A review of the literature and five case reports

ACESSOS CIRÚRGICOS PARA FRATURAS DA PAREDE ANTERIOR DO SEIO FRONTAL – REVISTA DA LITERATURA E RELATO DE CINCO CASOS *

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* Paper presented as a partial requirement of the Discipline of Teaching and Research Methodology for obtaining a Certificate of completion of the Residency in Oral and Maxillofacial Surgery sponsored by the Foundation for Medical and Hospital Development (FAMESP). Chair Professor: Prof. Dr. Clovis Marzola.

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ABSTRACT

The frontal bone is rarely affected by fractures when compared to the other facial bones. The etiology of frontal sinus fractures usually involves accidents with high energy intense trauma and may be associated with other midfacial fractures, including naso-orbital-ethmoid and zygomatic fractures. Due to its anatomical location, the frontal region is in the field of activity of various specialties, therefore several therapeutic modalities have been proposed for the treatment of its diseases. In addition, the use of several surgical approaches have been reported in the literature, with its indication related to the type of fracture, the structures involved and the possible complications of the intervention. The Oral and Maxillofacial Surgery operates in treating fractures of the anterior wall of the frontal sinus. This paper proposes a review of the main surgical approaches advocated for the treatment of these fractures, with the presentation of five clinical cases of patients treated by the service of Oral and Maxillofacial Surgery of Base Hospital of Bauru - São Paulo.

INTRODUCTION

The frontal sinus is an air cavity which, together with the other paranasal sinuses, is responsible for warming and humidifying inspired air, it promotes resonance of sound waves emitted by the vocal cords, reduces the
weight of the head and protects the brain in trauma of the upper third of the face (RIBEIRO JÚNIOR; BORBA; GOUVEIA, 2007 and MARZOLA, 2008).

This structure is protected by a thick layer of cortical bone, the frontal boné is more resistant to fracture any bones of the face. Consequently, frontal sinus fractures are relatively uncommon accounting for 5-15% of maxillofacial injuries, with higher prevalence in males in the fourth decade of life (GERBINO; ROCCIA; BENECH et al., 2000; OMAGARI; MARZOLA; TOLEDO-FILHO et al., 2002; BELL; DIERKS; BRAR et al., 2007 and MARZOLA, 2008).

The frontal injuries described come from isolated fractures of the anterior wall, resulting in a simple deformity of the frontal contour, to those complex fractures involving the nasofrontal duct, orbit, skull base, and intracranial contents. The signs and symptoms of these fractures may vary according to the extent of the injury may submit a frontal depression, epistaxis, nasal obstruction, and neurologic changes (STRONG 2009).

Most cases of fracture of the frontal bone are associated with high speed and high impact trauma as automobile accidents, assaults and sports injuries. Due to the force required to fracture the frontal bone impact, simultaneous occurrence of intracranial, ophthalmic fractures and other maxillofacial injuries is very frequent (RAVEH; LAEDRACH; VUILLEMIN et al., 1992 and MARZOLA, 2008). About 66% of these patients have other associated facial fractures as those naso-orbito-ethmoid fractures and zygomatic (STRONG, 2009).

Well conducted and computed tomography in thin sections in multiple planes as the axial, coronal and sagittal, physical examination should be performed in all patients who come to present suspected fracture involving the frontal bone. This type of examination is essential to assess the extent of damage, the involvement of other structures, and to indicate the proper treatment (MARZOLA, 2008 and STRONG 2009).

The risk of long-term morbidity can be significant, and it is vital to have perfect knowledge of frontal anatomy and the field of treatment strategies for the management of these fractures. Inadequate treatment not only leads to cosmetic deformities and functional problems, it can also lead to serious complications such as the development of mucoceles, osteomyelitis, and potentially fatal complications related to the central nervous system such as meningitis and abscesses (LARRABEE; TRAVIS; TABB, 1980; WILSON; DAVIDSON; COREY et al., 1988; GERBINO; ROCCIA; BENECH et al., 2000; MARZOLA, 2008 and STRONG, 2009).

The most appropriate treatment strategy may be determined by considering five anatomical parameters, namely the involvement of the frontonasal duct, the integrity of the anterior and posterior walls, and the dural involvement, the presence of cerebrospinal fluid leakage (MANOLIDIES; HOLLIER, 2007).

The goal of treatment of frontal fractures include restoration of sinus physiology, restoration of facial contour and the prevention of complications in the short and long term (MANOLIDIES; HOLLIER, 2007).
Sometimes surgery can be complex and controversial. Exploration of frontal sinus with simple reduction is reserved for a minority of cases of simple fractures. Most cases of fractures require the frontal sinus obliteration and is performed with preservation of the posterior wall. The most extensive fractures or injuries presenting cerebrospinal fluid leakage often require cranialization frontal sinus after repair of damage to the dura. In both cases the nasofrontal duct should be handled appropriately in order to prevent serious complications (BELL; DIERKS; BRAR et al., 2007).

The refinement of surgical technique is continuously evolving to enhance visualization, the positioning of the scar, the final appearance, protection of vital structures and to reduce the number of complications. In formulating a treatment plan, the selection of the surgical approach is critical and can influence the difficulty of reduction and fixation of fractured segments, the length of operative time and hospital stay (ABUBAKER; SOTEREANOS; PATTERSON, 1990 and MANOLIDIS; HOLLIER, 2007).

New techniques involving guided endoscopic surgery provide a very acceptable alternative for some patients with less complex frontal fractures (MANOLIDIES; HOLLIER, 2007).

For the treatment of fractures of the upper third or combined with midface, with an indication for open reduction, various approaches and incision designs have been reported. Among the main lines for the treatment of fractures involving the frontal region, those most commonly described are the use of pre-existing lacerations, the coronal approach and the use of superciliary incisions like "gull wing", each one with particular indications (GERBINO; ROCCIA; BENECH, 2000; RIBEIRO JÚNIOR; BORBA; GOUVEIA, 2007 and MARZOLA, 2008).

The "gull wing" approach though quick and objective in fractures lesser extent results is a poor cosmetic result as a main drawback, especially in those patients with light skin, because the position of the partially visible residual scar (RIBEIRO JÚNIOR; BORBA; GOUVEIA, 2007 and MARZOLA, 2008).

Preexisting lacerations should be considered as an alternative approach whenever foreseen that they may promote adequate exposure of the area of interest, eliminating the need for a new surgical laceration, and reducing the morbidity of the procedure (STRONG, 2009 and FUSETTI; HAMMER; KELLMAN et al., 2011).

The coronal incision is the method of choice when lacerations do not offer enough exposure and its extension will result in a poor cosmetic result. In patients with maxillofacial trauma, coronal approaches are indicated for the reduction of fractures with severe craniofacial dysfunction, including Le Fort type III, involvement of the frontal sinus, nasoetmoidal fractures, zygomatic arch and body of the zygomatic bone commination, when craniotomy procedures for the treatment of intracranial injuries are needed, or osteotomies for the reduction of old fractures (ABUBAKER; SOTEREANOS; PATTERSON, 1990).

Whenever possible all the involved bones should be directly exposed through the surgical approach. A good visualization of the surgical site allows a more efficient management of fractures and controls the degree of displacement by promoting adequate access to perform anatomical reduction.
and fixation. Where multiple or single incisions are used to expose the segments, these incisions should provide maximum exposure, less scarring, and minimal chance of damage to nerves and other vital structures (Abubaker; Sotereanos; Patterson, 1990 and Marzola, 2008).

The literature lacks comparative studies regarding the indications and risks of the various approaches. This paper proposes a review of the most commonly reported surgical approaches for the treatment of fractures of the anterior wall of the frontal sinus, used by the specialty of Oral and Maxillofacial Surgery as well as discussion of current legislation on the subject. In addition, the study proposes a brief review of the literature involving epidemiology, classification, and treatment related complications of frontal sinus fractures. Based on these data, the objective is the establishment of criteria for indicating the approaches, illustrated by the presentation of 5 surgical cases.

