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MATERIALS USED IN FRACTURE REHABILITATION "LE FORT I, II AND III"

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Abstract

Le Fort fractures are severe facial injuries that affect the maxillary bone and surrounding structures such as the nose and eye sockets. These fractures are classified into three main types: Le Fort I, Le Fort II, and Le Fort III, each with varying degrees of severity and clinical implications. Rehabilitating Le Fort fractures requires a multidisciplinary approach and may involve the use of a wide range of materials and techniques. Materials used in the rehabilitation of these fractures include titanium plates and screws for surgical fixation of the fractures, bone grafts to support healing and restore bone structure, as well as biocompatible materials to minimize adverse reactions. Additionally, the rehabilitation process may involve physical and occupational therapy to restore function and mobility of the maxilla and other associated structures. Close monitoring of recovery and management of complications may also be necessary to ensure complete recovery and optimal function of the affected structures. This review proposes a review of Le Fort fractures and the materials used in their rehabilitation, highlighting the importance of an integrated approach in managing these complex traumatic injuries.

Keywords*:* fractures le fort; facial rehabilitation; fastening materials

Introduction

Le Fort fractures are types of facial fractures that involve the jaw bone and can affect associated structures such as the nose and orbits.

Le Fort I: it is a transverse fracture that passes through the jaw line and can affect the bone palate and maxillary sinuses [1-3].

Le Fort II: it is a pyramidal fracture that passes through the nose, orbits and upper jaw, often causing complex dislocation of the nose and orbits [1-3].

Le Fort III: it is the most severe Le Fort fracture, which passes through a high and horizontal trajectory, affecting the entire maxillary-facial complex. It can cause dislocation of the ocular heights and may be associated with fractures of the base of the skull [1-3].

Rehabilitation of Le Fort fractures, a series of severe traumatic facial injuries involving maxillofacial structures, poses a complex challenge for surgeons and therapists. These fractures, classified into types I, II and III according to the Le Fort system, can seriously affect the patient's function and aesthetics, requiring precise surgery and specialized rehabilitation therapy [2-4].

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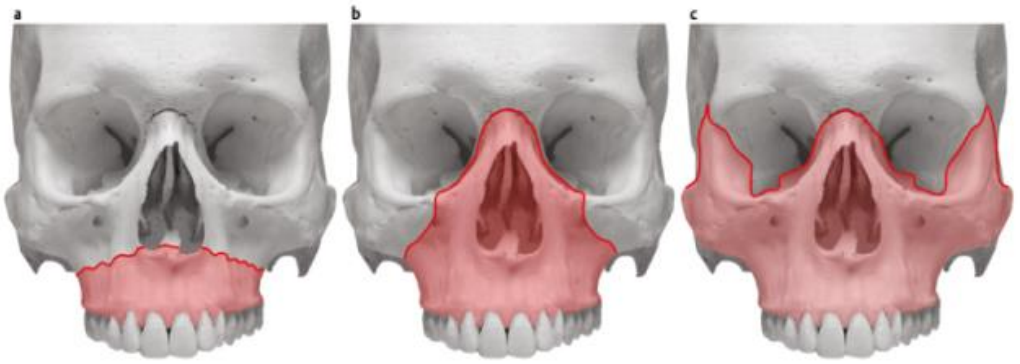

Fig. 1. Le Fort Fractures: a - Le Fort I; b - Le Fort II; c - Le Fort III

It is crucial to understand the nature and implications of each type of Le Fort fracture, as well as the role of the materials used in the rehabilitation process. From titanium plates and screws for fixing fractures to bone grafts and biocompatible materials, the right choice of materials is key to achieving optimal healing and restored function [1-4].

Proper rehabilitation is essential to restore normal function to the jaw and other facial structures damaged by Le Fort fractures. This may involve recovering the ability to speak, chew and swallow correctly, as well as restoring the aesthetic appearance of the face [2,4].

For many patients, Le Fort fractures can have a significant impact on quality of life, affecting basic facial functions and causing physical and psychological discomfort [1,3].

Proper rehabilitation can help maximize the results of Le Fort fracture treatment. By involving patients in physical and occupational therapy, as well as closely monitoring their progress, better results can be achieved in terms of facial function and aesthetics [1-4].

Characteristics and clinical implications of each type of Le Fort fracture

Type I Le Fort fracture:

Characteristics: Le Fort I fracture is a horizontal fracture that passes through a fracture line located in the middle part of the jaw. It can affect the bone palate and maxillary sinuses [3,4].

