Surgical Guides for Modified Oblique Le Fort III Osteotomy

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Abstract

Introduction The present work consists of the specific design of a surgical guide for modified oblique Le fort III osteotomy (MOLFIIO), developed previously in the Stereolithography model of the patient. The guides are designed to perform an osteotomy for the orbital floor, zygoma and pterygomaxillary fossa. The fundamental objective of the malar guides will be: symmetrical orbitozygomatic osteotomies bilaterally. Regarding the guide of the orbital floor, it is of primary importance to begin the osteotomy 5 mm ahead of the inferior orbital fissure (IOF) in orbital antero posterior direction, crossing the orbital floor. The pterygomaxillary fossa guide, will cover the internal face of the malar bone exactly in the posterior portion of the butres (hidden portion) toward the IOF. This guide will be useful, revolutionize and make it easier and secure to access the osteotomy of the area for a lot of surgeons who fear manipulating the pterigomaxillary fossa in its upper third, due to the fear of damaging the internal maxillary artery, that will be reduced to a minimum with the guides.

Materials and Methods Initially requires a CT scan, for designed the model patient stereolithography. The guides are prepared from self-curing acrylic and monomer.

Conclusion Surgical guides are very useful for MOLFIIO, as being custom, manage to make a stable symmetrical bilateral cut, decreasing the possibility of injury to vascular structures and shorten the surgical time.

Keywords Osteotomy · Le fort · Stereolithography · Pterygomaxillary · Guides

Background

Sir Harold Gillies, in 1950, attempted to perform a Le fort III osteotomy which was a failure [1]. It was not until 1957, that Tessier, considered the father and founder of cranio-maxillofacial surgery, succeeded in making the first advance of 20 mm in the middle third in a patient with Crouzon syndrome, which was the beginning of the mid-face surgery; since then, no guide for midface osteotomies have been designed [1–3].

It was not until 2013, that guidelines for modified oblique Le fort III osteotomy (MOLFIIO) (introduced by Garcia y Sanchez) [2], were designed with the help of stereolithography model. The objective of these guidelines is to give a symmetry in the oblique osteotomies. Calculated by using the formula of the value of the trigonometric sine (opposite leg over the hypotenuse); this symmetry is needed for displacement at the time of oblique postero anterior midface, bone cuts are perfectly predictable, stable and symmetrical.

The first guide designed, was used only for the oblique osteotomy of the malar bone. Subsequent to this, it was thought that this same guide should be fused with the orbital floor osteotomy for greater stability of the material (guide) without the need for a bone fixation.

The aim of the guide of the orbital floor, is to help make cuts without damaging the infraorbital nerve, delimiting perfectly the 5 mm prior to the inferior orbital fissure (IOF), have a bilateral symmetrical area, achieving an accurate osteotomy in both orbits; this guide is planned specifically to perform both osteotomies with burs and with piezo system.

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Fig. 1 Stereolithography

This guide revolutionizes the osteotomies of the region, toward the orbital floor, by performing the bone cuts with a 7 mm length oscillating saw with an angle of 105° giving it the great advantage of a pre-designed osteotomy that embraces and scrolls through the pterygomaxillary fossa directed toward the orbital floor without damaging noble structures (vessels of the internal maxillary artery) and joins with the osteotomy on the orbital floor, giving as the previous guide, a predictable and accurate cutting on the structure of the pterygomaxillary fossa.

Materials and Methods

Initially requires a CT scan of the facial skeleton axial, coronal and sagittal slices at 0.6 mm, in “DICOM” format.

Fig. 3 Layout of the orbital floor

Then it is designed in the miter cuts to transfer the same angle to the model patient stereolithography (Fig. 1).

In the stereolithography model the middle third osteotomies of the orbital floor and the pterygomaxillary fossa will be designed (Fig. 2).

The guides are prepared from self-curing acrylic, (polymethyl methacrylate, 1928, German chemist W. R) and monomer using the salt and pepper technique (powder/liquid) and a metal stop [3–6].

