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Case Report

Local Approaches for the Reconstruction of Frontal and Naso-Orbito-Ethmoidal (NOE) Fractures: Presentation of a Clinical Case and Literature Review

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Abstract: Naso-orbito-ethmoidal (NOE) fractures are considered a challenge in reconstruction, due to the anatomical structures involved, such as the medial canthal ligament and the lacrimal apparatus [1], which leads to a complex functional and aesthetic compromise. For surgical access to the area, the use of the coronal, Lynch-Howarth, glabellar "open sky", "gull wings" and a combination of the last two are described. However, the severity of the trauma and mainly the neurological compromise of the patient will dictate the choice of the approach that allows functional and comprehensive repair of the affected region. In cases where there is no neurological compromise and it is not necessary to carry out a subcranial approach, the use of local approaches is justified, providing adequate visibility and direct access to the fractured region, allowing an adequate reduction and placement of fixing material. A clinical case of anterior frontal sinus wall fracture and NOE fracture are presented, performing the combination of the gull-wing and open-sky approach, described as butterfly wings, achieving adequate visibility and reconstruction.

Keywords: Fractures, NOE, reconstruction, approaches, Lynch- Howarth, gull wings, glabellar, canthopexy.

INTRODUCTION

The frontal bone, compared to other facial bones, is rarely affected. High-energy trauma accidents usually involve frontal sinus fractures and may in turn be associated with midface fractures, such as NOE and zygomatic fractures [2]. Ellis reports up to 65% of concomitant fractures (Le Fort and frontal) in patients with NOE fractures [1].

NOE fractures are considered difficult to manage due to the compromise of different anatomical structures that have important functional and aesthetic repercussions [2]. The presence of brain injury and the extent of the fracture are criteria for choosing the surgical approach. In cases where there is a need for neurosurgical treatment, it is ideal to carry out the reconstruction of the fronto-nasal and orbital areas at the same surgical time [3].

A thorough physical examination in patients who have suffered a traumatic brain injury is of the utmost importance, it should also be complemented with a tomographic study with fine slices to analyze different planes and corroborate the presence of fractures that allow determining the degree of brain injury [3].

To decide on the treatment plan, the choice of the surgical approach is fundamental, because this can influence: the difficulty of reduction and fixation of fractured segments, the duration of the operative time and hospital stay [4]. During the choice of the surgical technique, the following must be considered: visualization, the positioning of the scar, the final appearance and, of course, the protection of vital structures [3, 4].

The coronal approach allows an adequate extension and therefore visibility for the correct placement of the reconstruction material. However, there are fractures whose extension is limited and without neurological compromise, for which minimally invasive approaches are described that allow access to the naso-orbital-frontal region [4].

In cases where the mechanism of the trauma has caused soft tissue injury that allows access to the fracture line, reconstruction may be performed for the present wound; In the case where a closed trauma occurs, we must consider other alternatives [2, 4].

For access to the frontal, nasal and orbital region, the glabellar approach has limited visibility, this approach is restricted to fractures involving the fronto-nasal suture. The Lynch-Howarth approach has also been described, which is an approach designed unilaterally to access the frontal and ethmoid sinuses for removal of mucoceles [2].

Other approaches described for the reconstruction of the fronto-nasal region are supraciliary approaches, such as the "open sky" approach, "gull wings" or the combination of both. Early repair benefits the cosmetic result in addition to reducing common sequelae in this type of injury, such as midface retrusion, palpebral fissures, telecanthus, dystopia, epiphora, nasal deformity, and cerebrospinal fistulas [1].

CLINICAL CASE

A 40-year-old male who suffered a car accident, hitting the steering wheel in the fronto-nasal region, causing facial deformity (Fig 1, 2 & 3).

Fig 1: Patient's frontal view. The nasal pyramid deviation to the right is appreciated

Fig 2: Patient's three- quarter view the nasal bones intrusion is appreciated

Fig 3: Patient's superior view. The nasal pyramid deviation to the right is appreciated

He is evaluated by the neurosurgery service, who diagnose mild traumatic brain injury, with fracture of the anterior wall of the frontal sinus, did not require neurosurgical treatment and had no contraindication for maxillofacial reconstruction.