Clinical implications: Patients with Le Fort I fracture may experience symptoms such as facial pain, swelling, and difficulty speaking or chewing. The displacement of bone fragments can affect breathing and sinus function [3,4].

Type II Le Fort fracture:

Characteristics: Le Fort II fracture is a pyramidal fracture involving the nasal areas, upper jaw and eye orbits. The trajectory of the fracture is inverted V-shaped [3,4].

Clinical implications: This fracture can have serious effects on facial appearance and function. Patients may experience dislocations of the nose, inflammation of the eyes, diplopia (double vision) and even abnormal protrusion of the eyes [3,4].

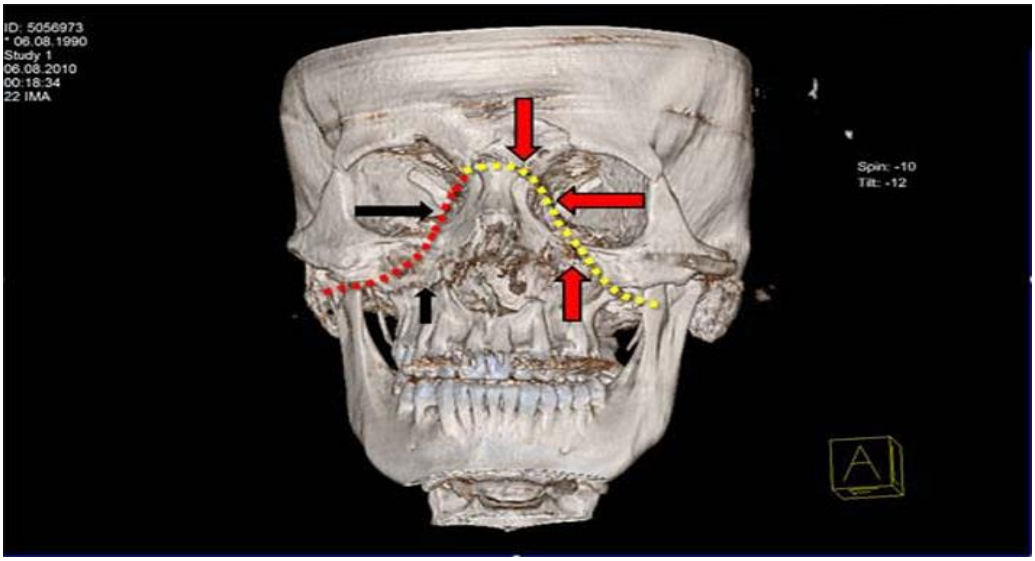

Fig. 2. Fracture line tracing, type II Le Fort fracture [4]

*Type III Le Fort fracture**:***

Characteristics: Le Fort III fracture is the most severe of the three types and goes through a high and horizontal trajectory, involving the entire maxillary-facial complex. This type of fracture may be associated with fractures of the base of the skull [3,4].

Clinical implications: Le Fort III fracture can cause severe dislocations of facial structures, including eyes that are lowered or shifted to the side. Patients may also experience shortness of breath, significant facial deformities, and complications of the central nervous system due to association with fractures of the base of the skull [3,4].

The etiology factors and mechanisms of Le Fort fractures can be presented in a detailed way, highlighting the various circumstances and situations that can lead to these serious facial injuries [3-6].

The sudden impact during car accidents can exert considerable forces on the face, causing Le Fort fractures, especially in the case of frontal or side impact [4-6].

Falls from a height or on hard surfaces can also cause Le Fort fractures, especially when the person hits their face directly or when the impact is unevenly distributed on different parts of the face [4-6].

Sports such as football, hockey or boxing can increase the risk of Le Fort fractures due to strong contact between athletes or between athletes and hard objects such as balls or sports equipment [4-6].

Strong hits or hitting with hard objects during fights or aggressions can cause Le Fort fractures, especially if directly impacted on the face or head [3-6].

Workers at risk in the workplace, such as those in construction or manufacturing, can suffer Le Fort fractures as a result of impact with equipment or machinery [4-6].

Falls during recreational or leisure activities can lead to Le Fort fractures, especially if the impact occurs on the face or head [4-6].

The materials used in Le Fort fracture rehabilitation are essential for stabilizing and restoring damaged facial structures [5.7].

