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Research Article

Fractured Palatal Bone During Maxillary Descent in Orthognathic Surgery

Juan Mancilla Uribe[1]*, Mauricio Duarte Ramírez[1], Felipe Estrada Caceres[2], Rodrigo Badilla Monasterio[1]

Abstract

Introduction: Maxillary descent is a procedure that is performed after completing the Le Fort I osteotomy in orthognathic surgery, to release the maxillo-palatine complex and mobilize it to the desired position. It is necessary to consider the various surgical factors that may cause the appearance of an unwanted fracture in the palatine bone at the time of maxillary descent. The objective of this work is to evaluate whether an unwanted fracture of the palatine bone occurs during maxillary descent and to analyze if there are factors or situations associated with the patient or the surgical technique that may cause an unwanted fracture.

Materials and methods: Observational analytical study, the universe corresponds to a sample of 20 patients undergoing orthognathic surgery. For statistical analysis, T-Test and a Chi2 Fischer's Exact were used, in both of which a significance level $P > 0.05$ was used.

Discussion: 20 patients analyzed, 5 patients (25%) presented an unwanted fracture, of which 3 (15%) suffered an incomplete fracture of the right maxillo-palatine suture and 2 (10%) a complete fracture of the maxillo-palatine suture. 15 patients (75%) without problems. In all patients with fractured palates, the expansion clamp was used to lower the maxilla. In all surgeries in which unwanted fractures occurred, there was difficulty in descent and the palate failed to descend on the first attempt.

Conclusion: Palatal fracture in Le Fort 1 osteotomies is not an uncommon event and should be protocolized. To perform a successful maxillary descent, it is essential to correctly separate the pterygo-maxillary suture and carefully perform all osteotomies that involve a Le Fort 1, so that they are completed properly.

Keywords: *Orthognathic Surgery, Fracture, Palatine, Bone*

Introduction

Orthognathic surgery can be defined as a surgical procedure aimed at correcting deformities associated with the maxilla and mandible. It is a highly protocolized surgery that must be accompanied by a pre-surgical orthodontic treatment that optimizes the dental positions in each jaw and a post-surgical treatment that regulates the intermaxillary dental relationships. The treatment not only changes the bone bases, but also the soft tissue, thus modifying the patient's appearance.[1]

[1]School of Dentistry, Universidad Andrés Bello, Santiago de Chile.

[2]DDS, Universidad del Desarrollo, Santiago de Chile.

***Corresponding Author**: Juan Mancilla Uribe, School of Dentistry, Universidad Andrés Bello, Santiago de Chile.

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Contemporary techniques of orthognathic surgery can be applied in broad branches of surgery; in addition to the correction of intermaxillary relations, they can be used for the treatment of obstructive sleep apnea syndrome, to improve phonetics and even tumor resections.[2]

The relationship that exists between the maxilla and the mandible in the horizontal, vertical and sagittal plane determines a functional as well as aesthetic skeletal state. Deviation to this normal state of relationship between both jaws may suggest surgical intervention either to improve the function or aesthetics of the patient.[3]

Orthognathic surgery can be classified into three types: maxillary surgery, mandibular surgery and bimaxillary surgery. The most frequently used surgical techniques are Le Fort I osteotomy in the maxilla, bilateral sagittal ramus osteotomy in the mandible, and geniusoplasty. These techniques are highly protocolized and allow predictable and stable results to be obtained over time.[4]

Le Fort I Osteotomy

The most common procedure performed in the jaw is the Le Fort I osteotomy. This surgery allows the manipulation and repositioning of the jaw complex in a more favorable and aesthetically correct position. Different movements can be performed to correct anteroposterior, transverse and vertical discrepancies.[5]

The Le Fort I osteotomy approach is completely buccal, then the maxilla is manipulated to move it to a new position and is generally stabilized by osteosynthesis of plates and screws.[6] The use of rigid fixation is used to provide good stability and reduce the failure rate.[7-8]

There are no big problems about the modification of the teeth and the narrowing of the canals after a Le Fort osteotomy. Complications that can threaten the patient's life are very rare. Necrosis due to lack of blood supply is one of the main complications of Le Fort I Osteotomy, however, it has been reported to have a very low incidence; less than 1%. These problems may be caused by rupture of the greater palatine artery, postoperative thrombosis, perforation of the palatal mucosa in segmental maxillary surgery, or excessive tension of the palatine fibromucosa during palatal expansion. Anatomical irregularities such as craniofacial dysplasias, orofacial clefts or vascular anomalies increase the risk of vascular problems.[9-10-11-12]