REVIEW OF THE LITERATURE

Frontal Sinus Anatomy

The frontal sinus is absent at birth and at two years of age ethmoid air cells starts invading the frontal bone and the frontal sinus reaches its adult size at fifteen years of age. The final shape of the frontal sinus is asymmetrical, divided by multiple incomplete septa that deviate from the plane of the midline (Blitzer; Lawson; Friedman, 1985; Gray; Williams; Bannister, 1995 e Bailey, 1998). Its floor creates the medial portion of the orbital roof, with the rear board forming a portion of the anterior cranial fossa. The anterior cortical shape of the forehead, eyebrows and glabella. The frontal sinus is absent in 4% of the population, its size and the adult form are highly variable (McLaughlin; Rehl; Lanza, 2001) (Figure 1).

The anteroposterior depth of the frontal sinus is relatively constant between 8 and 9,3mm, height is greater in the midline reaching 24,5mm and gradually reducing in lateral direction (Lee; Sakai; Spiegel, 2010).

The floor of the frontal sinus is formed by the roof of the orbit laterally and at the nasofrontal drainage tract medially. It is lined by respiratory mucosa consists of ciliated columnar pseudo-stratified epithelium. Along the rear wall lies the foramina of Breschet responsible for vascularization within and between the subdural venous system, and is intimately involved in cases of intracranial spread of infection (Doonquat; Brown; Mullings, 2012).

The frontal sinus communicates with the nasal cavity through the nasofrontal duct, the narrowest portion of the sinus and, with hourglass configuration (Ribeiro Júnior; Borba; Gouveia, 2007). The nasofrontal duct structure is indistinguishable in most cases, is identifiable only in 15% of patients. Thus, the cavity can drain through the duct or other structures such as the anterior ethmoidal cells. This fact justifies the naming nasofrontal drainage tract rather than nasofrontal duct (Stanwix; Nam; Manson et al., 2010).

The osteo or opening of the nasofrontal drainage tract has an average of 3 to 4 mm in diameter and is usually posterior, inferior and medially.
located on the floor of the sinus following caudal to the anterior middle meatus. There are several significant anatomical variations in thickness, length and shape of the tract nasofrontal drainage (ROHRICH; HOLLIER 1992).

**Figure 1** - The frontal sinus has relationships with several critical anatomic structures. Including the following: The floor of the frontal sinus shaped roof of the orbital cavity / anterior ethmoid cells, the posterior wall is the boundary of the anterior cranial fossa and the anterior wall forms the front boundary.


**Biomechanics of the Frontal Region**

The frontal bone is the strongest component of the craniofacial skeleton and can withstand forces equivalent to 3.6 – 7.1 kN (NAHUM, 1975) ou até 9.8 kN (LAKHANI; SHIBUYA; MATHOG et al., 2001) before fracturing. Each wall of the frontal sinus performs a dual function. The anterior wall, formed by the frontal bone, is responsible for aesthetic contouring of the forehead and upper orbital rhymes.

Furthermore, due to its average thickness, it has greater capacity to absorb impact, acting as a horizontal buttress of facial skeleton, especially along the supraorbital rim (LINNAU; STANLEY; HALLAM et al., 2003) (Figure 2). The rear wall is thinner and is not part of the force distribution system of the face. This structure forms the anterior boundary of the anterior cranial fossa, separating the contents of the skull and sinus, lying strongly adhered to the dura (LAWSON, 1991).

Fractures affecting the frontal sinus are mainly caused by forces applied directly to the anterior portion of the skull in the glabellar region, the vast majority being associated with blunt trauma (MANOLIDIS, 2004). Among the etiologies reported, the most frequent is associated with motor vehicle accidents.
where the intensity of the trauma usually higher (FRENCKER; RICHTNER, 1960; POLLAK; PAYNE, 1976 and MARZOLA, 2008). The second most common etiology involves injuries caused by beatings (MARZOLA, 2008).

The highest incidence of frontal sinus fractures comprising the age group 21-30 years representing 25% of the total. This finding can be explained due to the higher activity of this group and its exposure to risks inherent in society (WILSON; DAVIDSON; COREY et al., 1988; GONTY; MARCIANI; ADORNATO, 1999; GERBINO; ROCCIA; BENECH et al., 2000 and MARZOLA, 2008).

Injuries able to break through the anterior wall typically affect both the posterior wall, and elements of the floor of the anterior cranial fossa, including the ethmoid fovea and the cribiform plate. This fact leads to the intraoperative finding of comminution of the anterior wall to the posterior wall associated with disruption of the dura fracture, can cause drainage of cerebrospinal fluid (ROHRICH; HOLLIER 1992).

Perforating injuries arising from injury by firearms and industrial accidents are associated with trauma with a high degree of concentrated force in a small area. These injuries are therefore associated with a high risk of damage to both walls of the frontal sinus, dural rupture, fracture of the cribiform plate and ethmoid fovea as well as impairment of the frontal lobe (MANOLIDIS, 2004).

Figure 2 - The anterior wall of frontal sinus is thick and resistant to damage. It requires greater force to fracture of any bone of the face (3.6 – 7.1 kN) (NAHUM, 1975)

Fractures of the Frontal Sinus Diagnosis and Physical Evaluation

The accurate diagnosis of damage to the frontal sinus is crucial to determine its appropriate treatment plan. Physical findings suggestive of a
Frontal sinus fracture include abrasions / lacerations of the forehead, contour irregularities addition, paresthesias and hematoma. The signs and symptoms observed in the initial rating should be carefully documented to avoid errors in interpretation of results and postoperative complications of their treatment (STRONG, 2009 and ECHO; TROY; HOLLIER, 2010) (Figure 3).

Frontal lacerations should be examined under sterile conditions by evaluating the perfect integrity of the anterior, posterior and dura wall. Transfixing lesions of the frontal sinus have high morbidity and immediate surgical treatment is always indicated (MARZOLA, 2008; STRONG, 2009 and ECHO; TROY; HOLLIER, 2010).

Conscious patients should be questioned about the presence of watery rhinorrhea or postnasal drainage of salty liquid, possibly showing the leakage of cerebrospinal fluid. Drainage suspect cerebrospinal fluid can be roughly measured with the "double halo" test. The bloody fluid is dripped on filter paper. If the presence of cerebrospinal fluid, it will diffuse faster than blood, resulting in a clear halo around the blood. The test Beta-2 transferrin is the definitive test to confirm the presence of CSF, however, it is generally sent for external analysis, taking 5-7 working days for the results to be obtained (STRONG, 2009).

\textbf{Figure 3} - Illustration of the anatomical parameters that need to be evaluated in developing a treatment plan for frontal sinus fractures. Yellow anterior wall; red, posterior wall; blue, nasofrontal duct; green, integrity of the dura.


\textbf{Imaging Evaluation}

Computed tomography of thin sections (1.0 to 1.5 mm) in the axial, coronal and sagittal planes is the gold standard for the diagnosis of frontal sinus
fractures. Axial images prove the best information about the anterior and posterior wall, allowing the observation of the degree of displacement. Moreover, one should devote special attention in evaluating the presence of pneumocephalus, indicative of greater severity of injury, and may require immediate action of a neurosurgeon (STRONG, 2009 and ECHO; TROY; HOLLIER, 2010).

Coronal cuts are used to evaluate the sinus floor and the roof of the orbits. Sagittal reconstructions can be useful latency nasofrontal duct, and three-dimensional reconstructions may help in the visualization of the deformity of the outer contour to be evaluated and is seen less clearly in two-dimensional cuts (STRONG, 2009).

Classification of the Injuries

Considering the lack of uniformity of treatment, and the limited number of fractures, several types of classifications have been proposed for the frontal sinus injury (KELLY; MANSON, 1990 and MANSON; MARKOWITZ, 1990). Most of these ratings are based on anatomical location, watching intraoperative findings, compared with preoperative assessment and CT scans in high resolution (STANLEY; BECKER, 1987; STANLEY, 1988 and GEBRINO; ROCCIA; BENECH et al., 2000).

Elaborate systems of classification with multiple subdivisions not significantly collaborate in the management of injuries. It is essential that these divisions are simple and reproducible standard for developing treatments (DOONQUAH; BROWN; MULLINGS, 2012).

