Frontal sinus fracture

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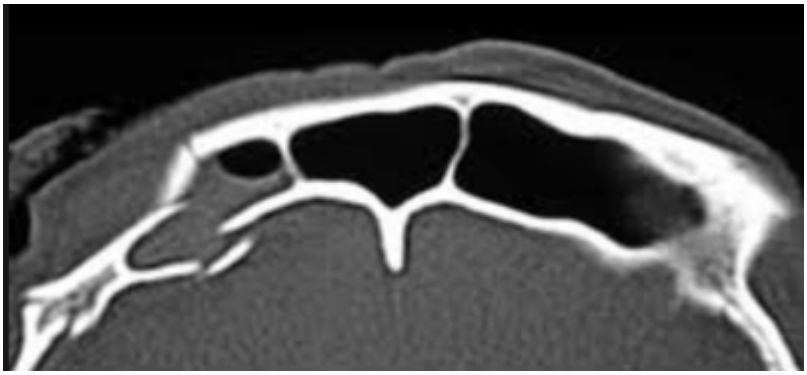

- Management of Traumatic Anterior Skull Base Fractures and Cerebrospinal Fluid Fistulas
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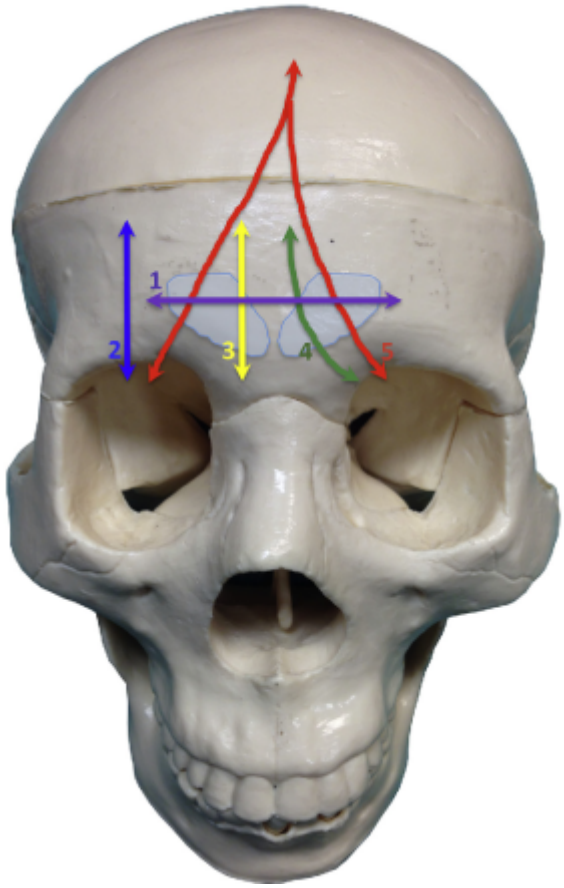
A “frontal sinus fracture” is a medical condition characterized by a break or fracture in the frontal bone of the skull, specifically involving the frontal sinus, which is one of the paranasal sinuses located in the forehead region. Frontal sinus fractures typically result from facial trauma, such as accidents, falls, or direct blows to the forehead area.

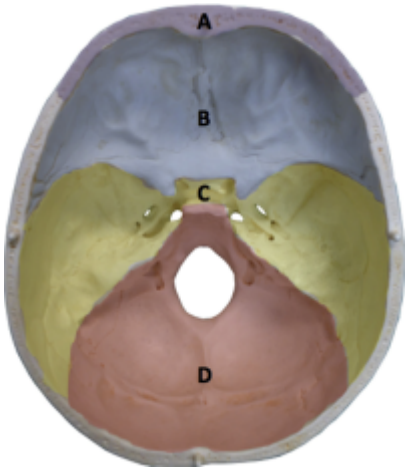
Epidemiology

Frontal sinus fractures account for 5 to 15% of all craniofacial fractures related to trauma [1) 2) 3)].