After the clinical and radiographic evaluation, a fracture of the anterior wall of the frontal sinus and Markowitz Type II naso-orbito-ethmoidal fracture were diagnosed (Fig 4 & 5).

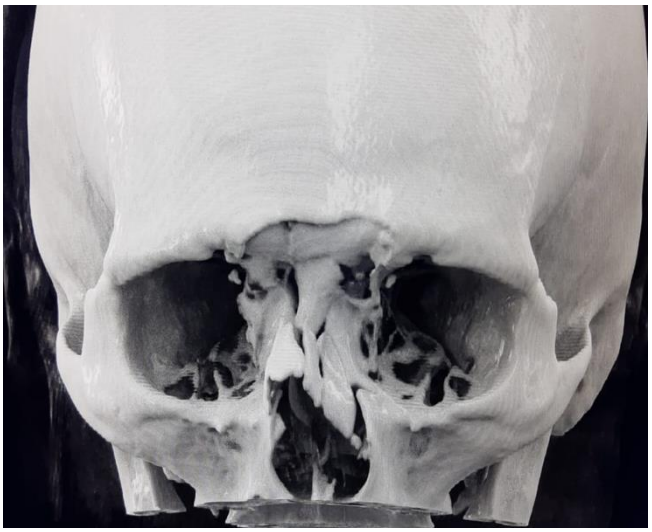

Fig 4: 3D reconstruction frontal view

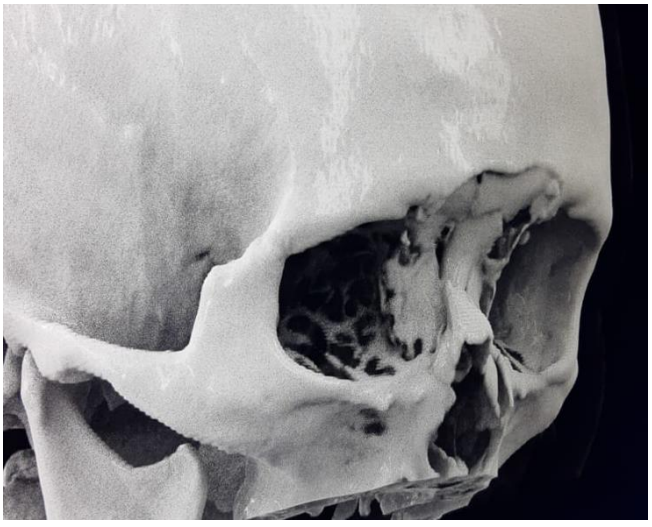

Fig 5: 3D reconstruction lateral three-quarter view

It was decided to perform a supraciliary approach described as "butterfly wings", which is performed with a supraciliary incision with an approximate lateral extension of 2cm. The anterior incisions approach medially, descending

in the region of the orbital rim until approaching the fronto-nasal suture, where they are connected perpendicularly by a line parallel to the fronto-nasal suture. An incision is made in the skin with a scalpel blade no. 15, blunt dissection is continued by planes until bone defect is identified. Anatomical reduction is performed by repositioning the larger fragments, which are fixed with plates and screws of the 1.5 system.

Fragments of the medial region of the orbit where there is no detachment of the medial canthal tendon are identified, which are repositioned and fixed with straight plates in the ideal anatomical position (Fig 6). The bowstring test is performed, and the wound is closed by layers using monocryl 4-0 in deep tissues and nylon 6-0 in skin. A rigid nasal splint is placed (Fig, 7 and 8).