Procedure

Layout of the orbitozygomatic guide:

1. An oblique line that initiates at 7 mm from the start of the piriform aperture towards the lower orbital rim 5 mm lateral to the anterior lacrimal crest.

Fig. 2 The stereolithography model is made through a program geomagic, mimix or amirac, which develops layer by layer with calcium sulfate or resins, according to the cuts of the tomography

Fig. 4 Oblique line, with an angulation of 30°

Fig. 7 Confirmation of the union of the osteotomies

Fig. 5 Layout of the pterygomaxillary fossa guide

Fig. 8 The guide stop for the pterygomaxillary fossa

Fig. 6 Inserting the needle

Fig. 9 “L” shape guide stop

2. The layout of the orbital floor will start from the end of the directed oblique line of the piriform to lower orbital rim by drawing a straight line to a depth of 10 mm, from this point; from there a horizontal line is drawn across

- the orbital floor stopping 5 mm prior to the most anterior level of the vertex of the IOF (Fig. 3).
3. From this point a line is drawn again directed to the lateral orbital rim junction with the inferior orbital rim.

Fig. 10 Avoid a longer cut on schedule

Fig. 13 Orbitozygomatic guide

Fig. 11 Technique of the salt and pepper

Fig. 14 Adequate stability of the guide

Fig. 12 Pterygomaxillary fossa guide

Fig. 15 Rowe guide

Fig. 16 Final polishing

4. Subsequent to the path of the orbital floor, there an oblique line will be designed on the zygomatic bone, with an angulation of 30° with respect to an imaginary horizontal line to the ground and ending in the lower union of the temporary zygomatic suture (Fig. 4).

Layout of the pterygomaxillary fossa guide:

1. An oblique line is drawn from the union of the pterygoid process with the maxillary tuberosity, directed toward the OIF, 5 mm forward and below by its external face (pterygomaxillary fossa) (Fig. 5).

To ensure the success of the osteotomy and that the guide works, the union of the cut in the orbital floor will be verified with the osteotomy of the pterygomaxillary fossa using a needle (0.90 mm internal diameter) that will be inserted at the level of the horizontal line drawn on the floor of the orbit (5 mm in front of the anterior vertex of IOF) which will need to coincide with the line of the path of the pterygomaxillary fossa (5 mm anterior and inferior to the IOF by its outer part.) (Figs. 6, 7). In the case that is used a resin (acrylic) stereolithography used a burs #701 to drill this point and verified with the needle, the cutting path.

The union of the orbital osteotomy with the pterygomaxillary fossa ensures the monoblock osteotomy in the middle third when the disjunction craneomaxilar is performed.

Once the osteotomy lines are drawn, proceed to place with brush, the acrylic separator stereolithography on the model, and allow to dry.

Fig. 17 Female patient diagnosed with maxillomalar hypoplasia, maxillary vertical excess, prognathism and laterognathia

Fig. 18 **a** Transoperative use of the orbitozygomatic surgical guide. **b** cut with piezo system. **c** final cut with guide

Fig. 19 Positioning of the pterygomaxillary fossa guide

Fig. 20 Placement of the Rowe with guide

A guide will be placed (needle) to mark the junction point of the cut in the orbital floor with the cut of the pterygomaxillary fossa, which will serve to position the guide stop for the pterygomaxillary fossa (Fig. 8).

An upside down “L” shaped stop is made with orthodontics wire, for the guide of the pterygomaxillary fossa, (Fig. 9). The area enclosed in red shows the area of the internal maxillary location, so the main function of the guide will be to move the saw away from this area and the stop will aim to stop the saw and avoid a longer cut on schedule, as the pterygomaxillary fossa cutting is done with a limited view (Fig. 10).