Classification



Type 1 fractures are isolated to the frontal sinus without a vertical trajectory (purple). Type 2 fractures are vertically oriented and extend into the orbit but not the frontal sinus (blue). Type 3 fractures are vertically oriented and extend into the frontal sinus but not the orbit (yellow). Type 4 fractures are vertically oriented and extend into ipsilateral frontal sinus and orbit (green). Type 5 fractures extend into the frontal sinus and extend into the orbit on both sides of the face or the contralateral side of the face (red).



Skull base penetration depths. Depth A fractures involve the anterior table of the frontal bone with or without posterior table involvement and do not extend into the anterior cranial fossa (purple). Depth B fractures involve the floor of the anterior cranial fossa (blue). Depth C fractures involve the middle cranial fossa (yellow). Depth D fractures extend into the posterior cranial fossa (red) [4].

see also Frontal sinus posterior wall fracture.

see Frontal sinus fractures in children.

Etiology

The most common etiologies of frontal bone fractures in adults are motor vehicle accidents (MVAs), falls, assaults, falling objects, and penetrating trauma [5].

Clinical features

Frontal sinus fractures can be associated with symptoms such as pain, swelling, deformity, or changes in facial appearance.

Complications

They can lead to complications, including sinusitis, cerebrospinal fluid leaks, or other issues related to the frontal sinus. Overwhelming complications such as meningitis, encephalitis, or brain abscesses are quite uncommon nowadays. Nevertheless, late development of invasive mucoceles is not a rarity, and therefore long-term follow-up is mandatory [6].

Treatment

Frontal sinus fracture treatment.

Case series

2023

This retrospective study aimed to present demographic data, mechanisms of injury, anatomical locations, and management strategies in patients with frontal sinus fractures. The study included 91 patients with frontal sinus fractures attending the Rajaee Hospital of Shiraz between 2014 and 2019. The data recorded for each patient included age, sex, injury mechanism, fracture classification, associated craniofacial fractures, nasofrontal duct injury, cerebrospinal fluid leak, and treatment approach. The mean age of patients was 31.0±14.0 years, with male predominance (95.6%). Car crashes represented the most frequent mechanism of frontal sinus fracture, involving 31 subjects (34%). Isolated anterior and posterior table fractures were seen in 32 (35.2%) and 5 (5.5%) patients. Fifty-four patients (59.3%) presented both tables' involvement. Frontal sinus injuries occurred frequently (74.7%) with other facial fractures. Nasofrontal duct injury was found in 7 patients (7.7%),

and 13 (14.3%) exhibited cerebrospinal fluid leakage. Fifty patients (55%) were treated with observation alone; 16 (17.5%) underwent sinus preservation, 12 (13.2%) experienced sinus obliteration, and 13 (14.3%) endured cranialization. Fisher's exact test revealed no significant association between the classification of fracture and the mechanism of injury (P=0.591). However, a significant association was observed between the fracture classification and the treatment applied (P=0.023). Frontal sinus fractures were most often caused by car crashes in young adults. Combined anterior and posterior table fractures were more commonly found than isolated anterior or posterior table involvement. Most frontal sinus fractures were treated conservatively without DDS surgical operation [7].

2022

125 patients (101 male, 24 female) with frontal sinus fractures with an average age of 22.4 years (range,17-66 years) were reviewed. All patients with isolated anterior table fractures without displacement were followed up on a conservative basis. 33 patients with anterior table fractures with displacement and 39 patients with anterior and posterior table fractures were also followed on a conservative basis without surgical intervention. The cut-off value of the maximum amount of displacement was confirmed to be 4.5 mm in the prediction of late-term contour deformities ($p < 0.001$). The maximum amount of displacement was decreased by an average of 1.8 mm in the late term. Apart from the standard protocols, within the limitations of the study, it seems that isolated anterior table fractures with a maximum amount of displacement of less than 4.5 mm can be treated conservatively without leading to contour deformities. CSF leakage in the acute setting might not always require cranialization and this may spontaneously resolve within 10 days. Cranialization should be considered whenever CSF leakage lasts longer than 10 days [8].

