3D Planning and Surgical Technique for Modified Le Fort I and Le Fort III Osteotomy in Non-Syndromic Patients

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Abstract: Total midface deficiency, to include the orbits, nose, zygomas, and maxilla, can occur in both syndromic and non-syndromic individuals. The treatment with combination of Le Fort III and I osteotomy could be used and it is few reported in the literature. The aim of the study is to present how technology can make the procedure for the correction of hypoplasia of the middle third more predictable and safer. The 2 clinical cases were managed under submental intubation and using VSP that generated 3D printing of oclusal splints and cutting guides. Modified oblique Le Fort III osteotomy (MOLFIIIO) and Le Fort I osteotomy were used due to patients present large sagittal discrepancy between maxilla and mandible (18 and 17 mm). The patients presented good outcomes without complications. In this study, the authors demonstrate that non-syndromic patient could be managed safety with MOLFIII and Le Fort I osteotomies for the correction of midfacial deformities using virtual surgical planning (VSP) associated with 3D printing technique and piezoelectric surgery.

Key Words: 3D Printing, Le Fort osteotomy, midface hypoplasia, piezosurgery

The anatomical complexity of the facial middle third in patients with severe facial deformities is challenge in planning and execution when considered full surgical correction.[1,2]

In non-syndromic cases, a traditional Le Fort III osteotomy in forward movement is used to treat deformity at the naso-orbito-malar level and may result in enophthalmos and undesirable increase in nasal prominence. Also, in larger advancements, a step deformity at the lateral orbital rims could be present. To avoid this, modifications in Le Fort III osteotomy have been realized.[3]

The modified oblique Le Fort III osteotomy (MOLFIIIO), designed for patients without facial syndrome, under maxillomalar hypoplasia and normal nasal projection has been reported.[1] When dental occlusion have more than 12 mm in sagittal discrepancy, Le Fort I osteotomy (LFIO) is performed in the same surgical time to obtain a greater advancement of the upper incisor and to correct the occlusal plane and sagittal discrepancy.[4]

In 1969, Obwegeser presented the first report on the possibility to use Le Fort III and I osteotomies at the same time; he stated that in the middle third of the face, in forward movement, the lower part is determined by dental occlusal and the upper part is oriented by the facial balance and esthetics.[5]

Although this procedure has the potential to correct complex deformities of the midface, relatively few simultaneous LF III/I osteotomies have been reported in the literature.[6] The aim of this report is to present 2 cases and literature review for the correction of hypoplasia of the middle third in a more predictable and safer strategy in non syndromic patients, based on the use of virtual surgical planning (VSP), 3D printing technique and piezoelectric osteotomy.

CASES REPORT

This study has been carried out in accordance with the Declaration of Helsinki. The patients sign informant consent to participate in this report.

Case 1

A 23-years-old female came to our clinic complaining bad functional and esthetic conditions of face. In the clinical exam the patient had a severe midfacial hypoplasia and severe class III malocclusion. The sagittal discrepancy between maxilla and mandible was 17 mm, with no asymmetry in the facial analysis (Fig. 1A and Fig. 1B). The decision-making was based on safe and stability of the procedure. Thus, 3D plan was realized from CT and intra oral scanner composed in software, obtained a modified Le Fort III osteotomy with a maximum sagittal movement of 5 mm (Fig. 1C). The Le Fort I osteotomy was planned to move maxilla 6 mm forward (Fig. 1D), mandible 6 mm in setback position and chin in 6 mm upward movement (Fig. 1E). 3D plan was realized by 3D segmentation using a Le Fort III movement and then a Le Fort I osteotomy; 3D print was used to create osteotomy guide in lateral position of the zygoma (Fig. 1F) and Le Fort III and Le Fort I splint.

Was used a submental intubation; the surgical technique was performed using bilateral transconjunctival approach and upper intraoral approach; communication between them was subperiosteal with extension in all the midface. Modified osteotomy include lateral oblique osteotomy in the zygoma body from the transconjunctival approach in the lower and lateral area of the orbit to the posterior area of the zygoma body (Fig. 1F). In the lower orbital rim was realized the second osteotomy, over the more strong bone area to introduce the piezo tip into de maxillary sinus. Before to lacrimal sacks we move the osteotomy in a lower direction until the piriform aperture in the same level that Le Fort I osteotomy will be realized (Fig. 1G).

Modified Le Fort III osteotomy was completed by the intraoral approach in the posterior area of the maxilla using chisel and piezo tips; nasal septum osteotomy was realized to permit the forward movement of the middle third using Rowe forceps.

