CASE REPORT
FRONTAL SINUS FRACTURES: REPORT OF ONE CASE AND REVIEW OF LITERATURE
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SUMMARY
The frontal sinus is a bilateral asymmetric and pyramidal structure located in the frontal bone. It is absent at birth. The frontal sinus is extremely resilient to injury. However, high velocity impacts such as motor vehicle accidents and assaults can result in frontal sinus fractures. Such high velocity impacts lead to aesthetic deformities. CSF leakage, hypoaesthesia and anaesthesia of the supra-orbital area. Long term complications associated with such injury include sinusitis and mucocoele formation.

With Multidisciplinary approach, endotracheal anaesthesia, advent of CT, reconstruction of facial bones along with new surgical techniques has dramatically improved the final outcome and appearance of patients who have sustained bonny injuries to the maxillofacial structures. This reality is completely or wholly the case in most developing countries and Maxillo-Facial centres.

Our experience at the maxillofacial unit of Ahmadu Bello University Teaching Hospital, Zaria, Kaduna, Nigeria, in managing such a case is shared here.

REPORT OF A CASE
A 30-year-old Nigerian peasant farmer was brought into the Accident and Emergency unit of Ahmadu Bello University Teaching Hospital, on the 17th October, 2010, on account of a Road traffic accident that occurred 4 days previously. The patient who initially was taken to General Hospital, Kafanchan, Kaduna Nigeria, from where he was referred to ABUTH on account of extent of injuries and lack of experienced personnel. The oral and Maxillo-facial team along with the Neurosurgery, orthopaedic and ophthalmology teams were invited to review the patient.

The young farmer married with five children, not involved in smoking or drinking, who was said to have been involved in an accident while traveling to dispose off his farm produce. He was said to have sustained serious injuries to the face, left leg and has been unconscious since after the accident. There was history of bleeding from the nose and mouth but not from the ear.

Clinical examination showed an unconscious patient with Glasgow coma score of 9, with a depressed frontal bone fracture, fractured and depressed medial halves of the superior orbital rims bilaterally, sutured laceration extending from the right eye brow to temporal aspect of lid (discharging purulent material). There was nil
perception of light in the right eye, con junction was quiet, cornea was opaque and pupil dilated and fixed. The left eye was quiet. There was fracture and depression of the nasal bridge. Caked blood in the nostrils evidence of previous nasal bleeding. There was no CSF rhinorrhoea. There was associated fracture of the left tibia and fibula. Patients' pulse was 87 beats/min, Bp 120/80 mmHg, heart sounds were S1 and S2 only, packed cell volume – 19%, urea – 6.0 mmol/L, Na⁺ – 140 mmol/L, K⁺ – 4.0 mmol/L, CL⁻ – 100 mmol/L, BC03⁻ – 19 mmol/L, random serum glucose was 6.1 mmol/L. Plain skull x-ray showed fracture of the frontal bone with no evidence of fracture of the posterior / inner table. Patient could not afford a CT scan.

The patient did well while on admission and regained consciousness on the 13th day of admission. Due to low PCV and lack of funds, surgery was delayed. He was taken to theatre on the 14th of December, 2020. Through a bicoronal approach, the scalp tissue was elevated above the periosteum up to the posterior edge of the frontal sinus defect. Incision was made on the periosteum and an area of fractured bone about 1.5 cm diameter was stripped of periosteum using a drill, a hole, big enough to allow entrance of a howarth’s periosteal elevator was created. The depressed bone of the anterior wall of the frontal sinus down to the base/roof of the nose, and the adjoining medial portions of the superior orbital rims bilaterally were elevated using the howarth’s periosteal flap and some flat dental elevators. After adequate reduction of the fractured segments, a straight mosquito artery forcep was used to introduce a size 16 foley’s urinary catheter via the nostril into the frontal sinus. Through the window made via the scalp into the sinus, the inflated balloon was positioned within the sinus and the scalp flap replaced and sutured. The patient recuperated uneventfully. The catheter was removed after 14 days when some stability has been achieved and no untoward effect would have been caused by the catheter to the mucosa of the sinus and the nose. Patient was satisfied with the outcome of surgery and reviews at one, three and six months post operatively, showed good result. Pain and occasional tearing from the right eye which patient complained about during the three month post operative visit were no longer there. No evidence of sinusitis or frontal anaesthesia was seen.