A retrospective study was conducted, which reviewed the medical records and computed tomographic (CT) scan images of patients with frontal bone fractures from January 2016 to February 2019. Patients with complete medical records and a follow-up of a minimum of 1 year were included in the study. Demographic details, mechanism of injury, associated intracranial injuries, maxillofacial fractures, management, and complications were analyzed. CT scan images were used to classify the frontal bone fractures using the novel classification given by Garg et al (2014). The indications for surgical treatment were inner table frontal sinus fracture with cerebrospinal fluid (CSF) leak, intracranial hematoma with significant mass effect requiring surgical evacuation, and outer table comminuted fracture that is either causing nasofrontal duct obstruction or for cosmetic purposes. Results A total of 55 patients were included in the study. Road traffic accidents as the commonest cause of frontal bone fractures. The most common fracture pattern was type 1 followed by type 5 and depth B followed by depth A. Four patients presented with CSF rhinorrhea. CSF rhinorrhea was more frequent with fracture extension to the skull base (depth B, C, D), which was statistically significant ($p < 0.001$).

Frontal bone fracture treatment has to be tailor-made for each patient based on the extent of the fracture, the presence of CSF leak, and associated intracranial and maxillofacial injuries [9].

2014

164 consecutive patients with fractures of the frontal sinus, treated at the Department of Craniomaxillofacial Surgery of the Medical University of Innsbruck from 2006 to 2010, have been

evaluated. 23 female (14%) and 141 male (86%) patients suffered mainly from traffic (31.7%) and sports accidents (28.0%), followed by work accidents (20.1%), violence (3.7%), and accidents at home (3.1%). 51.8% presented an isolated fracture of the anterior wall, 47.6% both anterior and posterior wall fracture, and 0.6% an isolated posterior wall fracture. Injury of the nasofrontal duct was found in 29.2%, and CSF liquorrhoea in 15.9%. In total, 44.5% of the patients underwent surgical therapy, 55.5% were treated conservatively by observation. Treatment decision depended significantly on concomitant injuries of the nasofrontal duct and the presence of rhinoliquorrhoea as well as on the fracture dislocation. A new classification of frontal sinus fractures depending on their maximum dislocation is proposed. In addition, a treatment algorithm considering displacement, liquorrhoea and injury of the nasofrontal duct is presented [10].

2013

A retrospective review of charts of 180 consecutive patients with frontal sinus fractures managed by plastic surgeons at the University of Kentucky between 1987 and 2007 was performed with institutional review board approval. Twenty-six charts did not meet the criteria. The remaining 154 records provided a 1-to-20-year follow-up. The study included 34 patients who underwent cranialization and 120 patients who did not. A low-complication rate of 6% after cranialization is ascribed by the authors to meticulous sinus mucosal debridement; thorough obliteration of the frontal sinus outflow tract (with sterile gelatin sponge pledgets and bone chips from the outer cortex of the temporoparietal skull); and avoidance of avascular barriers, such as abdominal fat. As high-resolution computerized tomography with parasagittal views was introduced, an increasing ability to preoperatively define the extent of injury of the medial and lateral sinus floor was observed. The authors conclude selective use of cranialization is indicated [11].

2010

In 857 patients, simultaneous displacement of anterior-posterior tables constituted the largest group (38.4%). Nasofrontal outflow tract (NFOT) injury occurred in most patients (70.7%) and was strongly associated with anterior (92%) and posterior (88%) table involvement (comminuted 98%). Sixty-seven percent of patients with NFOT injury had obstruction. Five hundred four patients (59.6%) had surgery with 10.4% complications and 353 patients were observed with 3.1% complications. All but 1 patient with complications had NFOT injury (98.5%).

Predictable patterns of injury based on specific computed tomographic data play a pivotal role in classification and surgical management of potentially fatal frontal sinus injuries. Radiologic diagnosis of NFOT injury in FSFs, particularly obstruction, plays a decisive role in surgical planning [12].