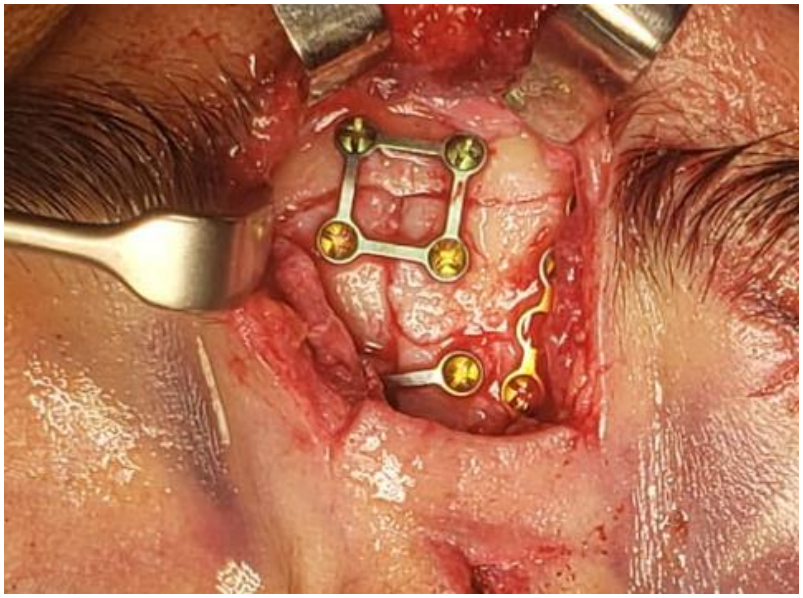

Fig 6: Open reduction and internal fixation

Fig 7: Wound closure

Fig 8: Rigid nasal splint

In the immediate postoperative volumetric reconstruction, an adequate reconstruction and position of the osteosynthesis material is observed (Fig 9).

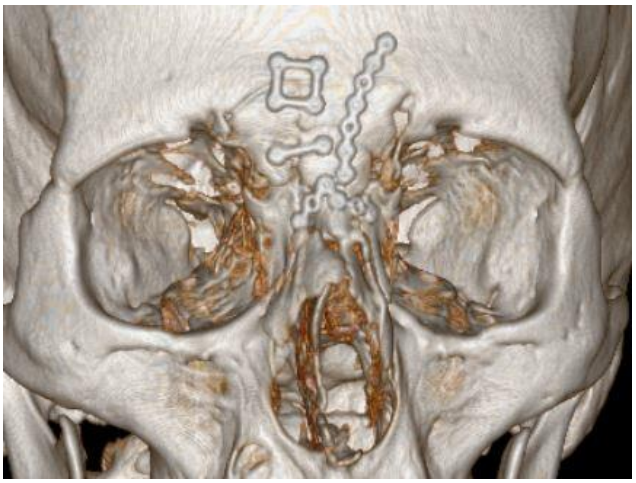

Fig 9: Immediate postoperative 3D reconstruction frontal view

Two months postoperative the nasal pyramid is appreciated central and symmetric, as well as a correct nasal bones projection. In addition, the scar is almost imperceptible (Fig 10, 11 and 12).

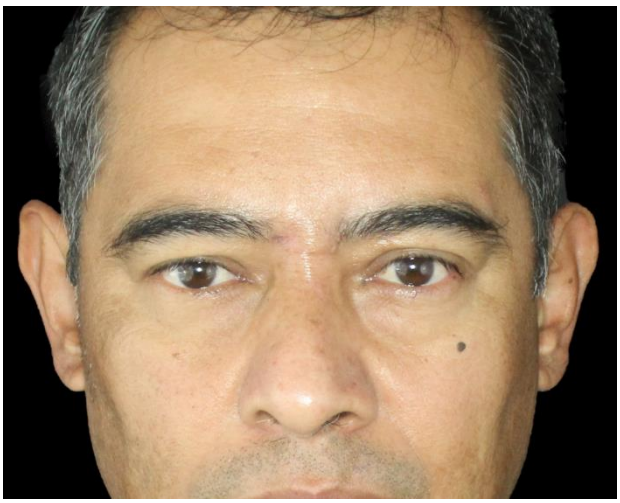

Fig 10: Two months postoperative patient's frontal view The nasal pyramid is observed central and symmetric

Fig 11: Two months postoperative patient's three-quarter view correct nasal bones projection is appreciated

Fig 12: Two months postoperative patient's lateral view correct nasal bones projection and symmetry is appreciated

LITERATURE REVIEW

The frontal sinus is the last of the paranasal sinuses to complete its development, usually reaching its final size in late adolescence or early adulthood. Fractures of the frontal bone and paranasal sinuses occur in approximately 5 to 15% of fractures of the facial skeleton. The frontal bone is one of the strongest bones in the facial skeleton, requiring more than 400 to 1000 kilograms of force to fracture [5].

Management of the frontal sinus depends on whether the anterior wall, posterior wall, or both are involved, to perform conservative treatment, endoscopic or open surgery [5].