Titanium plates and screws: are metal devices used to repair and stabilize fractured bone fragments. The plates are attached to the bone surface with titanium screws, providing a solid fit and ensuring proper alignment of fractures [5-7].

Bone grafts and fillers: For serious fractures involving substantial bone loss, bone grafts may be used to support healing and restore bone structure. Fillers, such as biomaterials or products derived from the patient's bones, can be used to fill gaps and promote bone tissue regeneration [5,6].

Biocompatible materials: include materials such as absorbable polymers, which are well tolerated by the body and gradually break down over time without causing significant side effects. These materials are used to support the healing process and reduce the risk of inflammatory reactions [5-7].

Absorbable osteosynthesis plates: are made of biodegradable materials and are gradually absorbed by the patient's body as the bone heals. They offer an alternative to traditional metal plates and can reduce the risk of long-term complications associated with permanent fastening materials [5-8].

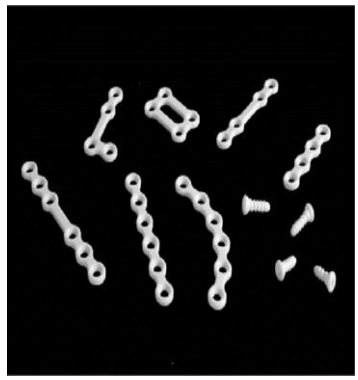

Fig. 3. Osteosynthesis plates [8]

Fig. 4. Le Fort I fracture (A) and transoral fixation (B)[8]

Suturing materials and dressings: to close surgical incisions and protect the intervention area, suturing materials and sterile dressings are used. They help prevent infections and promote proper skin healing [5-8].

Rehabilitation and recovery procedures for Le Fort fractures are essential to ensure complete recovery and optimal facial and jaw function [6-8].

After surgery to fix Le Fort fractures, the patient is closely supervised to detect any postoperative complications and ensure proper healing [6-8].

Proper administration of pain control medications is essential in the first days and weeks after surgery. This may involve the use of analgesics and anti-inflammatories [7-9].

Patients may benefit from physical and occupational therapy to restore mobility and function to the jaw and other affected facial structures. These sessions may include exercises to strengthen muscles, manipulation techniques, and speech and eating therapy [6-9].

In the case of Le Fort fractures that affect the ability to chew and swallow correctly, it is important to ensure proper nutrition to support the healing process and prevent nutritional deficiencies [6-9].

Patients and their families should receive detailed information about fracture and rehabilitation procedures and be supported in managing any emotional or psychological issues associated with recovery [6-9].

Long-term patient follow-up is essential to identify any late complications or functioning problems that might occur after the fracture initially healed [6-9].

Surgeries associated with Le Fort fractures can vary depending on the severity of the fracture and any associated complications [7-10].