Case reports

a 33-year-old man with a distant history of skull base injury after a traffic accident, 12 years ago. He presented with intermittent rhinorrhea and reported 2 episodes of bacterial meningitis in the last 7 years since the injury. Cerebrospinal fluid leakage was confirmed with β2-transferrin testing. Computed tomography and magnetic resonance imaging revealed a small defect of the posterior and superior wall of the left frontal sinus and an ipsilateral meningoencephalocele. Finally, there was a communication between the intracranial space and the frontal sinus that caused meningitis. A coronal

incision and frontal craniotomy with preservation of anterior pericranium were performed (frontal sinus cranialization using osteoplastic flap). In order to determine the precise margins of the frontal sinus and allow an accurate anterior table bone osteotomy and complete exposure of the sinus, the authors used a coronal view of a skull X-ray. Scissors are then used to cut along the margins of the sinus. An “R” is scratched into the right side of the template to record orientation. The template was sterilized and brought onto the surgical field and then placed over the left sinus. An external surgical approach (anterior table bone osteotomy) with the modern technique of osteoplastic flap access was performed. An elevator was used to separate the dura from the posterior table along the entire margin of the defect. Meningoplasty (cauterization of the meningoencephalocele) and closure of the osseous defect was followed. The authors repaired the defect of the posterior wall of the left frontal sinus using a combination of underlay and overlay techniques. Femoral fascia from the right thigh and fibrin glue was placed in order to cover the leak of the posterior wall of the left frontal sinus, respectively. Patients who present with a short or/ and distant history of traumatic brain injury should be evaluated for complications of a cerebrospinal fluid leak [13)].

Case report from HGUA

Multiple comminuted left craniofacial fractures.

Skull fractures: left parietal, temporal, and frontal bones, with herniation of brain parenchyma through them. Soft tissue hematoma in the left facial region with scalp involvement in the temporal and parietal regions. Fractures of the left zygomaticomaxillary complex: zygomatic arch, anterior and posterior walls of the maxillary sinus, frontal sinus fracture and hematosinus. Also associated with subcutaneous emphysema adjacent to the fractures.

Sphenoid bone fracture with involvement of both sinus walls, noting a fracture line in the clivus extending to the carotid canal.

Longitudinal and oblique fracture of the left petrous part, extending to the anterior wall of the external auditory canal (CAE)

The left orbital wall fracture is associated with inferior and lateral displacement of intraorbital contents, with herniation of extraconal fat into the maxillary sinus and slight displacement of the inferior rectus, without thickening of the same.

Zygomaticomaxillary complex fractures: Fractures of the left zygomaticomaxillary complex with inferolateral displacement: zygomatic arch, anterior and posterior walls of the maxillary sinus, with involvement of the frontal sinus and hematosinus.

Skull base fractures affecting the body, walls of the sinuses, and greater wing of the left sphenoid bone, noting a fracture line in the clivus extending to the carotid canal.

Longitudinal fracture line affecting the petrous part with probable incudomalleolar subluxation and hemotympanum, continuing with a fracture line of the greater wing of the sphenoid bone.

80 years, Female with a medical history of Hypertension, Type 2 Diabetes Mellitus, and Dyslipidemia.

The patient had experienced a contusion due to stumbling against a cemetery headstone, resulting in a frontal wound that affected deep layers of tissue. The patient reported tenderness upon palpation and mobility in the wound area. The Glasgow Coma Scale (GCS) score was 15, with no evidence of neurological focal deficits.

URGENT NON-CONTRAST HEAD CT SCAN

No indicative images of intracranial hemorrhage were observed, indicating the absence of bleeding within the cranial cavity. A small millimetric hyperdensity was identified in the left cerebellar hemisphere, situated over the left middle cerebellar peduncle, which is considered likely non-specific.

A comminuted and depressed fracture in the right frontal bone, with a diameter of approximately 2 cm, was identified. This fracture involved the anterior wall of the right frontal sinus, resulting in a small amount of hemosinus.

Based on the findings of the non-contrast head CT scan, the following conclusions are drawn:

The patient has a comminuted and depressed fracture in the right frontal bone that invades the paranasal frontal sinus.

The patient underwent surgery to address the frontal fracture. The depressed fracture over the paranasal frontal sinus was visualized through the traumatic frontal wound. An associated frontal osteoma was identified and excised. Three bone fragments were elevated and reassembled with silk sutures. The mucosa of the frontal sinus was resected, and the bone fragments were repositioned with silk sutures. Careful hemostasis was achieved, and Espongostan was applied over the fracture. Closure was performed in layers with intradermal skin sutures, without any complications.

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