Once preformed it is fixed with wax to the end point of the osteotomy, (5 mm below the OIF) and it starts to pour acrylic and monomer with the technique of the salt and pepper (powder/liquid), on the stereolithography delimiting the previously path drawn, to obtain a thickness sufficiently strong (Fig. 11). The acrylic will extend to the base of the zygomatic process to achieve better stability and retention (Fig. 12).

The orbitozygomatic guide will begin similarly, prior to the separator of acrylic, with salt and pepper technique delimiting pre-marked lines on stereolithography, with sufficient thickness to provide adequate stability. This guide will extend from the oblique line marked on the malar which connects on the orbital floor (5 mm to the anteroposterior IOF) and it will come down to the level of the piriform (Figs. 13, 14).

The last guide designed is the palatine guide or the Rowe guide. This is preformed on a intraoral print of the upper arch, symmetrically blurring two grooves on each side of the

Fig. 21 Postoperative control to 3 months

midline or concavities where it will adapt to the active part of the Rowe, by stabilizing in the oral cavity distributing the forces on a single vector, avoiding pressure on two points that could cause a palatine unwanted fracture (Fig. 15).

Once the guides are made, the excess material is trimmed and it is then polished (Fig. 16).

Clinical Case

Female patient, 18 years old, diagnosed with maxillo-malar hypoplasia, maxillary vertical excess, prognathism,

laterognathia (Fig. 17) underwent surgery with surgical guides for MOLFIIO technical and mandibular osteotomies for retroposition, in the Specialty Hospital, National Medical Siglo XXI, by the Maxillofacial Surgery Service.

Trasoperative Fig. 18a shows the intraorbital positioning of the orbitzygomatic surgical guide. Figure 18b shows the guided osteotomy, which is performed with piezo system, protecting the infraorbital nerve path. Figure 18c shows that the osteotomized area has a path of high precision.

Figure 19 shows the positioning of the pterygomaxillary fossa guide carried out for the planned osteotomy, this

Fig. 22 Male, 24 years, with maxillomalar hypoplasia, maxillary vertical excess, prognathism, laterognathia. Surgery: MOLFIIO, bilateral Intraoral Vertical Subsigmoid Ramus Osteotomies, advancement and reduction genioplasty

Fig. 23 Female, 18 years with hypoplasia of the superior and middle third of the facial skeleton. Surgery: MOLFIIO technical, Le Fort I maxillary advancement and frontal alloplastic graft

potentially avoids the maxillary artery and the pterygoid venous plexus.

Figure 20 shows the placement of the Rowe supported on the palatine guide already described above.

Mobilization of the middle third is performed; subsequently bilateral osteotomies of mandibular ramus for reposition ending surgery time (Fig. 21).

Fig. 24 Male, 23 years, with maxillomalar hypoplasia, maxillary vertical excess. Surgery: MOLFIIO

Fig. 25 Male, 32 years with maxillomalar hypoplasia. Surgery: Horizontal Modified Le Fort III Osteotomy for advancement

Other Cases Reports: (Figs. 22, 23, 24, 25)

Conclusions

Surgical guides are very useful for MOLFIIO, as they manage to make a stable symmetrical bilateral pterygomaxillary cut, decreasing the possibility of injury to vascular structures during the osteotomy, and shorten the surgical time, as it has a precise cut, previously designed; surgical prediction can be performed attached to actual patient's anatomy.

The usefulness of the guide will not only be on MOLFIIO, but above all osteotomies involving middle third, orbit, and fossa.

The pterygomaxillary fossa guide is particularly important, because we think that it will give security to the surgeon waging the concern of a possible collateral damage to the internal maxillary artery or major vessels of pterygomaxillary fossa region.

Another remarkable advantage of the guide, is that there will not be changes in the surgical planning of the patient due to operator run the cuts of the preplanned osteotomies, there will not be error on the osteotomies and this will give invaluable precision.

With regard to the craniomaxillofacial surgery, the guide will be indispensable in the future, and will be an action mechanism that surgeons will adopt for precision and planning of their osteotomies.

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