The maxillary osteotomy begins with a bur or reciprocating saw on the greatest convexity of the zygomatic buttress, 35 mm above the occlusal plane and advances through the anterior wall of the maxilla to the lateral edge of the piriformis foramen. Before performing the osteotomy of the lateral wall of the nostril, a small malleable leaflet is inserted under the periosteum under the inferior turbinate to protect the nasal mucosa. To complete the section of the posterior lateral wall of the maxilla, a separator is used in the suture of the maxillary tuberosity with the pterygoid process to reduce the risk of sectioning or damaging the maxillary artery or one of its branches. In this area the osteotomy is directed posteriorly and inferiorly, under direct vision with great precision and care.

According to the patient's surgical planning, it is determined whether it is necessary to remove bone with a saw or a bur from the lateral area of the piriformis foramen towards the posterior lateral wall of the maxillary sinus.

The osteotomy line should always pass at least 5 mm above the apices of the second molars, to reduce the risk of devitalizing the teeth. If there is a tooth retained above the line described, the osteotomy design should not be modified: the tooth should be extracted after descent of the maxilla.

The osteotomy of the septum and nasal wall continues. A vomer osteotome is inserted into the crest of the bony septum beneath the intact nasal mucosa in order to separate the septum from the transverse processes of the jaws.

The nasal wall is sectioned by an osteotome directed posteriorly in the direction of the perpendicular plate of the palatine bone, while a separator protects the nasal mucosa. The lateral wall of the nostril is thin and yields with little resistance to the chisel; When the palatal canal is reached, the resistance increases with a characteristic and detectable sound of the hammer against the chisel. The opposite lateral nasal wall is sectioned following the same procedure.

Finally, a curved chisel is positioned at the suture of the maxillary tuberosity with the pterygoid process. With the index finger, the palate is palpated in the area of the hamular groove to feel the tip of the chisel when the tuberosity of the pterygoid is disjuncted. The same procedure is done on the other side.

Descent of the Maxilla

Once the corresponding sections are made, the maxillary descent or downfracture is performed. This procedure is performed to free the jaw and be able to mobilize it in the desired position. It is carried out using digital pressure on the anterior surface of the maxilla or through expansion forceps.[13-14]

The palate must descend completely, that is, the maxilla must descend with the palatine bone, in order to then be able to segment it and/or position it according to the surgical planning.

Maxillary descent will predictably occur only if the osteotomies are performed correctly. The process of maxillary descent should require a minimum of force if all osteotomies have been completed.

An incomplete separation of the tuberosity from the pterygoid can cause a horizontal fracture of the pterygoid process or maintain the integrity of the pterygo-maxillary suture, which will make maxillary mobilization difficult.[15]

There is a lack of knowledge about the real incidence of this situation since it often goes unnoticed by the surgical team and is not part of the orthognathic surgery registration protocols.

This study aims to establish the prevalence with which this surgical event occurs and associate it with the possible variables that may affect an unwanted fracture of the palatine bone. It is intended to be the basis for the initiation of future studies associated with the postoperative behavior of patients in whom the palatine bone has been fractured during surgery.

The importance is relevant in cases in which the advancement of the maxillo-palatine complex and the soft tissue that accompanies it is rigorous; These tissues could affect peripheral airway obstruction syndromes or other pathologies associated with the position of the transverse process of the palatine bone or the soft palate.

Materials and Methods

An observational study was carried out with a sample size of 20 patients who underwent orthognathic surgery performed by different teams of maxillofacial surgeons in the city of Santiago, Chile.

The inclusion criteria corresponded to patients with ASA I classification, carriers of skeletal dysmorphosis with complete bone growth confirmed by hand x-ray with ossified metaphyses. They should require the performance of a conventional or segmental Le Fort I osteotomy, only if the segmentation is performed after the moment of maxillary descent. Patients must be protocolized in pre-surgical orthodontic treatment, candidates for orthognathic surgery or patients destined for Surgery First treatment (Surgery First or initial surgical treatment).

The exclusion criteria correspond to patients with ASA classification II or higher, syndromic patients, growing patients and in whom a conventional Le Fort I osteotomy is not performed or in which the maxilla is segmented before descending.

The data collection method was through a form prepared especially for this study, the initials, age, gender, skeletal class and diagnosis of each patient were recorded in writing. Regarding the surgeon, the surgical technique used, the skillful hand of the first and second surgeon, instruments used in each osteotomy, width and the curved chisel used were recorded. In relation to the surgery, the physical place where it was performed, the type of orthognathic surgery, the surgery performed, whether or not there was a fracture of the palate and its area and eventualities of the operation were recorded.

