus drainage, which is the case in one third of cases in one study [9] and half of our patients. Thus careful revision of the preoperative CT is of crucial significance especially that CT scan nowadays provides a 3 dimensional detailed study which help the clinicians to determine the need and the extent of the operative intervention [5].

one decision had to be made while operating on frontal sinus injury whether to preserve a functional sinus or to separate it from cranial cavity. some authors advocate the preservation in cases of displaced anterior wall, no nasofrontal duct obstruction and minimal or no disruption of posterior wall however others advocates complete removal of sinus membrane at the condition of its violation [10]. Others opted for duct reconstruction [11], however this technique was proven to have a high failure rate [12]. Some authors presented their experience in the use of frontal sinusotomy via endoscopic approach [13] but this technique should be applied in only selected cases without gross ductal fracture [2].

On the other hand, if the frontal sinus drainage becomes impaired, mucus will be retained followed by a mucocele formation and erosion of the bony walls of frontal bones, skull base and orbits, with subsequent sinusitis osteomyelitis, meningitis or abscess. Patients with frontal sinus fracture had a lifelong risks of brain abscess, mucocele, or mucopyelocele reported to occur over 20 to 25 years after the injury. Therefore, it is recommended to have sinus mucosa removal, packing and obliteration with a debate in the materials and methods in the implication of this goals [1,14].

Various materials could be used for the obliteration of the frontal sinus whether autogenous grafts (such as bone, fat, pericranium and muscles) or

autologous materials (such as methymethacrylate, calcium phosphate bone cement, hydroxyapatite bone cement) [3,4]. The autologous grafts have been used to avoid donor site complications, however some studies reported complete dissolution of these materials with subsequent mucocoeles formation during follow-up periods [4]. Also, we believe that it is a little bit challenging to put an autologous graft in a potentially contaminated wounds like those associated with frontal sinus injuries [15].

In our experience we did not encounter any donor site problems especially in the abdominal wounds used for harvesting fat grafts. We believe that careful dissection and hemostasis together with small abdominal wounds can be the clue to avoid such annoying drawback.

We assume that the difference in the results regarding the CSF leak originates from the fact that there is less resorption to the fat than the muscle, and the fat consistency permits its spread on larger area which lead to better sealing of the defect, while muscle resorption allows the possibility of delayed CSF leak.

In case of pericranial packing, the early leak may be attributed to the late adherence of the pericranial graft which we realize can be augmented by tissue or fibrin glue to overcome this disadvantage. Such enforcement can make the peicranium cope with the adherence rate of fat and muscle packing.

This was also agreed by Ravindra et al., in their institutional and literature review of traumatic frontal sinus fracture, they reported that the fat had less resorption than muscle and they found that simple plugging of nasofrontal duct is sufficient [5].

A strong additional barrier can be built between nasofrontal duct and the intracranial cavity. This efficient layer can be formed of vascularized pericranial flap that was well described by Donath et al., who concluded that the it is easy to harvest the pericranial flap which can be applied over the sinus. We found that this technique is simple to be performed and adds a lot to the corrective intervention [16].

Limitations:

There is a lack of long term follow-up of the patients for the development of the mucocoele formation.

Despite this issue we believe that our study provides a meaningful guide for the different methods of frontal sinus repair and packing based on our clinical experience and the outcome post-operatively.

Conclusion:

Frontal sinus fractures are challenging cases and management should be tailored for each case. We believe that experienced neuro radiologist and neurosurgeon assessment of the CT imaging is the corner stone for accurate judgement, and clinical decision making. In this pilot study we advocate for frontonasal duct plugging especially if it was impaired by fracture. Despite the wide variation in the plugging materials usage which is mostly attributed to the surgeon preference, we found a relative advantage and superiority of fat graft as a plugging material over both muscular and pericranial grafts. We do think that careful handling during fat graft harvest can guard against wound complications eventhough it has a separate abdominal wound. Early surgical intervention is highly recommended as it eliminates any potential sources of infection and was associated with good outcome and minimizing infection rate to the least. Further studies with more numbers of randomized patients and over extended periods of follow-up may be required to establish an agreement on safe and efficient plugging material used in frontal sinus fracture.