Between ratings for frontal sinus fractures, most authors consider the division of the anterior wall fractures with and without displacement of the posterior wall, and those fractures tract draining the fronto-nasal duct (LUCE, 1987; STANLEY, 1989; ROHRICH; HOLLIER, 1992; CHUANG; DODSON, 2000; GERBINO, ROCCIA; BENECH et al., 2000; BELL; DIERKS; BRAR et al., 2007 and STRONG, 2009).

Added to this, injuries to the dura, presence of cerebrospinal fluid leakage and trauma, often associated with loss of brain tissue exposure should be considered in the classification of fractures of the frontal sinus (BEL; DIERKS; BRAR et al., 2007; MANOLIDIS; HOLLIER, 2007 and STRONG, 2009).

It was proposed also a division classifying fractures of the frontal region in type 1, those linear fractures of the anterior wall (external) with little displacement; the type 2, are comminuted or depressed fractures of the anterior wall may be involvement of the nasofrontal duct; those of type 3, with the involvement of both the anterior and posterior wall comminuted fractures; fractures of type 4, those comminuted fractures of the anterior and posterior walls with dural injury and liquirrhea potential; those fractures type 5, the comminuted fractures of both the anterior and posterior walls with injury to the dura mater and liquirřéia potential loss associated soft tissue / bone (MANOLIDIS, 2007) (Figure 4).
Fractures of the Anterior Wall

Fractures that are confined to the anterior wall need greater exposure when involving large extent, associated with naso-orbito-ethmoid fractures and fractures when there is need for bone graft (Abubaker; Sotereanos; Patterson, 1990; Ioannides; Freihoffer; Friens, 1993 and Ribeiro Júnior; Borba; Gouveia, 2007).

Isolated anterior wall fractures occur in 61.4% of cases. Patients suffering from frontal sinus fractures often have other facial fractures and associated systemic damage. Combined fractures of the anterior wall, posterior wall and nasofrontal duct represent 33% of the injuries front, isolated posterior wall fractures are uncommon (Gerbino; Rocca; Benech et al., 2000).

Fractures with little or no displacement (less than 1 - 2 mm) of the anterior wall of the frontal sinus may follow conservative treatment is periodically observed with little risk of late morbidity. Fractures with larger displacement (2 -
6mm) may present low risk for mucocele formation. However, the risk of cosmetic deformity increases with the degree of displacement.

The hierarchy of treatment goals for repair of frontal sinus includes the prevention of complications in the short and long term, and reestablishment of facial aesthetic contouring and normalization of sinus function if possible (STRONG, 2009; MANOLIDIS; HOLLIER, 2007).

Fractures of the Posterior Wall

A force of high energy is required to cause a fracture of the posterior wall, since it is able to withstand forces between 362 and 997 kg prior to fracturing (NAHUM, 1975). These fractures generally affect both segments of the sinus floor, ethmoid cells, nasofrontal duct and cribiform lamina. More than a third of affected patients have injuries involving the dura with liquorrhea (Figure 5).

In cases of cerebrospinal fluid leaks around 20-60% closed spontaneously, but the professional must consider the risk of meningitis (KOUDSTAAL; VAN DER WAL; BIJVOET, 2004). If a conservative approach is chosen, the patient should be instructed to keep the head elevated position. By keeping the head at or below heart level there is an increased pressure in the fistula site stimulating spontaneous drainage of cerebrospinal fluid. In recurrent cases may consider lumbar drainage to relieve pressure at the level of the lesion. In persistent cases that exceed 1 to 2 weeks, surgical intervention should be considered by the neurosurgical clinic (ECHO; TROY; HOLLIER, 2010).
The primary criteria for surgical intervention are the degree of displacement and the presence of liquorhea. Most authors advocate surgical exploration and sinus obliteration in cases of posterior wall fractures with dislocation or injury to the nasofrontal duct. In cases of involvement of the posterior sinus wall associated with the drainage of cerebrospinal fluid, the goal of treatment should be the restoration of the dura mater and the isolation of the intracranial contents through the obliteration of the nasofrontal duct and cranialization. This method aims to prevent complications such as infection, mucocele, liquorhea, and late complications (VILLAFÁN QUIROGA; CIENFUEGOS-MONROY; SIERRA-MARTÍNEZ, 2010).

Damage to the Nasofrontal Duct

Fractures involving the nasofrontal duct obstruction resulting in the only way to drain the frontal sinus. Regardless of damage to the anterior or posterior walls, the nasofrontal duct injuries that result in obstruction of the drainage channel usually require frontal sinus obliteration. Due to the compact nasofrontal anatomy, diagnosing damage to the duct material is difficult to obtain, being performed by computed tomography. Another alternative is to perform a trepanation of the frontal sinus and observing the permeability of the duct by endoscopy. This test also enables the analysis of intact posterior wall of the frontal sinus. However, endoscopy sinusotomy after trauma in the nasofrontal duct region can be technically challenging and should be reserved for surgeons with experience in both endoscopic sinus surgeries as treatment for open reduction of frontal fractures (MANOLIDIS; HOLLIER, 2007; BELL; DIERKS; BRAR et al., 2007 and STRONG, 2009). If an accurate assessment through endoscopy is not possible and there is no other significant damage to the frontal sinus, the patency can be followed clinically with CT scan after 3 and 12 months to ensure permeability and absence of frontal sinus stenosis (MANOLIDIS; HOLLIER, 2007).

Treatment

Appropriate decisions regarding the management of frontal sinus fractures can be performed considering parameters that include neurological status of the patient, involvement of the anterior wall, posterior wall of the nasofrontal duct injury, disruption of the dura mater and dislocation / fracture comminution, determined by clinical examination and radiographs.

Fractures should be repaired ideally within the first 24 to 48 hours if the patient has been stable. Immediate treatment is especially important in cases of patients with cerebrospinal fluid drainage, which the incidence of intracranial infection increases significantly after one week post-trauma (DOONQUAH; BROWN; MULLINGS, 2012).

These findings can be applied in the algorithm to determine the appropriate treatment options (Figure 5). These options include observation, endoscopic repair of fractures, open reduction with stable internal fixation, sinus
obliteration, cranialization sinus and rarely ablation procedure or Reidel (BELL; DIERKS; BRAR et al., 2007; MANOLIDIS; HOLLIER, 2007; and STRONG, 2009).

Observation

Some authors advocate a non-surgical procedure in simple fractures involving the frontal sinus, keeping the patient was followed up with periodic CT scans. The range of these imaging tests will depend on the severity of the injury and subsequent follow-ups will depend on the findings of the first scan. However, the patient should be aware that the presence of frontal headache or rhinorrhea, this interval should be reduced (COLE; KAUFMAN; MOMOH et al., 2009). Patients are encouraged to use of antibiotics, decongestants, in order to prevent the occurrence of infections and assist in draining the frontal sinus (GONTY; MARCIANI; ADORNATO, 1999; GERBINO; ROCCIA; BENECH, 2000; CHEN; CHEN; MARDINI, 2006 and ECHO; TROY; HOLLIER, 2010).

Obliteration

In cases where the posterior wall is minimally displaced without comminution and absence of laceration of the dura mater, the frontal sinus obliteration can be considered. The technique includes debridement of all sinus mucosa and obliteration of the nasofrontal drainage tract by affixing graft. Many materials have been used to achieve obliteration including abdominal fat, autogenous bone, hydroxyapatite cement, calcium phosphate cement, methylmethacrylate, polитетрафуоретилено, bioactive glass, muscle, pericranium, and spontaneous osteogenesis or "self-obliteration" (THALLER; DONALD, 1994 and TIWARI; HIGUERA; THORNTON et al., 2005).

The main problem with plastic is the theoretical potential for infection in this environment and avascular foreign body reaction with eventual failure of the material (BELL, 2009). Although a second surgical site is necessary, the authors believe that the source of autologous graft promoting better results em longo prazo (DOONQUAH; BROWN; MULLINGS, 2012).