The ethics committee that approved the research protocol "Palatine Bone Fracture during Maxillary Descent in Orthognathic Surgery."

This study was conducted in full accordance with the Declaration of Helsinki of the World Medical Association.

Images of key moments of the surgery were recorded for later analysis, from the moment of the first osteotomy, until the moment of descent of the maxilla, these are:

A. Osteotomy of the anterior wall of the maxilla

B. Vomer osteotomy

E. Maxillary descent

C. Osteotomy of the nasal passages

D. Pterygomaxillary suture osteotomy

A photographic record of the descended palate was made, whether it was fractured or complete. For fractured palates, 4 possible scenarios were established, classified as:

A. Complete descended or unfractured palate

B. Fractured palate in palatine bone in maxillo-palatine suture

C. Fractured palate in the right palatine bone

D. Fractured palate in the left palatine bone.

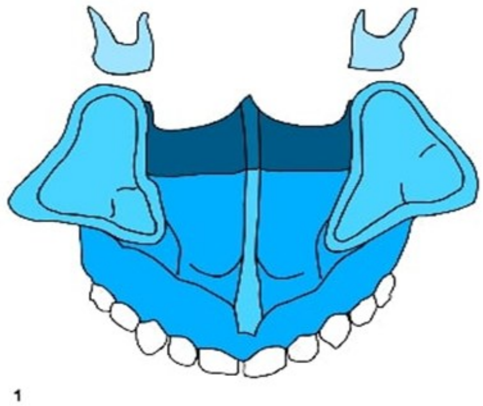

Figure 1. *Complete descended or unfractured palate.*

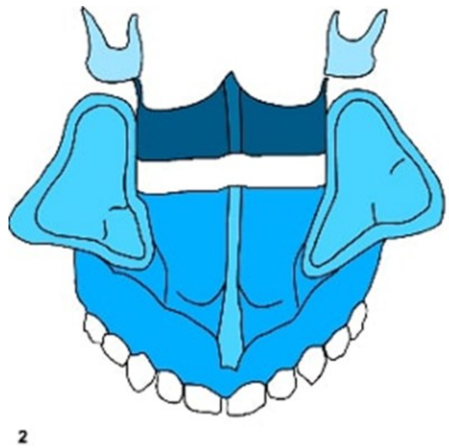

Figure 2. *Fractured palate in the palatine bone, at the level of the maxillopalatine suture.*

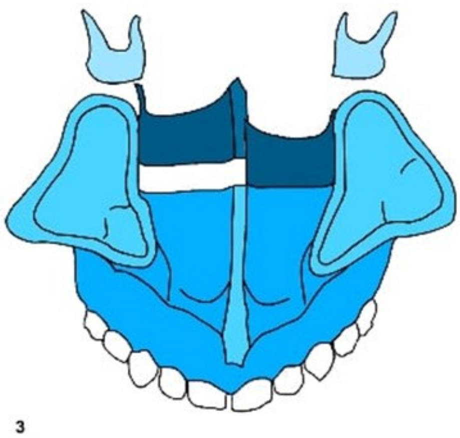

Figure 3. *Fractured palate in the right palatine bone.*

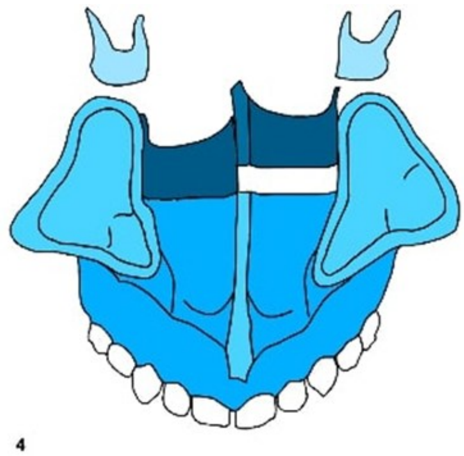

Figure 4. *Fractured palate in the left palatine bone.*

Data were collected and added to database tables, which were compared and analyzed.

Results

Of the total of 20 patients undergoing Le Fort I osteotomy:

- 15 (75%) of the cases presented a complete palate after maxillary descent.
- 3 (25%) of the patients presented an incomplete fracture of the right maxillo-palatal suture.
- 2 (10%) of the cases presented a complete fracture of the maxillo-palatine suture.

