



Access to the upper third of the face: a literary review of indications, techniques, and intercurrents

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DOI: <https://doi.org/10.54448/mdnt23S218>

Received: 04-04-2023; Revised: 06-15-2023; Accepted: 06-22-2023; Published: 06-24-2023; MedNEXT-id: e23S218

Abstract

Due to its location, anatomy, and projection in the upper third of the face, the frontal bone is frequently affected by trauma of different intensities that result in fractures. Access to the upper third of the face for the correct reduction and stabilization of the trauma requires an extensive approach. The main alternatives for correct exposure are coronal and transcutaneous incisions. The coronal incision is the incision of choice, as it allows us to adequately approach important structures related to fractures of the frontal bone. The transcutaneous incisions, these incisions comprise the region of the eyebrow, upper eyelid, eyebrow, and gull-wing incision and, when present, lacerations in the soft tissue of the trauma itself can be used as access to the fractures. The present work aimed to describe, through a literature review, the accesses to the upper third of the face, as well as to report the techniques and intercurrents. Even though it is the main choice for coronal access, it can cause alopecia, loss of sensitivity, compromised aesthetics, muscle depression, possible need for postoperative blood transfusion, facial nerve deficit, and supratrochlear deficit, among others. The alternatives are transcutaneous incisions, these incisions include the region of the eyebrow, upper eyelid, eyebrow, and gull-wing incision and, when present, lacerations in the soft tissue of the trauma itself can be used as access to the fractures. It was concluded that although coronal access is the main choice, the choice of incision depends on the location of the fracture, the presence of laceration, its extension, its relationship with other fractures, and surgeon preference, in addition to aesthetic factors.

Keywords: Upper third of the face. Front Bone. Trauma.

Introduction

Man, in his march towards civilization and technological development, increased the complexity of his relationships and locomotion [1-3]. As a result, facial trauma has increased significantly in recent years, due to car accidents, urban violence, and accidents at work. These facial traumas are often the cause of fractures in the bucomaxillofacial region [4].

The frontal bone is a flat, pneumatic anatomical structure and has an extensive hollow area in the central and lower portion, known as the frontal sinus, which gives it relative fragility [5]. Its bone thickness is made up of three layers: the external or cortical layer; the diploe or middle layer that presents abundant vascularization; and the inner one, also cortical, but less thick than the outer one. The frontal bone provides the facial contour of the forehead and fractures of this structure can cause a wide aesthetic impact [6].

Frontal complex fractures usually involve the anterior and posterior walls of the frontal bone and frontal sinus. The extension of the fracture on the posterior wall of the sinus may result in communication with the anterior cranial fossa, which may cause leakage of cerebrospinal fluid, infectious lesions, sinusitis, and mucocele [1,7,8].

In a retrospective study of 1,608 patients in Tehran, Iran from 1984 to 1990, the results found that the lower third was the most commonly affected by craniofacial trauma (69%), followed by the middle third

(42%) and damage to the upper third was the least common (28%) being the frontal bone the most affected structure [1,9].

It is reported that the common age of patients with frontal fractures is 29.1 years and 92.3% were male. The most common causes of fracture were car accidents and physical aggression, not to mention the large number of accidents at work. All patients had comminution and depression (fracture) of the anterior wall, 46% had fractures of the sinus floor and 34.6% had fractures of the posterior wall [4].

Fractures involving the naso-orbit-ethmoid region (NOE) are among the most complex, being classified as Type I, II, and III. Type I: when there is only a single central fragment with the canthal ligament; Type II: when there is a comminuted central segment with the medial canthal ligament still attached to the bone fragment; Type III: when there is a central fragment comminuted with a total detachment of the medial canthal ligament [10].

The possible clinical signs found in patients with fractures of the upper third of the face are edema, facial asymmetry, hematoma, epistaxis, blunt injury, ecchymosis, nasal discharge, eyelid ptosis, subconjunctival ecchymosis, crepitation, rhinorrhea, epiphora, mydriasis, depression, emphysema, and traumatic telecanthus. Local pain, headache, supraorbital nerve paresthesia, and visual alteration are the main symptoms that affect individuals with fractures of the frontal bones [8].

Also, Manson et al. (1995) [11] in studies present a treatment plan for craniofacial injuries based on the use of incisions that expose the three areas of the face: frontal, middle third, and lower third. According to the authors, seven incisions allow access to the entire anterior craniofacial skeleton: coronal, supra palpebral, subalgebra, superior and inferior gingivolabial sulcus, preauricular, retromandibular, and risdon. Through these incisions, there is access to the facial structures, allowing the reduction and rigid fixation of existing fractures.