Intraoral splint was installed to fix the Le Fort III osteotomy (Fig. 1H and I); then, was used bilateral titanium mesh to the orbit and 2.0 plates in the zygoma body. After that, traditional Le Fort I osteotomy was realized and easily mobilization was obtained; then, another intra oral splint was installed (Fig. 1I) and regular Le Fort I fixation was applied. After that, the splint was removed and suture was done. Mandibular setback of 6 mm was performed using bilateral sagittal split ramus osteotomy (BSSO) and vertical reduction genioplasty of 6 mm in a regular strategy. The average surgical time took 5 h. The surgical procedure occurred without complications; the patient achieved stable occlusion, good overjet and overbite, without relapse of skeletal position (Fig. 1J).

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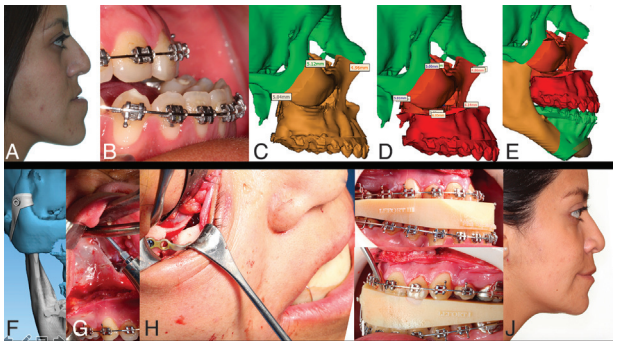

FIGURE 1. A 23 years-old female with severe midfacial hypoplasia, lateral view of the face (A); Occlusal discrepancy with negative overjet (B); Virtual surgical planning of modified Le Fort III osteotomy (C), Le Fort I osteotomy (D) and mandibular setback and chin vertical reduction (E) and 3D printing cutting guide for lateral osteotomy of the zygoma body (F); Osteotomy in frontomaxillary area before to lacrimal sacks (G); Fixation of Le Fort III osteotomy (H); Intraoral splints for Le Fort III and I movement (I); lateral view of the face 3 months after surgery (J).

Case 2

A 21-years-old male patient came to our clinic with same complains. In clinical exam he presented a long face, mandibular prognathism and atrophy in middle third of the face (Fig. 2B–D). The sagittal discrepancy between maxilla and mandible was 17 mm. VSP (Fig. 2A and E) was realized treated to incorporate an analysis of prediction in soft tissue movement. Identically surgical planning protocol and surgical conduct was choosing in this patient. MOLFIIIO was realized to move forward 5 mm and Le Fort I was oriented to move 6 mm forward. 6 mm mandibular setback was performed using bilateral sagittal split ramus osteotomy (BSSO) and vertical reduction genioplasty of 8 mm in a regular strategy for this case. The average surgical time took 5.5 hours. The surgical procedure occurred without complications using piezo surgery in all the surgery; the patient achieved stable occlusion, improvement of vertical maxillary position, good overjet and overbite, without relapse of skeletal position. (Fig. 2F–H)

DISCUSSION

A few articles of research or clinical report about the use of the Le Fort III and Le Fort I osteotomy or its modifications in non-syndromic midface hypoplasia has been published. Our report describes the application of a modified oblique Le Fort III osteotomy in combination with a Le Fort I osteotomy in the treatment of non-syndromic midface hypoplasia patients using a technological approach.

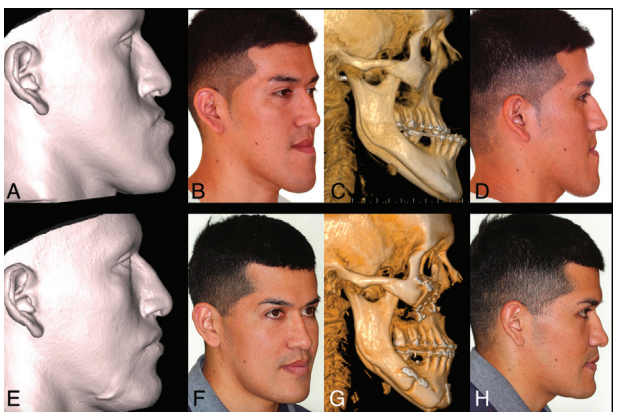

FIGURE 2. A 21 years-old male with long face and severe midfacial hypoplasia, virtual surgical planning before and after simulation (A–E); 3/4 and lateral views of the face (B,D), tomographic reconstruction before surgery (C); 3/4 and lateral view of the face 3 months after surgery (F,H); tomographic reconstruction after surgery (G).