In all patients with fractured palates, the expansion clamp was used to descend the maxilla. In turn, in all surgeries in which unwanted fractures occurred, there was difficulty in descent and the palate failed to descend on the first attempt.

The results obtained during the 20 surgeries analyzed were summarized in Table 1 and Table 2.

Table 1. Distribution of variables corresponding to: patient identification, age, gender, skeletal class, thickness, width, and angle of the curved chisel.

N° patient	Age	Gender	Skeletal class	Thickness of the curved chisel	Width of the curved chisel	Angle of the curved chisel
1	23 years	F	3	1 mm	11 mm	45°
2	17 years	F	2	1 mm	8 mm	45°
3	22 years	M	3	1 mm	11 mm	45°
4	22 years	M	3	1 mm	10 mm	45°
5	20 years	F	2	1 mm	8 mm	45°
6	18 years	F	2	1 mm	11 mm	45°
7	20 years	M	3	1 mm	11 mm	45°
8	15 years	F	3	1 mm	8 mm	45°
9	20 years	F	3	1 mm	11 mm	45°
10	18 years	M	3	1 mm	11 mm	45°
11	19 years	F	2	1 mm	11 mm	45°
12	18 years	F	3	1 mm	11 mm	45°
13	24 years	M	2	1 mm	11 mm	45°
14	22 years	M	3	1 mm	11 mm	45°
15	32 years	F	2	1 mm	8 mm	45°
16	23 years	F	3	1 mm	11 mm	45°
17	23 years	F	3	1 mm	11 mm	45°
18	28 years	F	3	1 mm	8 mm	45°
19	18 years	F	3	1 mm	8 mm	45°
20	21 years	F	3	1 mm	11 mm	45°

Table 2. Distribution of variables corresponding to: patient identification, surgical protocol, maxillary descent technique, type of orthognathic surgery, number of maxillary descent attempts, maxillary descent outcome.

N° patient	Surgical protocol	Maxillary descent technique	Type of orthognathic surgery	Number of maxillary descent attempts	Maxillary descent outcome
1	OLF1- OSBR	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	1	**COMPLETE**
2	OSBR- OLF1	LEFT LATERAL DIGI-TAL	CONVENTIONAL	1	**COMPLETE**
3	OLF1- OSBR	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	2	**FX RIGHT SIDE**
4	OLF1- OSBR	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	4	**FX BOTH SIDES**
5	OSBR- OLF1	BILATERAL DIGITAL AND EXPANSION FORCEPS	SURGERY FIRST	1	**COMPLETE**
6	OSBR- OLF1	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	2	**COMPLETE**
7	OLF1- OSBR- CHIN	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	2	**FX RIGHT SIDE**
8	OLF1- OSBR	LEFT LATERAL DIGITAL	CONVENTIONAL	1	**COMPLETE**
9	OLF1- OSBR- CHIN	BILATERAL DIGITAL, FRONTAL AND EXPANSION FORCEPS	CONVENTIONAL	3	**FX RIGHT SIDE**
10	OLF1- OSBR- CHIN	BILATERAL DIGITAL	CONVENTIONAL	1	**COMPLETE**
11	OLF1- OSBR- CHIN	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	3	**FX BOTH SIDES**
12	OLF1- OSBR- CHIN	BILATERAL DIGITAL	CONVENTIONAL	1	**COMPLETE**
13	OLF1- OSBR- CHIN	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	2	**COMPLETE**
14	OLF1- OSBR- CHIN	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	1	**COMPLETE**
15	OSBR- OLF1	LEFT LATERAL DIGITAL	CONVENTIONAL	1	**COMPLETE**

Table to be continued..

16	OLF1- CONDYLE- OSBR- CHIN	BILATERAL DIGITAL	CONVENTIONAL	1	**COMPLETE**
17	OLF1- OSBR- CHIN	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	2	**COMPLETE**
18	OLF1	BILATERAL DIGITAL	CONVENTIONAL	1	**COMPLETE**
19	OLF1- OSBR- CHIN	BILATERAL DIGITAL	SURGERY FIRST	1	**COMPLETE**
20	OLF1- CONDYLE- OSBR- CHIN	BILATERAL DIGITAL AND EXPANSION FORCEPS	CONVENTIONAL	1	**COMPLETE**

*FX: Fracture

**OLF1: Le Fort I Osteotomy

***OSBR: Bilateral Sagittal Ramus Osteotomy

Data analysis was performed using STATA 13.1 software for Mac. A T-Test and a Chi2 Fischer's Exact were used, both of which used a significance level $P > 0.05$.