Cranialization

The most severe damage evolving comminution with rupture of the posterior wall of the frontal sinus requires cranialization. This technique aims to remove bone fragments, restoration of dural continuity, removal of all sinus mucosa, communicating the space within the anterior cranial fossa. This approach, however, need to avoid sinus obliteration relationship between the dura and the inhaled air (RIBEIRO JÚNIOR; BORBA; GOUVEIA, 2007).

However, cranialization is a procedure with certain morbidity, requiring a craniotomy and neurosurgical expertise. Currently, there is a paucity of data evaluating results of nonoperative treatment of fractures of the posterior
wall of the frontal sinus, but some authors have reported success even in the presence of fragmentation, dislocation or drainage of cerebrospinal fluid (CHOI; LI; SHAPIRO, 2012).

Open Reduction

Fractures of the anterior wall that can not be managed conservatively through preservation or managed endoscopically may require open reduction and internal fixation. Among the risks associated with this approach we highlight risks of bleeding, infection, paresthesia, headache, liquorrhea, eye damage, diplopia, meningitis, external deformity and delayed mucocele formation. It is important to clean the wound meticulously, remove debris and devitalized sinus mucosa attached (DOONQUAH, BROWN; MULLINGS, 2012). After complete exposure of the frontal bone, the attention turns to the reduction of the fracture. Reduction of non comminuted depressed fractures can be extremely challenging. When the convex surface of the frontal bone is fractured, she undergoes a compression phase before becoming concave. The fracture reduction requires enough to pull bone fragments through the compression force, and it may require removal of the bone fragment to release tension and create space for the reduction. If comminution or bone segments overlap in the fracture zone, a small bone hook can be positioned between the fragments to assist in its reduction. Another technique places a screw from 1.5 to 2.0 mm in depressed segments, capturing the screw with a strong forceps and pulling upwards to reduce the segments. All attempts should be used to keep most of the fragments in position, allowing the most accurate repair (STRONG, 2009).

In situations in which the comminution is long or when bone fragments were missing, cranial bone grafts or iliac crest should be considered to restore the contour of the anterior wall (DOONQUAH, BROWN; MULLINGS, 2012). After opening with rigid internal fixation of the anterior wall of the frontal sinus and naso-orbito-ethmoid damage reduction, patients should be periodically evaluated with computed tomography scans. Long-term sequelae of frontal sinus fractures include chronic sinusitis, mucocele, meningitis and brain abscess (STRONG 2009). Also reported the occurrence of intracranial infection, osteomyelitis, epidural and epidural abscess and mucopyoceles (POLLAK; PAYNE, 1976).

Endoscopic Treatment

The use of endoscopy in trauma affecting the facial skeleton is a natural tendency in minimally invasive treatments between surgical specialties. The advantages of this technique include incisions small and discrete, limited and shorter postoperative recovery dissection. Authors have reported maneuvers for improving endoscopic techniques employed in otolaryngology and facial cosmetic surgery (FRITZ; KOLTAI, 2002; BELL; DIERKS; BRAR et al., 2007 and MANOLIDIS; HOLLIER, 2007).
Endoscopic interventions are applied in the treatment of facial fractures involving the region of the mandibular condyles, orbital floor and walls, zygoma and frontal sinus, with success rates varying (FRITZ; KOLTAI, 2002). Although surgical treatment is indicated, the risk of alopecia resulting from a coronal incision may result in a more severe deformity that iatrogenic traumatic injury. The endoscopic repair may also be indicated for this degree of displacement. Endoscopic treatment can be technically challenging, and sometimes preferable to observe her patients and perform an endoscopic camouflage fracture by filling the defect if a cosmetic deformity will develop. This avoids the need for surgical incision and allows the patient to observe the degree of deformity after the recession of the frame of edema. At this point the patient can choose whether to more clearly be subjected to surgical treatment (FRITZ; KOLTAI, 2002 and BELL; DIERKS; BRAR et al., 2007) (Figure 6).

Endoscopic fracture repair has been carried out satisfactorily with the use of bone substitutes to recreate the frontal boundary. In addition the use of bone replacements in the presence of acute injury is associated with risk of secondary infection, and should be systematically monitored. (FRITZ; KOLTAI, 2002)

**Figure 6** - (A) Illustration of the compressive forces on the frontal bone resulting from a fracture of the frontal sinus. (B) Illustration of the forces to be applied to reduce the frontal bone to its convex shape.


**Surgical Approaches**

The optimal surgical approach for the treatment of craniomaxillofacial fractures should provide maximum exposure of the fractured segments, ensuring less potential damage to the facial structures and allow satisfactory cosmetic results (ABUBAKER; SOTERNAOS; PATTERSON, 1990). Among the most common incisions described in the literature for access to the frontal sinus are the coronal or bicoronal techniques, superciliary approaches such as the "gull wing" and its variations, the modified endoscopic approach, the Lynch incision or through an existing approach laceration (GERBINO; ROCCIA; BENECH et al., 2000 and CHEN; CHEN; MARDINI et al., 2006) (Figure 7).
Figure 7 – Surgical approaches to the frontal sinus: A. Coronal incision, a line that extended across the coronal region from the temporal region to the contralateral side. B. Open-sky, curved incisions in the medial orbital region bilaterally joined by a straight incision on the nasal bridge. C. Gull Wing, curved incisions in the eyebrow area or slightly lower, bilaterally, connecting in the nasion. D. Butterfly, a combination of incisions Gull Wing and Open-Sky. E. Unilateral medial orbital incision. F. Approach through pre-existing lacerations.


Among the endoscopic access, the transnasal and Brow incisions modified to treat endoscopically have limited applicability. They are often used in small isolated fractures of the anterior wall of the frontal sinus without displacement, which require minimal attachment (DOONQUAH; BROWN; MULLINGS, 2012).

The resection of the floor of the frontal sinus ostium was dilated externally was much publicized (LYNCH, 1921 and HOWARTH, 1921). This approach is known as much access Howarth Lynch. A curvilinear incision is made just below the medial end of the eyebrow following to the medial corner. The frontal process of the maxilla and lamina papyracea is removed. The region of the frontal sinus is accessed through your floor and the lining mucosa is curetted, allowing endoscopic approach to fracture reduction. A stent or silicone tube is placed in the frontal sinus ostium to prevent stenosis and held in place for a period of 4 weeks to maintain the patency of the frontal sinus (HOWARTH, 1921 and LYNCH, 1921).

Limited in the anterior wall of the frontal sinus without involvement of the nasofrontal duct or the medial portion of the orbit with no other associated craniofacial fractures fractures can be reduced by a pre-existing laceration. If significant lacerations are present in the frontal region, these can be used to expose the fracture area. If more exposure is required, the laceration may be extended in one of the lines. However, if this has not torn significant extent, less than 5 mm, another approach must be used (STRONG, 2009).

The brow incisions are used since the early 20th century to gain access to the frontal, ethmoid and anterior skull base. The brow incisions as
"gull wing", a modified access "butterfly" and unilateral eyebrow incision provide direct and easy access to the frontal region, providing excellent exposure (BEASLEY; JONES, 1995).

The score line access "gull wing" generally passes through the eyebrow, bilaterally, joining the nasion at a sharp angle. A modification used unites the incisions through a linear incision that crosses the nasal bridge in a straight line, about 1 cm below the skin of the glabella, this modification is called access “butterfly” (LAWSON, 1991 and DUCIC; HOM, 1998). In both the approaches the incision is well camouflaged in the eyebrow, but becomes more evident on the nasion may result in a more visible scar than the other.

The indications for the use of a “gull wing” incision include cases of sinusitis in need of external bilateral approach sinus extendin intraorbitally or intracranially indicating external approach disease, and in patients with alopecia for better aesthetics, impossibility of using coronal access when needed or limited exposure (BEASLEY; JONES, 1995).

When performing the "gull wing" approach, the incision line is demarcated and infiltrated with epinephrine and local anesthetic to maximize hemostasis. The incision begins along the lateral portion of the brow medially and is held parallel to the hair follicles. Subcutaneous dissection continues until the occipitofrontal muscle. When this structure is achieved the supraorbital neurovascular bundles are identified. Other than unfavorable aesthetic, another major drawback to this approach is the possibility of paresthesia of the scalp, in some cases, it is unpredictable (BEASLEY; JONES, 1995 and DUCIC; HOM, 1998) (Figure 8).