The clinical examination begins with the evaluation of the fracture line with tomographic support, identifying the presence of hypoesthesia or anosmia, as well as evaluating the cerebrospinal fluid (CSF) leak [5, 6].

There are multiple classifications for NOE fractures, the Markowitz classification has been widely accepted. It classifies fractures into 3 types according to the degree of comminution of the central fragment and the state of insertion of the medial canthal tendon. Type I fractures have a single central fragment with the median canthal ligament attached. Type II fractures have a comminuted central segment with the tendon remaining attached to a solid piece of bone. Type III fractures have a comminuted central segment and a detached tendon [7].

The treatments to repair frontal sinus fractures include obliteration of the sinus, cranialization and reconstruction of the anterior wall for aesthetic indication [6].

Frontal sinus obliteration aims to maintain or restore a barrier between sinus and intracranial contents. This includes management of any CSF leaks and posterior wall fractures [5, 6]. Cranialization instead aims to remove the posterior wall of the frontal sinus; In both treatments it is extremely important to completely remove the frontal sinus mucosa [6].

The naso-frontal region involves different anatomical structures such as the medial orbital region, for access different approaches are described. The Howarth Lynch approach allows access to the floor of the frontal sinus with visualization of the ascending ramus of the maxilla and the ethmoid orbital portion. A curvilinear incision is made just below the medial end of the brow continuing to the lateral end [8].

The "gull-wing" approach is also described, with two curved supraciliary lines joined at the nasion with adequate visibility of the frontal region. The “butterfly wing” modification is a combination of the “gull wing” approach with an inferior extension up to one centimeter inferior to the glabella skin joined by a horizontal line [8, 9].

Effective repair of traumatic telecanthus has challenged surgeons for decades. Achieving an optimal result is difficult because in the intercanthal region of the face, even minor deficiencies are easily perceived. The medial canthus commonly has two anterior and posterior major bellies and a minor superior belly. The anterior limb is widely attached to the anterior lacrimal crest and nasal bone, the posterior belly is attached along the posterior lacrimal crest and medial orbital wall [8].

DISCUSSION

The reconstruction of the upper and middle facial third must contemplate both functionality and aesthetics.

Kim *et al*., [11] mentioned that the coronal approach has advantages such as: optimal exposure for taking bone, muscle and temporal fascia grafts, however, its disadvantages are large scar, dense paresthesias, headache, facial nerve injury (temporal branch) and alopecia. Establishing brain injury should be our priority in the therapeutics to be followed. Both in the choice of simultaneous neuro-surgical intervention and maxillofacial reconstruction, as well as the decision of which approach to carry out adjusting to the therapeutic needs.

Dalla Torre *et al*., [9] suggest that fractures with minimal bone displacement (0-2 mm) should be observed initially, while displaced fractures of more than 5 mm require surgery. Moderately displaced fractures (2 to 5 mm) are variable from case to case, but some are better treated with observation and follow-up, and in turn, Delaney *et al*., [12] proposes that in fractures with displacement less than 2mm, it is suggested to maintain with conservative treatment because of the minimal risk of visible deformity. In larger displacements, the extent and degree of comminution should be considered both for the choice of approach and for the need for autograft harvesting [5].

Pissano *et al*., [13] mentioned the canthal tendon is essential for the success of the operation, due to the increase in the intercanthal distance created by a detached tendon known as traumatic telecanthus. The average intercanthal distance is 30 to 35mm in adults [13]. The repair of the traumatic telecanthus is a challenge in the reconstruction of NOE fractures, the detachment of the median canthal ligament is clinically evident.

The goals of canthopexy include reestablishing the normal position of the medial canthal tendon, restoring the palpebral fissure, and preserving a palpebral occlusion. The posterior belly of the medial canthal ligament alone (without the anterior limb) is strong enough to maintain the position of the medial canthal after reduction [10].

CONCLUSION

The choice of surgical approach will be determined by the neurological status of the patient and the extent of the fracture.

The coronal approach is an excellent option, it allows the best visibility of both the upper and middle facial third. When the conditions exist, reconstruction treatment should be chosen in conjunction with neurological treatment.

In the case of patients who do not require neurosurgical treatment, supraciliary approaches are a good option, which allow sufficient visibility, less risk of bleeding, less surgical time, as well as less recovery time and hospitalization; Aesthetic compromise is minimal when proper wound closure is performed.

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