The use of coronal access in craniofacial trauma has proven to be indispensable in the management of severe facial injuries. This technique exposes a wide field of critical structures such as the skull, frontal sinus, orbit, and middle third. Although very useful, severe complications such as facial nerve damage, diplopia, telecanthus, and flap necrosis may occur [11,12]. The treatment of fronto-naso-orbito-ethmoidal fractures aims at the adequate restoration of the architecture of the frontal bone, the intercanthal distance, maintenance of the lacrimal drainage system, and restoration of facial aesthetics [8].

Complications of frontal sinus fractures, even today, continue to be a dilemma for facial trauma surgeons, mainly because they are often addressed by multidisciplinary teams, which provides a wide variation in the description of handling and techniques. surgeries to repair these injuries. One cannot forget that many of the serious complications, such as CSF leaks and ocular damage, may be present regardless of the correct handling of these traumas [13].

Thus, the present work aimed to describe, through a literature review, the accesses to the upper third of the face, as well as to report the techniques and intercurrents.

Methods

The search strategies for this review were based on the keywords (MeSH Terms): *Upper third of the face. Front Bone. Trauma*. The research was carried out from February to May 2023 in Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. In addition, a combination of keywords with the Booleans "OR", "AND" and the operator "NOT" were used to target scientific articles of interest.

Results

Literature Review

The frontal sinus is a pneumatic bony cavity lined internally by the ciliated epithelium of the respiratory tract. The thin posterior bony wall separates the frontal sinus from the meninges and the frontal lobe of the brain. The anterior wall is covered by soft tissue. Through the floor of the frontal sinus cavity, there is communication with the other paranasal sinuses, as well as with the ethmoid cells, through which the anterior cranial fossa and olfactory filaments communicate. The orbital roof is also composed of the frontal bone [14].

Frontal sinus fractures often result from motor vehicle accidents. From a wide sample of fractures, a rate of 70% of frontal sinus fractures was found due to car accidents, 20% due to physical aggression, and the rest caused by falls, and industrial and sports accidents [14,15].

The signs and symptoms of frontal bone fractures are a pain in the frontal region, hypoesthesia in the supratrochlear region, epistaxis, and rhinoliquorrhagia (laceration of the dura mater). On physical examination, attention should be paid to frontal bulging, the fracture line that may affect ocular muscles, altering ocular motility, edema or subgaleal hematoma present that may prevent adequate palpation, masking sunken fractures, cerebrospinal fluid rhinorrhea is suggestive of posterior wall fractures

it can be determined by glucotest, B2-transferrin dosage or use of radioisotopes, there are no pathognomonic signs for fractures of the frontonasal duct [16].

Surgical Access

Frontal bone fracture treatment starts with a good diagnosis. The coronal surgical approach provides better access to the frontal bone and frontal sinus and produces more desirable cosmetic effects. Skin lacerations can be considered a type of surgical approach, but their size and shape rarely provide sufficient access for adequate fracture reduction and fixation [1-3].

Gull-wing or arched incisions result in highly visible unsightly scars due to their prominence in the eyebrow and resulting reflection of light. The "open sky" approach is also deforming, leaving an H-shape over the eyebrows and nasion [15].

Coronal access requires prior preparation. Trichotomy should be performed, the skin should be degreased with a degerming agent and an antimicrobial agent should be used, preferably a povidone-iodine solution. An incision should be marked that should go from the left pre-auricular region to the right pre-auricular region. Infiltration of anesthetic with vasoconstrictor is used to help with hemostasis. Electrocautery should not be used on the initial incision because it can damage hair follicles. The incision is made in the loose aponeurotic layer. The flap is moved along this plane and above the periosteum in an anterior direction. Raney clips are useful in achieving hemostasis; however, hemorrhage may arise when they are removed and electrocautery can be used carefully to obtain a clean surgical field [14].

The flap is displaced approximately 2cm or 3cm from the fracture or supraorbital margins. The pericranium is then incised and the folding of the flap continues closely to the pericranium so that the branches of the facial nerve can be protected. A posterior reflection can be obtained with greater exposure, by extending the preauricular incision, galea splinting (if a galea flap is not anticipated), or releasing the supraorbital nerve from its foramen or notch [17].

The recovery of bone fragments in communitive fractures is best performed during coronal flap reflection. The outer cortical fragments must be freed from the periosteum and reduced one at a time. Methods for organizing these fragments must be followed. After reducing and mounting the fragments, exploration of the frontal sinus, internal cortical bone, and nasofrontal duct should be performed [16].