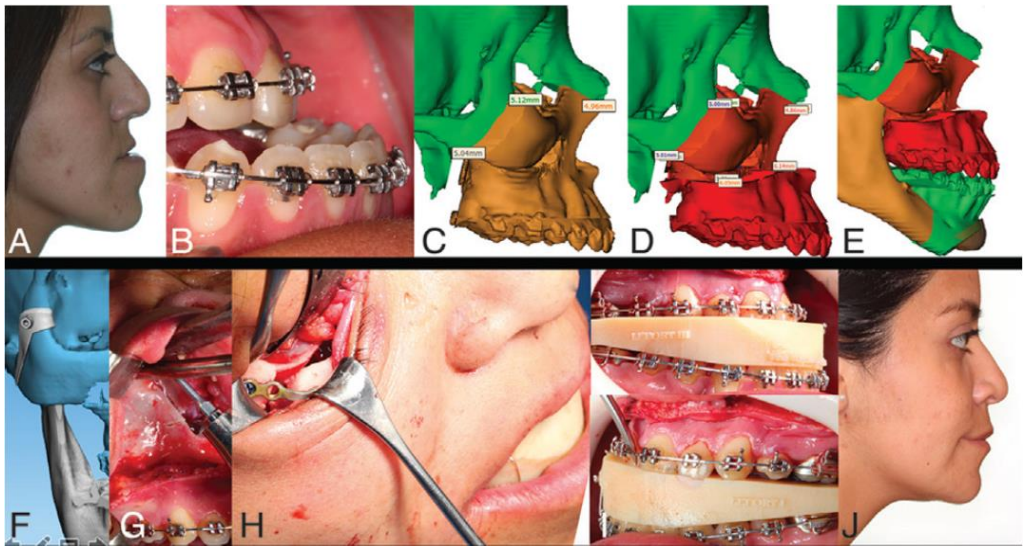

Fig. 5. Case study: (A) Woman, 23 years old, false mandibular prognathia, profile view of face, (B) Severe negative overjet, (C,D,E,F) Virtual planning of modified surgical osteotomy Le Fort III, Le Fort I osteotomy and jaw trusion with vertical chin regression as well as 3D printing of the milling guide for osteotomy of the lateral zygomatic body, (G) Osteotomy was performed in the fronto-maxillary area; h) following the osteotomy, fixation was performed; (I) Intraoral splints for the purpose of fixing Le Fort III and I; (J) profile picture of the face 3 months after surgery. [10]

Surgery is often necessary to restore fractured bone fragments to the correct position and fix them in this position. This may involve the use of titanium plates and screws or other fasteners to establish the bone in place [7-10].

In cases where the Le Fort fracture has caused bone loss or severe facial deformities, additional surgery may be needed to reconstruct the damaged facial structures. This may involve the use of bone grafts and other fillers to restore the shape and function of the face. [7-10]

In some cases, Le Fort fractures may be associated with additional complications, such as damage to facial nerves, sinuses or orbits. Surgery may be necessary to treat these complications and minimize the risk of long-term consequences [7-10].

In addition to treating bone fractures, surgery may be necessary to repair damaged soft tissues, such as muscles, ligaments, and skin. This can be important to restore function and aesthetic appearance of the face [7-10].

Le Fort fractures can often affect dental structures as well. In cases where there are tooth deformities or dislocations, surgery may be needed to correct these problems and restore proper tooth alignment [7-10].

The evaluation of postoperative outcomes in Le Fort fractures is essential to evaluate the effectiveness of treatment and subsequently guide patient management [10-12].

It is important to evaluate the function of the jaw and other facial structures after healing of Le Fort fractures. This may include assessing your ability to speak, chew and swallow food adequately, as well as assessing the mobility of your jaw and other facial joints [10-13].

The aesthetic appearance of the face can be evaluated to determine whether the aesthetic result of surgery is satisfactory. This may involve assessing facial alignment, facial symmetry and proportions, as well as scars resulting from surgery [10-12].

X-rays and computed tomography (CT) scans, may be used to evaluate fracture healing and identify possible postoperative complications, such as displacement of bone fragments or formation of pseudartrosis [10,11].

In cases where the Le Fort fracture involves the maxillary sinuses or airways, it is important to assess respiratory function and monitor for any symptoms of nasal congestion or shortness of breath [10-13].

It can evaluate and monitor complications that may occur in the long term after fractures heal, such as facial deformities or sinus and airway occupation problems [10-13].

Physical and occupational therapy plays a crucial role in the recovery of patients with Le Fort fractures, helping to restore normal facial and jaw function and improve quality of life [12-14].

Patients may benefit from exercises to improve mobility of the jaw and other facial joints affected by the fracture. These exercises may include jaw opening and closing movements, rotation, and lateralization of the jaw [12-14].

Physical therapists may use muscle stimulation techniques to strengthen the muscles of the face and neck, helping to restore normal muscle function and prevent muscle atrophy [12-15].

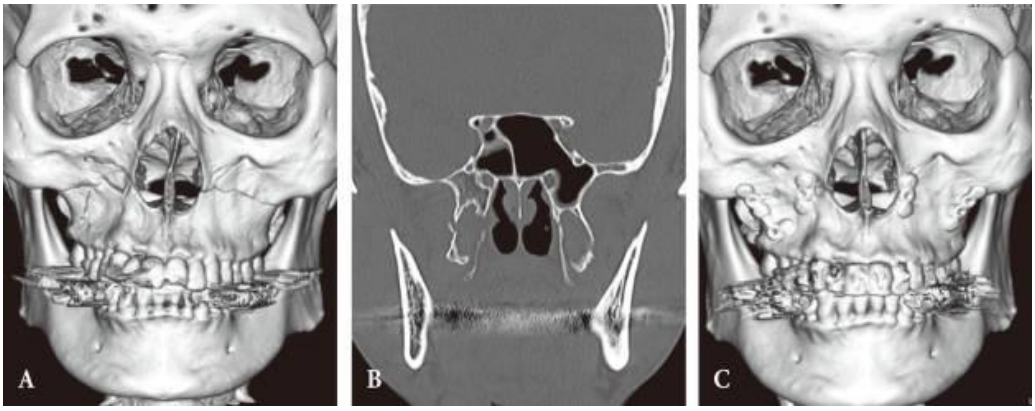

Fig. 6. Le Fort I fracture (A); Pterigoid plate fracture (B); 3,5 months after surgery (c)[14]

Manual manipulation techniques can be applied to reduce muscle stiffness and tension, as well as improve blood circulation and lymph flow to the affected area [12-15].