We expect to observe the patient for a longer time to elicit any complication that may follow the operation or use of catheter in the area for the period it was applied (see pix).

**REVIEW OF LITERATURE**

**ANATOMY**

The frontal sinus is absent at birth. The anterior ethmoid air cells invade the frontal bone at about 2 years of age. The normal adult size is attained at approximately 15 years of age. The frontal sinus is commonly bilateral, a symmetric and pyramidal in shape. The pyramidal base is located inferiorly and the apex is located superiorly. The floor of the sinus forms the medial portion of the orbital roof. The anterior table forms part of the forehead, eyebrow and glabella. It averages 4 mm in thickness but can be as thick as 12 mm. The posterior table abuts the anterior cranial fossa. The thickness of the posterior table ranges from 0.1 – 4.8 mm, and it is much less resistant to injury than the anterior table. The frontal sinus measures 30 mm tall, 25 mm wide and 19 mm deep in the average adult and has an average volume of $10 \text{cm}^3$.

The frontal sinus has two osita located on the posterior inferior aspect of the sinus floor. They
are positioned anterior to the anterior ethmoid air cells, medial to the orbit, lateral to the inter sinus septum and posterior to the frontal bone. Each ostium is approximately 3-4mm in diameter and represents the sole damage site for the frontal sinus. The supra-orbital and supratrochlear vessels provide arterial supply to the frontal sinus. Venous drainage occurs through three pathways: the facial vein, the ophthalmic / cavernous vein and the foramina of Breschet / subarachnoid space. Sensory innervation of the frontal sinus comes from the ophthalmic branch of the fifth cranial nerve.

ATHOPHYSIOLOGY
Hippocrates described an array of facial injuries as long as 400BC. Endotracheal anaesthesia and radiography developed during the First World War, led to a better understanding and treatment of facial fractures. During the second world war, a multidisciplinary approach to treatment of facial fractures continued to improve the outcomes of severely injured soldiers. Advent of CT reconstruction of facial bones along with new surgical techniques has dramatically improved the final appearance of patients who have sustained bony injuries.

Maxillofacial fractures result from blunt or penetrating injury. Blunt injuries are far more common, resulting from vehicular accidents, altercations, sporting – related trauma, occupational injuries and falls. Penetrating injuries mainly are the result of gunshot wounds, stabbings and explosions. Type of object striking the face and behind the objects are the main determinants of whether a person sustains soft tissue or bony injury. The frontal sinus is extremely resilient to injury. However, high velocity impacts such as motor vehicle accidents and assaults, can result in frontal sinus fractures. The potential for intracranial injuries, aesthetic deformities, and late mucocele formation is high. Frontal sinus fractures account for 5-12% of all facial fractures. Motor vehicle accidents account for 71% of frontal sinus fractures, assaults account for 10%, industrial accidents account for 5%, recreational accidents account for 4% and other causes leg gunshot, account for 6%. Isolated anterior table fractures account for 33-39% of frontal sinus fractures, combined fractures of the anterior table, posterior table and or nasofrontal recess (NFR), appear in 55-67% of cases. As many as 33% of patients have an associated cerebrospinal third (CSF) leak.

CLINICAL FEATURES
Patients with frontal sinus fractures often have associated facial injuries or pan facial fractures. A thorough head and neck examination is imperative. Symptoms of frontal sinus fracture include the following – forehead swelling, forehead and nasal pain, forehead paraesthesia. Serious injuries are associated with frontal sinus fractures in 75% of patients, associated facial fractures are prevent in 66% of patients, initial loss of consciousness in 76% of patients, and prolonged periods of unconsciousness occur in 23% of patients.

Displaced fractures of the anterior table without overlying lacerations may not be apparent on physical examination because of soft tissues swelling and haematoma. All forehead lacerations should be examined under sterile conditions to assess the integrity of the anterior table, posterior table and dura. Clean and examine the nasal cavity for the presence of a CSF leak. Query all conscious patients about the presence of watery rhinorrhea.
or salty postnasal drainage. Palpate the nasal bones for crepitus and comminution.

**TREATMENT**

Since most of the injuries are the result of trauma primary survey and attention to the ABCs take priority, that is a focus initially on the patency of air way, that is a control of cervical spine any evidence of the patient having difficulty in breathing, and to determine if the patient is experiencing symptoms of shock or neurologic impairment.