In relation to the variables of age, gender, skeletal class, order of osteotomies, type of surgery and width of the curved chisel, a P greater than 0.05 was obtained, so these variables are not statistically significant.

In the use of the expansion forceps and attempts to descend the maxilla, a P of less than 0.05 was obtained, which shows statistical significance, having a relationship with the fracture of the palatine bone.

Discussion

Osteotomies

There are fundamental critical moments for maxillary descent to occur correctly. Traditionally they are done with saws, osteotomes and chisels. The disjunction osteotomy of the maxillary tuberosity with the pterygoid process requires special attention.[16]

In all surgeries analyzed, a curved chisel of equal thickness and different width was used, which did not produce significant differences. There are works by various authors that suggest new techniques that would allow cuts to be made with saws and chisels using an ultrasonic system. Olate et al. states that the use of ultrasonic systems reduces the average bleeding by 200 ml and improves the recovery of the alveolar nerve among other advantages; However, a longer surgical time and a precise technique is necessary to control the pressure required by the insert to avoid damaging the tissues.[17] Craniomaxillofacial osteotomies with ultrasonic systems. This technique allows in some cases to replace the reciprocating saw and curved chisels.[18] However, authors such as Landes et al, reveal that it is not possible to use it in the separation of the nasal septum and in the separation of the maxilla with the pterygoid process, being necessary to use curved chisels in 100% of their cases.[19]

The use of piezoelectric in the area of the maxillary tuberosity is limited due to the necessary angulations needed to perform osteotomies of the pterygo-maxillary suture.

Hernández Alfaro proposes a technique for pterygo-maxillary disjunction through a rotation technique using a frontal approach with a straight osteotome introduced through the anterior osteotomy of the maxilla from the piriformis foramen to the pterygoid process. Once introduced, it is rotated internally causing maxillary descent. The author describes it as a safe and effective technique performed successfully in 1,297 patients.[20]

Descent of the Maxilla

After completing the osteotomies, it is sometimes difficult to begin maxillary mobilization. During this study, various techniques were used to perform maxillary descent and were subsequently analyzed.

In the case of using the expansion clamp, the result was clear; In all patients with fractured palates, the expansion clamp was used to lower the maxilla.

In all fractured palates there was difficulty in descent and the palate failed to descend on the first attempt. This could be due to incomplete osteotomies that make descent difficult and consequently require the use of the expansion forceps.

Wolford suggests a simplified maxillary descent technique that consists of using the same instruments used in previous osteotomies. In this technique, a curved elevator is inserted on each side on the nasal floor and then the vomer osteotome is inserted to the edge of the palate. The three instruments are taken, and rotated downwards. According to Wolford et al., this method provides good mechanical leverage and provides better distribution of forces, which reduces the appearance of unfavorable fractures.[21]

A maxilla with correctly performed osteotomies should descend using mild digital pressure, without presenting greater resistance, which eliminates the use of forceps or expanders.

Fractures

In the literature, various studies are described in cadavers and using computed tomography that compare the use of osteotomy techniques in the pterygo-maxillary separation.[22]

Li and Stephens associate edentulous patients with a higher frequency of unwanted maxillary fractures. All movements must be controlled during the osteotomy and circuit breakers must be used judiciously in order to avoid the appearance of unwanted fractures.[23]

Fracture of the palatine bone or fracture of the union of the horizontal lamina of the palatine bone with the palatine process of the maxillary bone, is associated with an incomplete or defective separation of the pterygoid process with the maxillary bone. Some studies show that fractures are not affected by the type of chisel used, but rather by the angle of attack.[12-24]

The incidence of unfavorable fractures of the pterygoid process after pterygomaxillary separation is probably underestimated. Many of these fractures go unnoticed by surgeons if the patients do not present complications.

The anomalous fracture in the maxillo-palatine suture could be relevant in the important advances of the maxilla since this advance would be limited by the palatine fibromucosa that remains attached to the horizontal portion of the palatine bone.

Conclusion

Palatal fracture in Le Fort I osteotomy is not an uncommon occurrence and must be properly protocolized.

To perform the procedure with a successful maxillary descent, it is essential to carry out a correct separation of the pterygo-maxillary suture, carefully performing all the osteotomies that involve the Le Fort I osteotomy, allowing the maxilla to descend without the need to use instruments of expansion, which carry a greater risk of fracture.

Orthognathic surgery, despite being a safe treatment with predictable results, is not exempt from accidents, so the surgeon must have adequate anatomical-surgical knowledge to control any eventuality that may occur during the procedure.

Conflict of Interest

The authors declare no conflict of interest.

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