Figure 8 – Comparative illustration of bone exposure obtained by different entrances: The figure A illustrates the area of maximum exposure promoted by superciliary access, limited to the supraorbital portion of the forehead, nasal bones and frontal process of the maxilla, while in B and C show the area exposure obtained through the coronal access, being able to expose the entire anterior portion of the skull, the frontal sinus, the anterior cranial base and sides, top portions of the lateral and medial orbital cavity, nasal dorsum, and, to the extent pre-ear the zygomatic bone, zygomatic arch, the temporomandibular joint, mandibular condyle and subcondilar region.

In other cases, the incision can be performed so complete the neurovascular bundles brow medially bilaterally. Since supraorbital neurovascular bundles are identified, an attempt is made to isolate and collect the fibers and the scalp is raised to a level Subgaleal the frontal sinus limits are reached. This incision tends to create visible scars from the midline, so careful consideration must be given to the patient before proposing such an approach (WELCH, 2010).

The unilateral eyebrow technique begins with the infiltration of local anesthetics with the medial portion of the brow extending 1 to 2 cm along the supraorbital rhyme allowing access to the frontal sinus. The incision can be made inside the eyebrow or taking advantage of a region with some creasing. In cases where the incision is made inside the eyebrow hair follicles to injury can be minimized by performing the incision parallel thereto and avoiding the use of electrosurgical this region. In patients with thin eyebrows incision can be positioned above or below this region in parallel the natural line of the hair bow. The incision tends to heal properly with better cosmetic results (MALIN; SHERRIES, 2010). Then, continuing to subperiosteal dissection to the level carefully to avoid injury to the supraorbital nerve can result in numbness in the forehead (HARDY; MONTGOMERY, 1976 and FUSETTLI; HAMMER; KELLMAN et al., 2011). The coronal incision promotes extensive exposure of the skull and allows access to the upper and middle third of the craniofacial skeleton with minimal morbidity. These states the aesthetic advantage of hidden by hair from scar patient factors were responsible for its popularity and its widespread use by various specialties (GABRIELLI; GABRIELLI, HOCHUL-VIEIRA et al., 2004; PASTORI; MARZOLA; SAAB et al., 2008 and STRONG, 2009). The technique was first described (HARTLY, 1907 and KENYON, 1907), being used by neurosurgeons for access to the anterior portion of the skull. Its use by maxillofacial surgery was first described (TESSIER, 1970) and subsequently reporting its use for performing osteotomies Le Fort II and III (KERAWALA; GRIME; STASSEN et al., 2000).

The coronal approach, a technique that is widely used for craniofacial osteotomies and is an excellent alternative to neurosurgical approach to intracranial contents. When used in conjunction with subciliary and buccal intraoral incisions, promotes optimal exposure and access to craniofacial fractures and middle third. The coronal access also provides the opportunity to collect the cranial bone through the same incision when ready for grafting is displayed and eliminates the need for a secondary incision in the other donor site (ABUBAKER; SOTERNAOS; PATTERSON, 1990). Although surgery uses this access for over a century, was only around 1990 that the implications of this technique were critically reviewed and surgical refinements were introduced to minimize the risk of complications. In this context, the surgeon must carefully consider the design, placement of the incision to the dissection plane, especially in the lateral extension of the coronal access to the zygomatic arch (MARTOU; ANTONYSHYN, 2011). The anesthetic intubation is connected to tracheostomy or oral / nasotracheal tube should be positioned to promote better access to the entire head, face and mouth (ABUBAKER; SOTERNAOS; PATTERSON, 1990).
The hair of the patient does not need to be shaved, but long hair need to be properly tied to delimit the incision line. Application of water-based lubricant on the hair facilitates the separation and the rapid application of bands. Surgical towels are stapled to the scalp immediately above the incision line (ABUBAKER; SOTERNAOS; PATTERSON, 1990 and STRONG, 2009).

Shaving, when done, should be extended at least 2-3 cm posterior to the planned incision line. In patients with long hair (at least 3-4 cm), the author advocates the zigzag incision technique positioned 4-6 cm posterior to the line of the scalp (KERAWALA, GRIME, STASSEN et al., 2000).

Postoperatively, when the patient is standing, the zigzag pattern causes gravity attracts the hair of the patient on the line segment transverse incision covering masking it. If the patient uses the default shorthaired only lengthens and accentuates the incision. In this situation, the coronal access through the traditional linear incision has the same results and is easier to perform. If a simple incision is performed, some type of marking shall be used along the incision to assist in the symmetric closure of the scalp and can be used for coloring or a bend in the anterior medial portion of the incision (ABUBAKER; SOTERNAOS; PATTERSON, 1990 and KERAWALA, GRIME, STASSEN et al., 2000).

In male patients with alopecia incision can be moved later to be camouflaged among the hair strands and need a slightly more extensive lateral dissection flap from the scalp to allow rotational flap forward (ABUBAKER; SOTERNAOS; PATTERSON, 1990 and STRONG, 2009).

The coronal incision starts at the upper junction of the ear helix and is extended transversely over the cranial vault to the opposite. The incision can be curved slightly forward on the vertex of the skull, following, but posterior the hairline (ABUBAKER; SOTERNAOS; PATTERSON, 1990) (Figure 9).

The pivot point of the previous retail coronal access was identified as its inferior aspect. If the coronal access is extended inferiorly dissection of the pre-auricular region is inevitable and is facilitated by the release of the periosteum at the root of the zygomatic arch before dissection in a plane just lateral to the capsule of the temporomandibular joint. Through this technique the parotid gland is deflected earlier, increasing the chance of facial nerve preservation. Also, it allows adjustment of the coronal incision anteroposteriorly without limiting access to the facial skeleton, placing it in the occipital region and preventing the exposure of the scar in patients prone to the development of alopecia (KERAWALA, GRIME, STASSEN et al., 2000).

The skin and the subcutaneous tissue are incised from a temporal line to the other. Two double claw hooks are used to retract the scalp and removes it from the skull, protecting the underlying pericranium undamaged. In the moment the aponeurotic galea is incised, the subgaleal space is invaded by air, forming an excellent dissection plane (ABUBAKER; SOTERNAOS; PATTERSON, 1990)

Any bleeding from large vessels should be contained individually. When possible, generous amount of vasoconstrictor should be injected into the subgaleal plane prior to surgery. The electro cautery should be used cautiously, avoiding injury to the hair follicles. Raney Clips can be used to aid in
hemostasis according to surgeon preference (ABUBAKER; SOTERNAOS; PATTERSON, 1990 and STRONG, 2009).

The lateral dissection of the scalp requires detailed anatomical knowledge of the temporal region. At the point where the temporal fascia splits into two layers, an incision running at 45 degrees superiorly and forth is performed on the superficial layer of the temporal fascia approximately 2 cm above the zygomatic arch. The incision should be deepened about 1 to 2 mm, performed by temporoparietal fascia, connecting the temporal artery and vein and confirming the presence of the temporal muscle (dark red mass) below this plane. The flap is then shifted earlier by blunt finger dissection or through gauze, with limited use of the scalpel dissection. The integrity of the temporoparietal fascia should be maintained, as this contains the frontal branch of the facial nerve (ABUBAKER; SOTERNAOS; PATTERSON, 1990 and STRONG, 2009) (Figure 10).

The scalp is then rotated forward, or by incision and blunt may be used for dilatation of Subgaleal flap up to 3 to 4 cm above the supraorbital edge dissection. Care should be taken to avoid injury to the supraorbital and supratrochlear neurovascular pedicles. The flap of pericranium is then incised parallel 2 cm behind the initial incision in the scalp (Figure 11).

Once the plane of dissection is established superficial deep layer of temporal fascia, the plane of dissection is continued inferiorly until the periosteum of the zygomatic arch is reached (ABUBAKER; SOTERNAOS; PATTERSON, 1990 e STRONG, 2009) (Figure 12).