After access has been obtained, exploration of the

surgical field can be put to good use. Relative duct patency can be assessed by placing an angiocatheter in the nasofrontal duct and introducing an appropriate fluid medium so that flow can be checked. A 3.8 cm (1.5 inch) 18-gauge angiocatheter is the best instrument for this purpose. Patency of the nasofrontal duct can be confirmed by introducing saline solution and observing its exit below the middle nasal concha or its collection in the posterior part of the pharynx. Due to its hue, methylene blue dye has been used as an appropriate fluid to assess patency. However, this dye can make it difficult to visualize the surgical field because the complete removal of methylene blue is complicated during the surgical procedure. Fluorescein is an excellent alternative because it is clean, colorless, water-soluble, and radiolucent. On the other hand, its visualization sometimes requires an ultraviolet light source and dimmed operating room lights. A radiopaque dye has been suggested for use as a diagnostic tool in nasofrontal duct fractures, but its visualization requires a C-arm fluoroscopy unit. In addition, any radiopaque dye should be cleaned thoroughly before additional radiographs or CT scans. computerized to be made [1,2,17].

Anterior and Posterior Wall Fractures

The anterior wall of the frontal sinus is highly susceptible to fracture. Simple greenstick fractures or those without anterior wall displacement do not require surgical treatment, whereas fractures with displacement require open reduction. During surgery, the surgeon should inspect the sinus floor, posterior wall, and patency of the nasofrontal duct. If the posterior wall and floor are free of lesions, the outer cortical fragments can be fixed with titanium mini plates. Any remaining space in the anterior wall after reconstruction can be closed by placing a titanium mesh, methylmethacrylate, or bone graft. Then the soft tissue synthesis by planes can be performed [1,17].

Fractures of the posterior wall of the frontal bone are more worrisome because of their proximity to the anterior cranial fossa. These fractures are classified into three categories: without displacement, with displacement, with displacement, and neurological injury. Each subclassification is associated with penetration of the outer cortex. They are treated in different ways and require evaluation by a neurosurgeon.

Antibiotic coverage is important in preventing infection. The surgeon must carefully check for fracture displacement, cerebrospinal fluid leakage, sinus membrane entrapment, and dural fissures. If the injury is not substantial and the nasofrontal duct is patent, the

anterior wall is repaired, and soft tissue suturing is performed. Communion of the posterior wall, penetrating injury, cerebrospinal fluid leakage with extensive dura mater damage, or frontal lobe injury demands cranialization of the frontal sinus. In such situations, the posterior wall would be gently removed with a diamond bur or a delicate instrument. Care must be taken with the sagittal sinus to avoid severe bleeding. All breast irregularities are smoothed out. After bone removal, the dura mater will be reconstructed by primary closure with fascia or synthetic cover or a galea or pericranium flap [1].

Careful attention must be given to meticulously removing all mucosal sinus elements and septa from all bone fragments. Failure to remove such elements may result in mucocele or pyocele. The mucosa is reflected into the nasofrontal duct, and the orifice is obstructed by bone or local musculature. The fat is collected and placed in the breast and compacted until it is filled [1-3]. Finally, the anterior wall is placed in position and fixed as would be done in the case of a simple fracture of the outer cortex [1].

Reconstruction of the Orbital Roof

Once the posterior wall of the sinus floor has been explored, inspected, and assessed for damage, the orbital roof can be corrected. After these procedures, a galea flap should be reflected, the sinus obliterated and the nasofrontal duct obstructed. Free bone fragments that are retrieved, mapped, and arranged on the table must be rigorously curetted to remove any respiratory epithelium that would be trapped between the bones during reconstruction. Any remaining respiratory epithelium should be removed from each fissure or sulcus bottom so that future mucocele formation is minimized. The reduced bone fragments must be fixed with titanium mini plates and screws. The titanium mesh has an advantage in terms of supporting and consolidating the segments in the three planes of space. Once this phase is completed, the nasofrontal ducts can be obstructed (if indicated), the sinus obliterated, the brain isolated with a galea flap (if indicated) and, finally, the anterior wall replaced or fixed [3,13].

Complications

Complications of frontal bone injury vary in severity and can occur many years after the trauma. The main types of complications are those that occur directly at the time of the injury, of an infectious nature and those that are chronic. More devastating changes are the neurological problems resulting from the displacement or penetration of the frontal bones in the

brain. These injuries can result in a concussion, severe brain injury, or death. Displacement of the floor of the frontal bone can cause orbital damage. The most common ocular complication is diplopia. Damage to the superior oblique muscles and trochlea causes limited movement in the eyeball. Supraorbital nerve rupture due to trauma or flap reflection leaves permanent anesthesia in the forehead region. Trauma to the floor of the frontal sinus or displacement of the medial supraorbital margin can cause extravasation of cerebrospinal fluid. In most cases, fracture reduction corrects these problems. If persistent, neurosurgical repair is indicated [2,3,17].