Occupational therapists can work with patients to improve functional skills needed to perform daily activities, such as speaking, chewing, and swallowing food [12-15].

Adaptations and auxiliary devices may be recommended to facilitate daily tasks and compensate for any functional deficiencies resulting from the Le Fort fracture [13-16].

Occupational therapists can provide counseling and emotional support to patients and their families to manage the physical and psychological impact of Le Fort fractures and the recovery process [13-16].

Management of postoperative complications in Le Fort fractures is essential to ensure a complete and uncomplicated recovery of the patient [16-19].

One of the most common complications is infection in the operative area. This can be managed by administering antibiotics and proper drainage of abscesses, and in some cases surgery may be required to drain the infection [16-19].

In some situations, surgically fixed bone fragments can move out of their correct position. This may require additional surgery to realign and refix bone fragments [17-20].

Sometimes postoperative wounds may experience difficulties in the healing process. It can be caused by a number of factors, such as infection, excessive tension on the sutures or clotting disorders. Proper wound management, including proper care of sutures and dressings, can help avoid these problems [17-20]

In some cases, the aesthetic results of surgery may not be in line with the patient's or surgeon's expectations. This may include facial asymmetries, unsightly scars, or residual deformities. In such situations, additional corrective or aesthetic repair procedures may be required [17-20].

Sometimes Le Fort fractures can affect the functionality of the jaw and other facial structures, such as talking or chewing. Management of functional complications may involve physical and occupational therapy, as well as surgical correction of persistent problems [17-20].

C**onclusions**

Le Fort fractures are complex traumatic injuries of the face that require meticulous evaluation and treatment by a medical team specializing in maxillofacial surgery.

The use of appropriate materials in the rehabilitation of Le Fort fractures is crucial for achieving a solid fixation and optimal healing. The selection should take into account the characteristics of the fracture, the general condition of the patient and the risk of complications.

Evaluation and monitoring of postoperative results is essential to evaluate the effectiveness of treatment and identify any long-term problems or complications. This allows the care plan to be adjusted according to the individual needs of the patient.

Physical and occupational therapy plays an essential role in patients' recovery, helping to restore function and mobility of the face and jaw. The integrated and personalized approach can lead to better results and faster recovery.

Postoperative complications are an inevitable part of Le Fort fracture treatment, and their prompt and effective management is essential to avoid serious consequences and ensure proper recovery.

Continuous research and innovation in the field of Le Fort fractures are essential to address existing challenges and improve outcomes for patients in the future.

References

[1] Phillips BJ, Turco LM. *Le Fort Fractures: A Collective Review*. ***Bull Emerg Trauma***. 2017. doi: 10.18869/acadpub.beat.5.4.499

[2] Bagheri SC, Holmgren E, Kademani D, Hommer L, Bell RB, Potter BE, Dierks EJ. *Comparison of the severity of bilateral Le Fort injuries in isolated midface trauma*. ***J Oral Maxillofac Surg***. 2005. doi: 10.1016/j.joms.2005.04.003.

[3] Kühnel, Thomas & Reichert, Torsten. *Trauma of the midface*. ***GMS Current Topics in Otorhinolaryngology, Head and Neck Surgery***. 2015

[4] Akoglu E, Onur O, Denizbasi A, Kosargelir M, Akoglu H, Ibrahim A. *Heading the ball: a case of a Le Fort II fracture in a football match*. ***BMJ Case Rep***. 2011. doi: 10.1136/bcr.01.2011.3787.

[5] Kraft A, Abermann E, Stigler R, Zsifkovits C, Pedross F, Kloss F, Gassner R. *Craniomaxillofacial trauma: synopsis of 14,654 cases with 35,129 injuries in 15 years*. ***Craniomaxillofac Trauma Reconstr***. 2012. doi: 10.1055/s-0031-1293520.