The periosteum is then incised and deflected over the arch, the body of the zygoma and lateral orbital rim. When the flap and the subperiostal flap in the supraorbital region are inverted inferiorly and forth they promote exposure of the frontal bone, the upper part of the nose and nasoetmoidal region; the roof, sidewalls and medium orbits, the zygomatic bone; zygomatic arch and the entire (ABUBAKER; SOTERNAOS; PATTERSON, 1990).

After the fracture treatment follows for the closure of the surgical wound. Should reposition the soft tissues to avoid temporal brow ptosis and upper midface long term. The periosteum and the temporal fascia are sutured using 3-0 sutures reabsoríveis. Two monofilament sutures of 2-0 nylon are passed through the temporoparietal fascia and suspended in the temporal muscle fascia (STRONG, 2009).

While there may be tears in the periosteum in the fracture zone, careful dissection to preserve greater loss of vascularization should be taken providing an extensive flap that can be used to repair liquorhea or obliteration of the sinus if necessary.

Maxillofacial surgeons have used the coronal access nearly four decades for access to the craniofacial skeleton. However this technique is not without complications. Poor cosmetic outcome has been reported, particularly in patients with a tendency to male alopecia (KERAWALA, GRIME, STASSEN et al., 2000).
Figure 9 - Incision lines for coronal access and its various modifications. A. Front view. B. Right Side View. C. Classical linear incision, used in patients with short hair. D. Zigzag incision used in patients with long hair that will hang over the incision line. E. Incision with previous curve "widow's peak", avoiding exposure of patients with a tendency to male alopecia.


Figure 10 – Illustration of the tissue layers of the skull showing the plane of dissection flap in the coronal access. The initial incision is made down to the level of the aponeurotic galea and dissected inferiorly over the pericranium (ABUBAKER; SOTERNÃOS; PATTERSON, 1990).

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Figure 11 - Illustration of temporal dissection during the coronal access. The surgeon should be familiar to the anatomical planes of the temporal scalp to avoid injury to the temporal branch of the facial nerve.


Figure 12 - Incision of the superficial temporal fascia for exposure of the zygomatic arch. This plane of dissection allows protection to the temporal branch of the facial nerve as shown in the illustration.


A closed drains system is positioned superficial to the pericranium. The incision is then closed in two layers. The galea is closed using interrupted sutures of 3-0 Vicryl and the skin is closed with continuous 3-0 nylon sutures. A pressure dressing is applied, and should be removed along with the drain in 48 hours postoperatively (ABUBAKER; SOTERNAOS; PATTERSON, 1990).
The presence of visible scarring has been reported in up to 7% of patients without alopecia (ABUBAKER; SOTERNAOS; PATTERSON, 1990). The traditional straight through the scalp was changed to a pattern W (Zigzag) by Munro and Fearon to prevent scar visibility, and currently most coronal incisions consist of a non-linear incision or W pattern in a lightweight format S. Inferiorly the incision can be extended ahead of or after the ear. Both promote excellent healing results, but the pre-auricular extension puts the superficial temporal vessels at risk. For this purpose, recent designs position the incision at least 8 cm posterior to the hairline to ensure no visible scar and preservation of the superficial temporal artery (SHEPHERD; WARD-BOOTH; MOOS, 1985).

A retrospective study showed a low incidence of permanent morbidity with the use of this type of access, while 35% (24) of the 68 patients analyzed show some kind of immediate sensory abnormality having spontaneous resolution in all cases. Three patients developed alopecia male postoperatively, resulting in exposure of scarring and poor cosmetic outcome (KERAWALA, GRIME, STASSEN et al., 2000).

Complications of access were reported temporary permanent nerve injuries (10% -15%) or (2%), sensory loss, depression of the temporal fossa, hair loss and bruising. Most injuries to the frontal branches is secondary to excessive flap retraction, lower extensions in the pre-auricular incision tend to improve the mobility of the flap without tension. Sensorial damage in this region are temporary if the supraorbital nerves are adequately protected by covering the subperiosteal dissection. The depression of the temporal fossa is caused by the absence of the fat layer, blood supply of the temporalis muscle by excessive dissection or cautery or even inadequate suspension of deep temporal fascia. A combination of blunt dissection and well conducted in the zygomatic arch region tends to minimize damage to the blood supply of the fatty layer (KERAWALA, GRIME, STASSEN et al., 2000 and FRITZ; KOLTAI, 2002).

Performing the incision parallel to the hair follicles and limited use of cautery and dissection in the subcutaneous region incisions can prevent permanent loss of hair strands (FRITZ; KOLTAI, 2002). Other hits such as access "open" and unilateral medial orbital incision were described and used in a limited way to treat these fractures. (CHUANG; DODSON, 2000).

The approach "open" can be advantageous in elderly patients who developed wrinkles in the glabella region due to the action of the procerus muscle. This approach can be used to avoid the use of coronal incision in cases where less exposure is needed (FUSETTI; HAMMER; KELLMAN et al, 2011). However, the exposure provided normally makes it not appropriate for treatment of frontal bone fractures.

The incision usually results in an H-shaped scar very visible over the region of Nasion, due to the prominence of the anatomical region and the consequent reflection of light, requiring bulky frame glasses to be hidden (CHUANG; DODSON, 2000). Unilateral orbital incision provides good visibility of the medial region of the orbit, but of very limited applicability for the treatment of frontal sinus fractures and is not indicated for use for the treatment of these fractures. Access still results in a very visible scar in the medial canthal region (FUSETTI; HAMMER; KELLMAN et al, 2011).
Legal, Normative and Scientific Aspects

The Dentistry specialty of Oral and Maxillofacial Surgery works in the reconstruction of the front contour in patients with isolated fracture of the anterior wall of the frontal sinus with or without other facial fractures (ABUBAKER, 1990 and ELLIS, 2005).

Brazilian law is inaccurate when imposing anatomic limits to the action of the specialty, clearly establishing only the lower limit for cervical approaches to the face as the height of the hyoid bone, infrahyoid approaches being of exclusive medical competence (Article 43 and 48 CFO-100/2010 CFM and No. 1950/2010). However, there is a gap regarding to the upper and posterior limits of action of the specialty.

Art. 43. The use of infra-hyoid neck incision is forbidden to the dentist, as it escapes the dominion of their area of expertise, as well as the practice of cosmetic surgery, except for the aesthetic-functional surgery of the masticatory system.

Art. 48. It is the sole responsibility of the medical professional the treatment of malignancies, neoplasms of the major salivary glands (parotid, sublingual, submandibular), access the infra-hyoid neck incision, as well as the practice of aesthetic surgery, aesthetic-functional except for the stomatognathic system which are the responsibility of the dentist.

The ear tragus posteriorly and the hairline superiorly seems to be the limits of action of the specialty, however the use of surgical approaches for the treatment of frontal disorders with precise indication of the coronal approach, which is positioned posterior to the hairline it is not specifically described (GREGORI, 1987) (Figure 13).

Figure 13 - Anatomical limits of action of the Oral and Maxillofacial specialty, as described by GREGORI (2005) the triquium as the upper limit, the posterior limit being the ear tragus and the lower limit the hyoid bone.

Fonte: Illustration courtesy photographer Wesley Iguti, his private collection.
The Article 6 of Law 5081/66 implies that “incumbent upon the dentist to practice dentistry all relevant actions arising from knowledge acquired in the ordinary course or courses of postgraduate”. Added to this the Article 5 of Chapter II the basic rights of the Council of Ethics provides dental professionals enrolled, according to their specific tasks, the right to “diagnose, plan and execute treatments, with freedom of belief, in the limits of their responsibilities, observing the current state of science and their professional dignity”.

Authors enshrined within the dental profession ratify as being competence of maxillofacial surgery the treatment of fractures of the upper third of the face (ABUBAKER, 1990 and ELLIS, 2005).