In cases with normal nasal projection, the modified osteotomy is useful because nasal bone stay at the same level; in these cases, a great forward advance led to combine some techniques. Predictability in soft tissue resulting from this facial movement is difficult to obtain because this approach is not common and no research has been focus on this topic.

In our clinical cases, no asymmetry was observed; however, if asymmetry is present, the surgical splint in Le Fort I, after Le Fort III osteotomy, have to contain the solution for the asymmetry because is more stable and better for facial balance; if the surgeon treat to incorporate the asymmetric movement in the Le Fort III, surgeon could lack control in the final position in the Le Fort III osteotomy. After MOLFIIIO, orthognathic surgery could move as usual, but the suggestion is to complete Le Fort I first than BSSO because the final position is more critical and complex in the maxillary movement than the mandibular movement.

Garcia et al[7] present some modifications of Le Fort III showing a tendency to customize the technique considering the especial conditions of each patient. In our cases, was decided to use minimally invasive MOLFIIIO associated with Le Fort I osteotomy using piezoelectric surgery, to address advantages showed by Fariña et al,[8] as reduction of the surgical time and the blood loss compared with other techniques.

Nout et al[9] included 41 patients to evaluate the requirement of additional orthognathic surgery in patients with severe midface hypoplasia treated in the first time with Le Fort III or monobloc advancement. Seven patients were underwent additional orthognathic surgery, others patients had malocclusions and were dentally compensated with orthodontic treatment. Dental occlusion is related to stability of movement, so the use of combined techniques in complex cases could be recommended, including 3D plan, 3D print and piezo surgery technique.

Despite the most of the operative descriptions for Le Fort III and other facial advancements describe the use of a nasotracheal intubation. We choose to use a submental intubation; this is a safe procedure with an average operative time of 15 minutes. It also reduces the risk of damaging the endotracheal tube during osteotomies or dislodging the tube from the trachea when moving the nasomaxillary segment forward. Additionally, the surgeon can insert the Rowe forceps during down-fracture without a nasotracheal tube obstructing or being damaged. Tracheostomy, as another option, comes with a more significant risk of long-term sequelae of the airway.[6]

Boos Lima et al[4] evaluate the stability of a series of non-syndromic patients who underwent Le Fort III osteotomy with LF I osteotomy after 18 months of surgery. The results showed that combined technique is a stable procedure to treat large class III malocclusions associated with midface hypodevelopment. The stability reported in this study was related to three main features: the surgical technique, the type of fixation, and the final position of soft tissue after advancing the middle third of the face.

The surgical planning is the most important step to achieve satisfactory outcomes; the use of CAD/CAM technology and stereolithography model was introduced by Garcia et al.[10] Surgical guides printed are very useful for MOLFIIIO in the osteotomy and in the maxillo-mandibular fixation, because to show the real position of the cut in the zygoma and the real position of the forward movement.[11–13] In these cases, only software process was done and the print was for surgical bone guide and occlusal splints, reducing the economic cost of the procedure.

3D CAD/CAM technology used for VSP included the MOLFIIIO in a forward movement with no movement in laterality or vertical movement. Segmentation in the software has to include the posterior area of the septum with the ethmoidal junction, the posterior area of the septum and the pterygoid area. Movement has to be calculated in the zygomatic osteotomy because this area has to maintain the correct position with no more than 5 mm in movement. After that, traditional virtual planning for orthognathic surgery is done using the Le Fort I osteotomy and then BSSO. In the stages of planning, it is possible to build a surgical guide for each osteotomy and for dental splint.[10]

This technique has several advantages over the conventional osteotomy: on the one hand, lower morbidity of the surgical approaches[8] and predictability in the bone movement.[1] The clinical cases achieve good outcomes regarding face symmetry, facial esthetic, oral function without complications. The osteotomy success depends on the skill of the surgeon and the use of piezo surgery is a clear advantage for this technique.

This system has great advantages, such as clarity and control in the osteotomy, decrease in damage of soft tissue, properly saline solution irrigation reducing the need for irrigation by the assistant and lower risk of injuring of vascular structures.[14]

Simultaneous Le Fort III and Le Fort I osteotomy can be used in one surgical time as unique solution in complex class III facial deformities; could be used for stable forward movement of the upper central in cases with great atrophic in the middle third of the face; piezosurgery and CAD/CAM planning as to be standard.

CONCLUSION

The authors of this study advocate the combination of MOLFIIIO and Le Fort I osteotomy using VSP, 3D printing guides and piezosurgery in the treatment of midface deformities in non-syndromic patients. These models become increasingly affordable and also provide timely and incalculable benefits to current and next generation surgeons in order to achieve predictable outcomes in rare and high-risk procedures.

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