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إغلاق الجيوب الأنفية الأمامية أثناء التدخل الجراحي لعلاج كسور الجيوب الأنفية الأمامية دراسة تجريبية لمقارنة الرقع الذاتية التي يمكن استخدامها

كسور عظام الجيوب الأنفية الأمامية تنتج عن إصابات الرأس ويمكن أن تؤدي إلى مضاعفات وإلتهابات خطيرة في بعض الأحيان مع انسداد مجرى التدفق الأنفي الأمامي إذا لم يتم علاجها بصورة صحيحة. لذا، أثناء التدخل الجراحي، يجب أن يتم السيطرة على تسرب السائل النخاعي المصاحب مع الوقاية من المضاعفات في الجيوب الأنفية الأمامية، يجب أن يوفر أيضاً تصحيحاً جيداً للتشوه الشكلي للوجه.

الهدف من هذه الدراسة: هو تقييم فاعلية الترقيع الذاتي بالرقع المختلفة (غشاء القحف، الترقيع العضلي، وبالدهون)، والتي تُستخدم في سد الجيوب الأنفية الأمامية في حالات كسر الجيوب الأنفية الأمامية مع سيلان الأنف للسائل الدماغي، وتقييم معدل نجاحها في غلق الجيوب الأنفية. والقناة الأنفية الأمامية ووقف تسرب السائل الدماغي النخاعي.

أجريت هذه الدراسة بأثر رجعي في مستشفيات جامعة القاهرة، على المرضى الذين يعانون من كسور الجيوب الأنفية الرضحية المصابة بسيلان الأنف CSF الذين تم علاجهم جراحياً بما في ذلك ٣٠ مريضاً تم علاجهم بين يوليو ٢٠١٧ وديسمبر ٢٠١٨، تم تقسيم المرضى عشوائياً إلى ٣ مجموعات تحتوي كل مجموعة على ١٠ مرضى حسب مادة الترقيع المستخدمة في إغلاق الجيوب الأنفية الخارجة سواء كانت عضلية أو غشاء قحف أو دهون.

النتائج: كان لدينا ٢٥ ذكراً، ٥ إناث بنسبة ذكر إلى أنثى ١:٥.

تراوح العمر بين ١٩ و٤٥ سنة بمتوسط ٣٢ سنة. كانت آليات الإصابة متغيرة، حوادث السيارات في ٨ مرضى (٢٧٪)، حوادث الدراجات النارية ١١ (٣٧٪)، السقوط من ارتفاع ٦ مرضى (٢٠٪)، إصابات الوجه الحادة (مثل الاعتداء) ٥ (١٦٪)، والإصابات المصاحبة على شكل كدمات أمامية في ١٤ حالة (٤٧٪)، أورام دموية خارج الجافية في ١١ حالة (٣٧٪).

تم الكشف عن وجود كسور في القناة الأنفية أو طمسها في (٥٠٪) من الحالات في الأشعات المقطعية قبل الجراحة. لم يحدث في أي من الحالات التي خضعت للجراحة مضاعفات من حيث تشكيل الغشاء المخاطي أو تكوين لخراج بالمخ، أو التهاب العظم، أو تجمعات دموية، أو تشوهات شكلية، أو وفيات في حالة الترقيع الدهني، هناك حالة واحدة فقط (١٠٪) بها تسرب مؤقت لسائل المخ ليوم واحد توقف تلقائياً، في حين أن ٤ (٤٠٪) من أصل حالات المرقعة بالعضلات الصدغية حدث بها تسرب السائل المحي الذي تمت علاجها تحفظياً، ثم احتاجت حالة واحدة إلى إعادة الجراحة بعد تكرار تسرب السائل النخاعي لاحقاً وحالتان (٢٠٪) من أصل ١٠ تم ترقيعهم بغشاء القحف حدث بهم تسرب مبكر بعد الجراحة للسائل النخاعي توقف عن طريق العلاج التحفظي.

على الرغم من الاختلاف الواسع في استخدام مواد الترقيع والذي يُعزى في الغالب إلى تفضيل الجراح، وجدنا ميزة نسبية وتوقفاً في الترقيع باستخدام الدهون على الرقع العضلية وغشاء القحف. يمكن أن يحمي التعامل الحذر أثناء أخذ الرقع الدهنية من مضاعفات الجرح إذا ان به جرح منفصل في البطن.

يوصى بشدة بالتدخل الجراحي المبكر لأنه يقضي على أي مصادر محتملة للعدوى ويؤدي إلى نتائج أفضل ويقلل من معدل العدوى إلى أدنى حد.