The literature also describes the use of coronal incision as a precise approach for complex fractures involving the region of the upper and midface, its execution being made by a dentist specialized in oral and maxillofacial surgery (ABUBAKER, 1990; ZANINI, 1990; BARROS, 1993; ELLIS, 2006; FREITAS, 2006 e MARZOLA, 2008).

In the field of Law, Jurisprudence is defined as the uniform and consistent set of judgments on similar cases. The law has no force of law but express the applicability of the law, which can be changed according to the socioeconomic moment the company is. So it can be used both by magistrates, as lawyers, to base their interpretations of legislation (MONTORO, 2000).

Suit post, considering the lack of specific and relevant laws and regulations on this topic, it seems reasonable to adopt here the same legal principle of Jurisprudence of Law for Science, which, by analogy, could be assigned as the Scientific Case, or Scientific Precedents, where numerous publications of Classical Literature and Consecrated demonstrate unequivocally that ALL access in vogue, are used over the past 60 years by Professional Dentistry and Specialty Surgery and Oral and maxillofacial Traumatology, ratifying, even tacitly, possibility of their use by the maxillo-facial surgeon, without thereby be acting unlawfully against the legislation, and in spite of the fact that there is nothing that says otherwise. (ABUBAKER, SOTEREANOS; PATTERSON, 1990; ZANINI, 1990; BARROS; MANGANELLO-SOUZA, 1993; ELLIS III; ZIDE, 2006; DE FREITAS, 2006 and MARZOLA, 2008).

Case Reports

Case 1

L. G. S. patient, male, 25 years old, leucoderma, came to the Clinic of Oral and Maxillofacial Surgery of the Base Hospital of Bauru - FAMESP sent by the Neurology Service to restore the contour of the anterior wall of the frontal sinus following in conservative treatment of a fracture of the posterior wall of the frontal sinus. The patient reported having been the victim of physical aggression with a building block 17 days before the consultation, soon after the injury the patient was treated at the Emergency Center. Physical examination revealed a large residual scar on his forehead from a cut originated by a blunt trauma injury that was immediately sutured in the time of the lesion and depression of the forehead.
Analysis of imaging studies revealed a frontal sinus fracture involving both anterior and posterior walls. The approach was performed through the existing laceration. The patient underwent general anesthesia and the incision was performed encompassing the unfavorable scar, seeking its removal during surgery. The reconstruction of the anterior wall of frontal sinus was carried using titanium mesh (Figures 14 to 20).

**Figure 14** – Preoperative frontal view, noting the presence of unfavorable scar on forehead.
*Fonte:* Collection of the Department of OMS of the Base Hospital of Bauru.

**Figure 15** – Computerized axial tomography, preoperative cut, showing traces of frontal sinus fracture of both the anterior and posterior walls.
*Fonte:* Collection of the Department of OMS of the Base Hospital of Bauru.
Figure 16 – Surgical approach via the pre-existing laceration.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 17 – Exposure of the frontal region, showing comminuted fracture anterior wall of the frontal sinus.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 18 – Anatomical reduction and reconstruction of frontal contour with a titanium mesh.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
Case 2

Patient L.C.M. male, 48 years old, leucoderma, attended the Clinic of Oral and Maxillofacial Surgery Service of the Base Hospital of Bauru – FAMESP claiming to have been victim of a work accident (bull kick) 25 days before presenting at the physical examination sinking in frontal region and right wall of the nose. Intense post-trauma epistaxis with decreased nasal patency at query time was also noted (Figures 21 to 29).
Figure 21 – Preoperative frontal view, sinking frontal and right nasal wall are observed. 
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 22 – Computed tomography in the preoperative axial cut, showing fracture of the anterior wall of the frontal sinus. 
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

A Butterfly incision was elected as an access to the fractured region, two arched brow incisions connected by a linear incision in the nasal bridge. Continues with plan dissection with careful preservation of the supraorbital neurovascular bundle bilaterally. Anatomic reduction of viable segments was performed, followed by rigid internal fixation with screen plates and screws, continuing with the closure of the surgical wound and sutured by planes.
Figure 23 – Computed tomography in the preoperative axial section showing nasal fracture.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 24 – Eyebrow Butterfly incision.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 25 – Plane fivulsion and exposure of fracture lines, indicating the presence of neurovascular bundles bilaterally supraorbitários and showing their possible intraoperative distention without prejudice to its preservation (left beam under afastador of Farabeuf).
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
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Figure 26 – Anatomical reduction of viable segments and rigid fixation with titanium plates and screws.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 27 – Suture of the dissected planes, immediate postoperative.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 28 – Postoperative 7 days.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
Case 3

Patient L.P.T.R., male, 17 years old, leucoderma, came to the Clinic of Oral and Maxillofacial Surgery Service of the Base Hospital of Bauru - FAMESP reporting having been the victim of a motorcycle accident. On physical examination there was swelling with palpable sinking frontal, left lateral, complaining of intense pain. After examining the imaging studies that revealed traces of fracture compatible with isolated fracture of the anterior wall limited to the left lateral portion of the frontal bone frontal sinus, the patient underwent open reduction with internal fixation, using the unilateral eyebrow access due to the fracture area. Work continued with the incision of the skin and subcutaneous tissue eyebrow sequentially by performing careful dilatation of the plans in order to avoid injury to the supraorbital neurovascular bundle, which was retracted and secured with a strip of latex during surgery (Figures 30 to 38).

Figure 30 – Preoperative frontal view.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
Figure 31 – Computerized axial tomography in, showing sinking of the anterior wall on the left side.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 32 – Unilateral eyebrow approach.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 33 – Divulsion plans with preservation of the supraorbital nerve vascular bundle.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
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Figure 34 – Exposure of the fracture area.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 35 – Fracture reduction and reconstruction of the anterior wall with titanium mesh.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 36 – Immediate postoperative.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Case 4

Patient J.G.M. male, 17 years old, leucoderma, came to the Clinic of Oral and Maxillofacial Surgery Service of the Base Hospital of Bauru - FAMESP claiming to have been victim of a motorcycle accident. Physical examination revealed sinking of the frontal region. The analysis of imaging studies confirmed the diagnosis of isolated fracture of the anterior wall of the frontal sinus, with loss of the cranial shape of fronte. The approach chosen for open reduction and fixation was a coronal incision. After marking the incision with bright green coloring, planning a curve in the medial portion (widow's peak), providing male senile alopecia patient a more aesthetic positioning this incision within this circumstance was performed. The incision was carried deep to the plane of the pericranium, the forehead flap was displaced anteriorly being dissected on the plane superior to the pericranium up to the supraorbital margin. Hemostasis was achieved with the use of sutures festooned with 2-0 cotton and electro bipolar cauterity (Figures 39 to 49).
Figure 39 – Pré-operatório, vista frontal.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 40 – Preoperatively, top view.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 41 – Computed tomography axial section showing involvement of the anterior wall of the frontal sinus.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
**Figure 42** – Three-dimensional tomographic reconstruction showing frontal sinking. 
**Fonte:** Collection of the Department of OMS of the Base Hospital of Bauru.

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**Figure 43** – Demarcation line coronal incision to access with bright green dye. 
**Fonte:** Collection of the Department of OMS of the Base Hospital of Bauru.

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**Figure 44** – Coronal approach exposing the fractured region. 
**Fonte:** Collection of the Department of OMS of the Base Hospital of Bauru.
Figure 45 – Reconstruction of the anterior wall with titanium mesh and screws. 
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 46 – Anterior view of the same previous reconstructed front wall with titanium mesh. 
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 47 – Closing surgical access plans with installation of closed and active drain Portovac® drainage of exudates. 
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
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Case 5

A.P.R. patients were male, 36 years old, leucoderma, came to the Clinic of Oral and Maxillofacial Surgery Service of the Base Hospital of Bauru - FAMESP claiming to have been the victim of a sports / work accident (professional bull riding) per day with an interval of 160 days, subject to prior approach for reducing frontal fracture (Figures 50 to 56).

Figure 50 – Preoperative view showing the lateral incision scar hemicoronal previous surgery 2 months before.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
Figure 51 – Preoperative coronal view showing hemicoronal incision in previous surgery, two months old scar.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

On physical examination showed subsidence frontal, left lateral portion, associated with palpable depression of the right temporal region. The patient had limited mouth opening.