[6] Warin K, Limprasert W, Suebnukarn S, Paipongna T, Jantana P, Vicharueang S. *Maxillofacial fracture detection and classification in computed tomography images using*

convolutional neural network-based models. ***Sci Rep***. 2023. doi: 10.1038/s41598-023-30640-w.

[7] Erol B, Tanrikulu R, Görgün B. *Maxillofacial fractures. Analysis of demographic distribution and treatment in 2901 patients (25-year experience).* ***J Craniomaxillofac Surg.*** 2004. doi: 10.1016/j.jcms.2004.04.006.

[8] Sukegawa S, Kanno T, Katase N, Shibata A, Takahashi Y, Furuki Y. *Clinical Evaluation of an Unsintered Hydroxyapatite/Poly-L-Lactide Osteoconductive Composite Device for the Internal Fixation of Maxillofacial Fractures*. ***J Craniofac Surg***. 2016. doi: 10.1097/SCS.0000000000002828.

[9] Pham TD, Holmes SB, Coulthard P. *A review on artificial intelligence for the diagnosis of fractures in facial trauma imaging*. ***Front Artif Intell***. 2024. doi: 10.3389/frai.2023.1278529.

[10] Goulart DR, Huentequeo-Molina C, Alister JP, Olate S. *Three-Dimensional Planning and Surgical Technique for Modified Le Fort I and Le Fort III Osteotomy in Non-Syndromic Patients*. ***J Craniofac Surg.*** 2020 doi: 10.1097/SCS.0000000000006754.

[11] Wang TJ, Su JH, Leung KW, Liang SY, Wu SF, Wang HM. *Effects of a mouth-opening intervention with remote support on adherence, the maximum interincisal opening, and mandibular function of postoperative oral cancer patients: A randomized clinical trial*. ***Eur J Oncol Nur***s. 2019. doi: 10.1016/j.ejon.2019.04.001.

[12] Somaiya KJ, Patil S, Thorat R. *Rehabilitation Strategies for a Patient With Traumatic Multiple Fractures: A Case Report.* ***Cureus. 2022***. doi: 10.7759/cureus.29732.

[13] Naran S, Steinbacher DM, Taylor JA. *Current Concepts in Orthognathic Surgery*. ***Plast Reconstr Surg.*** 2018. doi: 10.1097/PRS.0000000000004438.

[14] Kim HS, Kim SE, Lee HT. *Management of Le Fort I fracture*. ***Arch Craniofac Surg***. 2017. doi: 10.7181/acfs.2017.18.1.5.

[15] Manson PN, Clark N, Robertson B, Slezak S, Wheatly M, Vander Kolk C, Iliff N. *Subunit principles in midface fractures: the importance of sagittal buttresses, soft-tissue reductions, and sequencing treatment of segmental fractures*. ***Plast Reconstr Surg***. 1999.

[16] Phuc LH, Tien CH, Ngoc DV, Tuan NV, Chanh LT, Phuong LH, Duc NM. *A Novel Approach to the Treatment of Le Fort Fractures Using Internal Fixation to Achieve Mandibulomaxillary Fixation*. ***Med Arch***. 2021. doi: 10.5455/medarh.2021.75.366-370.

[17] Navarro-Fernández G, Gil-Martínez A, Diaz-Saez MC, Elizagaray-Garcia I, Pili-Mayayo PQ, Ocampo-Vargas JE, Beltran-Alacreu H. *Effectiveness of Physical Therapy in Orthognathic Surgery Patients: A Systematic Review of Randomized Controlled Trials.* ***J Funct Morphol Kinesiol.*** 2023. doi: 10.3390/jfmk8010017.

[18] Al-Hiyali A, Ayoub A, Ju X, Almuzian M, Al-Anezi T. *The Impact of Orthognathic Surgery on Facial Expressions*. ***J Oral Maxillofac Surg***. 2015. doi: 10.1016/j.joms.2015.05.008.

[19] Gómez Roselló E, Quiles Granado AM, Artajona Garcia M, Juanpere Martí S, Laguillo Sala G, Beltrán Mármol B, Pedraza Gutiérrez S. *Facial fractures: classification and highlights for a useful report*. ***Insights Imaging***. 2020. doi: 10.1186/s13244-020-00847-w.

[20] Septa D, Newaskar VP, Agrawal D, Tibra S. *Etiology, incidence and patterns of mid-face fractures and associated ocular injuries*. ***J Maxillofac Oral Surg***. 2014. doi: 10.1007/s12663-012-0452-9.

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