The treatment goals of frontal sinus fractures are protection of intracranial contents, avoidance of short and long term complications (such as meningitis, mucocele), return of normal sinus function and re-establishment of the premorbid facial contour. A team approach involving the maxillofacial surgeon, otolaryngologist, plastic surgeon, Neurosurgeon and ophthalmologist is recommended.

Treatment options include observation, open reduction, internal fixation (ORIF), sinus obliteration, sinus exenteration, (i.e. removal of anterior table, Reidel procedure) and sinus cranialisation. Five anatomic parameters need to be evaluated before deciding on the most appropriate treatment option. The parameters include – NFR fractures, anterior table fractures, posterior fractures, dural tears (CSF leak) and degree of fracture comminution.

All patients undergoing open frontal sinus procedures should be counselled on the potential risks which include external scar, especially in patients with male pattern baldness, bleeding, infection, forehead paraesthesia or anaesthesia, external deformities, diplopia, visual loss, CSF leak, meningitis, chronic sinusitis mucocele, mucopyocele formation, brain abscess, death.

For coronal flap dissection, part of the hair in a widow’s peak pattern 4-6cm behind the anterior hair line. A 1 to 2-cm strip of hair can be shaved along the incision line, but this is not mandatory.

The scalp is incised and elevated in a subgaleal plane. Avoid brow incisions to prevent prominent scars and forehead anaesthesia. The pericranium is incised 1-2cm above the sinus and elevated below the fracture. As the frontal bone fractures, it is deformed from a convex shape to a concave shape. Reduce the concave fracture segments. If the fracture segments overlap, a bone hook can be insinuated between the fragments and pulled forward. If the bone fragments do not overlap, fracture reduction can be difficult. The traumatic force applied to the frontal sinus results in horizontal compression of the bone.

Displaced fractures greater than 1-2mm have an increased risk of aesthetic deformity and mucocele formation. ORIF of the fracture is indicated within 7-10 days.

Anterior table fractures with only mild comminution can be repaired with preservation of the frontal sinus function; however, injuries with severe comminution and marked mucosal injury may require bone grafting and frontal sinus obliteration.

Treatment of posterior table fractures remains controversial. Some authors advocate exploration of all posterior table fractures, no matter how slight. Others recommend observation even when the posterior table is significantly displaced. Non-displaced fractures have a reduced risk of complications (e.g. dural tears, CSF leak, meningitis, mucocele formation) when compared with displaced posterior table fractures. The need for exploration often depends on the presence or absence of a CSF leak.

CSF leak absent – when possible, patients should undergo frontal sinusotomy and endoscopic...
evaluated. Sinus endoscopy is helpful to rule out mucosal injury, dural tear, CSF leak or NFR injury.\textsuperscript{15,16}

When CSF leak is present, - the patients with active CSF leaks may be observed for 5-7 days while undergoing treatment with antibiotics. Approximately half of these patients have spontaneous resolution of the CSF leak. Frontal sinus obliteration is indicated if the CSF leak is persistent.\textsuperscript{6,13,14}

Displaced fractures have an increased risk of complication and require a more aggressive approach. Categorize cases by the severity of posterior table comminution.\textsuperscript{13}

When CSF leak is absent – mild comminution requires osteoplastic flap and sinus obliteration. Moderate to severe comminution requires cranialization. Use of a pericranial flap for dural repair is necessary.

CSF leak present-patient should undergo open reduction with an osteoplastic flap. If minimal to mild comminution is present, sinus obliteration is indicated. Moderate to severe comminution requires sinus cranialisation.\textsuperscript{6,13,14}

The need for long term follow-up of patients with frontal sinus fracture cannot be overemphasized. The risk of late mucocele formation is significant.\textsuperscript{4,7,10}

Use of seat belts and airbags can reduce incidence of facial injuries in motor vehicle accidents. Use of helmets with facial guards can reduce injury in motorcycle accidents and in such sports as skiing, snowboarding, hockey and football.\textsuperscript{11,17}

**SUMMARY**

A case of frontal sinus fracture-depressed fracture of the anterior table is reported. The fracture was reduced and supported with a sinus balloon. The result achieved was good and no complications were recorded up to six months postoperatively. This case illustrates how team work and application of available materials are beneficial in giving quality care to an injured patient.

**REFERENCES**