Tomography showed suggestive traces of the anterior wall of the frontal sinus, no gift fixing material fracture. We also observed comminuted fracture of the zygomatic arch of the left.

The elected approach of fractures was the pre-existing laceration already used with hemicoronal incision (Figures 49 to 55).

Figure 52 – Preexistent hemicoronal incision for access to the zygomatic arch.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 53 – Exposure of the anterior wall of the frontal sinus fracture after exposure.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
Figure 54 – Exposure of the zygomatic arch fracture.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 55 – Reconstruction of the anterior wall with titanium mesh, anatomic reduction and rigid internal fixation of the left zygomatic arch with plate and screws.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.

Figure 56 – Immediate postoperative.
Fonte: Collection of the Department of OMS of the Base Hospital of Bauru.
DISCUSSION

Frontal sinus fractures are usually associated with motor vehicle accidents and injuries caused by physical aggression (FRENCKER; RICHTNER, 1960; POLLAK; PAYNE, 1976 and MARZOLA, 2008). The cases presented in this study corroborate the literature as the main reported etiologies are traffic accidents and physical aggression, with the exception of clinical cases 2 and 5, which had trauma related to risks of the work environment.

The highest incidence of frontal sinus fractures comprising the age group between 21-30 years (WILSON; DAVIDSON, COREY et al., 1988; GONTY; MARCIANI; ADORNATO, 1999; GERBINO; ROCCIA; BENECH et al., 2000 and MARZOLA, 2008). Although the mean age of the patients reported in this study was 28.6 years, there was a variety of ages of which only the patient of the case 1 was in the proposed range, the other patients were on the second (cases 3 and 4), forth (case 5) and fifth (case 2) decades of life.

The isolated involvement of the anterior wall of the frontal sinus was present in 80% of cases, in congruence with the literature that mentions a higher frequency of involvement of this region (GERBINO; ROCCIA; BENECH et al., 2000 and MARZOLA, 2008).

In the present study, we observed association of frontal sinus fractures with fracture of other structures of the midface in 40% of cases, evidencing the zygomatic bone fracture (20%) and nasal fractures (20%). The data obtained confirm the findings reported by other studies describing the association of frontal sinus fractures with other facial injuries in 58.2% of cases, including NOE fractures, Le Fort II and III, zygomatic, orbital and nasal (GERBINO; ROCCIA; BENECH et al., 2000; GABRIELLI; GABRIELLI; HOCHULI-VIEIRA et al., 2004; BELL; DIERKS; BRAR et al., 2007 and MARZOLA, 2008).

The surgical approach should be elected targeting maximum exposure of the fractured segments, less potential damage to the facial and satisfactory cosmetic results structures (ABUBAKER; SOTEREANOS; PATTERSON, 1990). In case 1 the patient had a large scar from previous laceration in the frontal region, allowing its use for access, reduction and fixation of fractured segments. The conduct was congruente with the literature that describes the use of residual scars for the treatment of fractures limited to the anterior wall of the frontal sinus without involvement of the nasofrontal duct or the medial portion of the orbit and no other craniofacial fractures associated (STRONG, 2009b).

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The brow incisions such as "gull wing" and its variations provide direct and easy access to the frontal region (BEASLEY; JONES, 1995). Some authors have reported unfavorable aesthetic, when using the supraorbital techniques as gull wing and butterfly, especially in the nasion region (BEASLEY; JONES, 1995; DUCIC; HOM, 1998 and WELCH, 2010). This philosophy is not shared in our service, which in selected cases makes use of these approaches, as noted in case 2 where a butterfly approach was elected presenting satisfactory cosmetic result. In case 3 the patient had fractures...
involving the supraorbital region without involvement beyond the midline allowing the execution of an access to a lesser extent, justifying the choice of a unilateral brow incision. Although authors have reported the possibility of injury to the supraorbital nerve can result in numbness on the forehead, this finding was not observed in our case (HARDY; MONTGOMERY, 1976).

The coronal access promotes extensive exposure of the skull and allows access to the upper and middle third of the craniofacial skeleton with minimal morbidity and aesthetic impairment and promote simultaneous exposure of donor area for possible bone grafting (GABRIELLI; GABRIELLI, HOCHULI-VIEIRA et al., 2004; PASTORI; MARZOLA; SAAB et al., 2008; MARZOLA, 2008 and STRONG, 2009b). Authors reported as complications of this approach temporary or permanent nerve injury, sensory loss, depression of the temporal fossa, hair loss and hematoma (KERAWALA; GRIME; STASSEN et al., 2000; MARZOLA, 2008; FRITZ; KOLTAY, 2002 and STRONG, 2009b). Where there was a greater involvement of the frontal region requiring wide exposure of the surgical site. The present study is consistent with the literature that reports extensive exposure of the frontal region coupled with lower morbidity and aesthetic advantage justifying the election of coronal and hemicoronal incisions respectively for the resolution of cases 4 and 5. Furthermore, unlike some studies, no complications were observed for the use of these approaches. The complications inherent in frontal sinus fractures can be severe, with reported pneumocephalus, intracranial infection, sinusitis, osteomyelitis, meningitis, epidural abscess and epidural mucocele and mucopyoceles (POLLAK; PAYNE, 1976 and STRONG, 2009b). In disagreement with the literature, no complication was observed in the cases reported in this study.

The legislation is still imprecise and vague in certain aspects regarding our specialty, especially in determining the limits of acting of Oral and Maxillo Facial surgeons. However, regarding the Law and the Normative governing the practice of Dentistry and Specialty of Oral and Maxillofacial Surgery and Traumatology, by customs and by analogy to the concept of Case Law, the scientific case law or scientific precedent, is doctrinally ensured the role of expert in the treatment of injuries affecting the upper face and the use of the approaches described. The coronal access is included in this range of approaches, it is recommended for full and proper implementation of surgical procedures, specifically the Oral and Maxillofacial Surgery, sheltered and supported by existing legal regulations (BRASIL, 1966; ABUBAKER; SOTEREANOS; PATTERSON, 1990; ZANINI, 1990; BARROS; MANGANELLO-SOUZA, 1993; MONTORO, 2000; CFO, 2005; ELLIS III; ZIDE, 2006; DE FREITAS, 2006; MARZOLA, 2008; CFO, 2010; CFM, 2010 and CFO, 2012).

CONCLUSIONS

Oral and Maxillofacial Surgery acts in restoring sinus physiology, facial contour and to prevent of complications in the short and long term in cases
of fractures of the anterior wall of the frontal sinus with or without involvement of other facial structures. The selection of the surgical approach influences the difficulty of reduction and fixation of fractured segments and also has a direct impact on intraoperative time. The ideal incision should promote maximum exposure, minimal scarring, and less chance of damage to the facial nerves and other vital structures and existing lacerations should be considered as an access path whenever they have sufficient length to promote adequate exposure of the area of interest thus decreasing the morbidity of the procedure.

The indication for the surgical approach should consider the extent of the fractured area, the structures involved and the particular aesthetic relevance of each case, in order to reduce morbidity and the risk of possible complications. In this context added to the cases presented, it is observed that the use of superciliary accesses in treating fractures of the upper third of the face is a viable alternative for fractures without involvement of other facial structures and less aesthetic relevance. In cases of more extensive fractures, affecting or not other facial structures, where wide exposure is needed, the coronal access the most appropriate choice for the treatment of these patients.

In the presence of specific legislation with certain gaps, the right of acting of Oral and Maxillofacial surgeons in treating fractures of the upper third of the face, as well as the use of any approaches that are deemed necessary for treatment of the same, are ensured through legislation into customs and practices, and through the current stage of Science, based on classic literature of the specialty, considering the fact that there is nothing stating the contrary.

REFERENCES *


* According of the ABNT norms and of the ATO’s Review.
SURGICAL APPROACHES FOR FRACTURES OF THE ANTERIOR WALL OF THE FRONTAL SINUS – A REVIEW OF THE LITERATURE AND FIVE CASE REPORTS


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