Infectious complications arise from occlusion of the nasofrontal duct or contamination of the sinus by penetrating foreign bodies. The most commonly encountered infection is meningitis. If the nasofrontal duct is occluded, blood can pool in the sinus, creating an environment conducive to the growth of anaerobic bacteria. Frontal sinus abscess is disseminated by direct extension into small frontal bone fractures or transosseous anastomotic vessels. The result is brain abscess, meningitis, cavernous sinus thrombosis, or osteomyelitis. Mucoceles are the most common chronic problem. Respiratory mucosa trapped between fractured segments or left behind during obliteration may continue to grow. This continued growth can lead to the formation of mucoceles or pyoceles. Frontal sinus images should be ordered to detect a postoperative mucocele or pyocele. Imaging should be performed 1, 2, and 5 years after surgery or when symptoms appear. The pain and headache can be chronic and persist without an identifiable cause. Cosmetic deformities such as deficiencies or contour irregularities originate from various causes. Bone loss from the injury may not be noticed for months. Osteomyelitis with subsequent debridement leaves gaps in the bone. Even if fractures are properly treated at the time of injury, remodeling can leave irregularities [18,19].

Discussion

Frontal bone fractures are usually associated with high-energy trauma. The most frequent etiologies are car accidents with 40% of occurrences; physical aggressions appear as the second most frequent with 32% and the other ones together are 28% of the occurrences [1,18]. The most frequent frontal fracture etiology was car accidents, followed by physical aggression, accidental falls, sports accidents, cycling accidents, being run over, and accidents with animals. In the case presented, the patient was the victim of a serious car accident [3,19].

The anatomical relationships in the treatment of

fronto-naso-orbito-ethmoidal fractures need to be very carefully observed, to promote the re-establishment of the correct intercanthal distance between the medial palpebral commissures, the projection of the nasal dorsum, the leveling of the globe ocular, in addition to the relationship of drainage of the frontal sinus through the frontonasal duct, which, for many times, may not be patent, generating mucocele in the frontal sinus and creation of an anaerobic environment with subsequent osteomyelitis and possible intracranial extension, leading to brain abscess [20].

Clinical examination and X-rays of the skull, lateral skull, Towne, and Waters, are means used for diagnosing fractures of the frontal bone [1]. The diagnosis of frontal fractures is performed through clinical exams and complementary imaging exams. Computed tomography is an essential exam for the diagnosis of the type of frontal fracture and good surgical planning [2,3].

Fractures of the external cortex of the frontal bone are more common than those of the internal cortex, as this is the region that suffers the initial impact during trauma. The treatment modality to be used is different depending on the type of fracture [20,21]. Fractures of the frontal complex involve anterior and posterior walls and, when compared to the others in the maxillofacial region, are considered to be a controversial treatment since it varies according to the type present [22]. When there is a displacement of the anterior wall, it is usually treated with open reduction and rigid fixation using mini plates, however, other methods such as the use of the "camouflage" technique of the aesthetic defect can also be used [23].

The treatment of fractures of this type aims to prevent infections with possible sepsis, restoration of function, and aesthetics, among others. Even after a long time after the accident, serious complications can occur if the treatment is performed inappropriately, being divided into [24]:

- (1) **Aesthetics:** depression or irregularities in the anterior wall of the sinus;
- (2) **Neurological:** cerebrospinal fluid fistulas, brain abscess, subdural abscess, meningitis, encephalitis, pneumocephalus, and cavernous sinus thrombosis;
- (3) **Functional:** recurrent sinusitis, frontal bone osteomyelitis, mucocele, mucocele, and soft tissue abscess;
- (4) **Ophthalmologic:** amaurosis, orbital abscess, and ophthalmoplegia.

All surgical approaches for frontal bone reduction aim to promote aesthetic responses, restore function and prevent surgical complications, but despite this,

worldwide there is no agreement on which form of treatment or management is best to achieve the objectives [25].

The supraciliary "butterfly wing" access is made from a linear incision in the glabella region, with lateral extensions to the eyebrows. In this way, it ensures good visualization and exposure of the operative field with direct and simple access, aiming at a subsequent reduction and rigid internal fixation of the lesion [12,21]. The evaluation as well as the treatment of the frontal sinus is of extreme importance, aiming at the prevention of possible late pathological processes [1].

Conclusion

Automobilist accidents have been one of the main etiologies of fractures of the bucomaxillofacial complex. After the trauma, the excellence of a multidisciplinary approach can be decisive in the patient's prognosis. The fronto-naso-orbito-ethmoidal fracture is a challenge for the surgeon, given the complexity of the fractures and their management. The correct diagnosis, associated with early surgical planning and treatment, minimizes sequelae and provides a more predictable aesthetic and functional result. The objectives of the surgical treatment of frontal bone fractures are the prevention of infection, and the isolation of the intracranial content, in addition to restoring the function and aesthetics always achieved with the reconstructive technique used. It is important to emphasize that the success of the treatment depends on the correct indication for each surgical case and a long follow-up of the patient.

Acknowledgement

Not applicable.

Funding

Not applicable.

Ethical Approval

Not applicable.

Informed consent

Not applicable.

Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

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