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Anatomical Conditions in Simultaneous Orthognathic Surgery and Structural Rhinoplasty. A Clinical Series

Condiciones Anatómicas en Cirugía Ortognática y Rinoplastia Estructural Simultanea. Una Seria Clínica

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SUMMARY: Orthognathic surgery and rhinoplasty show synergy in terms of function and aesthetic results. The aim of this research is to analyze variables related to simultaneous orthognathic surgery and rhinoplasty and to discuss the surgical sequence. Male and female subjects between 18 and 45 years old were included in this research. Diagnosis related to nasal morphology (nasal tip bifid, rotate, square and others as well as the alae morphology and columella), facial deformity (sagittal and vertical deformity), type of surgery (rhinoplasty techniques and orthognathic techniques) and complications were included. The minimum follow-up was 12 months; Chi-Square and t test were used to define correlations, considering a value of $p<0.05$ for statistical significance. Class III facial deformity was observed in 40 % of subjects and class II facial deformity was present in 43 %. For the nasal deformities, the tip and nasal bridge were most prevalent; primary nasal deformity was observed in the 83 % of subjects and was significant more than secondary nasal deformity ($p=0.042$). Bimaxillary surgery was performed in 31 cases (88 %). In 10 cases a change of the original plan for rhinoplasty due to previous maxillary surgery was realized, mainly in class III facial deformity, with no statistical differences. Revision rhinoplasty was realized in 5 cases (14 %) and was not related to surgical variables; revision for orthognathic surgery was not necessary in this series. Rhinoplasty and orthognathic surgery simultaneously show low complications and predictable results. We can conclude that maxillary mandibular osteotomies and rhinoplasty could be performed safely. However, larger studies are necessary to understand the best choice and variables involved in simultaneous procedures and soft tissue response.

KEY WORDS: Orthognathic surgery; Rhinoplasty; Face surgery.

INTRODUCTION

Facial deformity (FD) affecting functions at different levels with an involvement of facial aesthetic (Figueroa *et al*., 2014; Joshi *et al*., 2014; Olate *et al*., 2017); in FD anomalies in the hard and soft tissue of the lower and middle third of the face can be observed; the nose shows an important role in this area (Jeong *et al*., 2017).

The nasal bones grow along with the entire nasofrontal structure, and this growth continues from 2 to17 years of age through the remodeling (Lestrell *et al*., 1991). Sarnat & Wexler (1966, 1969) and Sarnat (1970, 1991) demonstrated that to obtain suitable maxillary and palatal growth, the correct position of the nasal septum and vomer is necessary. Another significant stage in the facial growth is controlled by the mandibular condyle; between 10 to 15 years old, the mandibular condyle could growth vertically 10 to 15 mm, including an intense growth of the ramus and body of the mandible (Buschang *et al*., 2002) and maxilla.

Previous studies by our group have demonstrated that 85 % of subjects with a class III skeletal deformity were associated to changes in the position of the nasal septum

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and in the entire nasal morphology (Olate *et al*., 2015). It could be expected that the deformity in the maxillary bone will lead to changes in the nasal morphology.

Maxillary osteotomy (Le Fort I type osteotomy) could create a new condition in the nasal function and morphology. Dantas *et al*. (2015), indicated that upper reposition of Le Fort I osteotomy can create 85 % mobilization of the nasal tip to the anterior position, 80 % in rotation of the nasal tip and widening of the alar base in 95 %. In some cases, orthognathic surgery and rhinoplasty is necessary to achieve the full facial proportions and morphology.

Rhinoplasty simultaneously to orthognathic surgery has been presented in the past (Seah *et al*., 2012), demonstrating good results. Early in 90´s, Waite *et al*. (1988), showed 22 patients, presenting a protocol for the management and surgical sequence to obtain aesthetic and functional results. Later, Costa *et al*. (2008), published a sequence of 13 patients treated by Le Fort I osteotomy and rhinoplasty, showing some points to be improved.

Rhinoplasty and genioplasty are the most common cosmetic surgeries in the world (Buschang *et al*., 2022), so that combining a nasal surgery and a maxillomandibular surgery show synergy in functional and aesthetic results. Advantages to performing the rhinoplasty in a second surgical time are related to stability of the facial tissue with all the soft tissue in the final position and the possibility to achieve stable outcomes; in this case, to plan the rhinoplasty could be safe. On other hand, simultaneous surgery may help to reduce the financial cost because it is performed an a single surgical time, and there is a one-time postoperative period.

The aim of this research is to know variables involved in performing orthognathic and rhinoplasty in the same surgical time in a clinical case series

MATERIAL AND METHOD

A case series in Latin-American patients treated with orthognathic surgery and rhinoplasty simultaneously, was analyzed. Male and female subjects between 18 to 45 years old with facial deformity type I, II or III or vertical deformity were included, as long or short face and subjects with primary or secondary nasal deformity; all subjects signed a consent form to participate in the study. Patients with facial malformations, a medical record of maxillofacial trauma or maxillofacial pathology with reconstructive surgeries were excluded. Subjects with facial asymmetries associated with a temporomandibular joint disease such as hyperplasia or hypoplasia of the mandibular condyle were also excluded. All methodologies and study protocols were approved by the local Ethics Committee and was conducted in accordance with the Declaration of Helsinki.

Diagnosis and Planning. The facial type was classified at sagittal level (Angle class I, II and III) and vertical (vertical maxillary excess or vertical maxillary deficiency). The diagnoses were supported by clinical analysis and 2D cephalometry using the protocol proposed by McNamara and Ricketts (Guerrero *et al*., 2018); the facial analysis was performed following the protocol by Koury & Epker (1992).

The nasal deformity was analyzed according to anatomical areas, recording deformities in the nasal tip (rotated, squared, wide, bifid or asymmetric, or augmented lateral crura with greater projection of the tip), alae morphology and columella (bifid columella, hanging columella and other columellar alterations). The length and width of the nose and the width of the alar base (wide and narrow alar bases) were also recorded and analyzed to establish the nasal deviations (Starck & Epker, 1996). Humps or saddle deformities were classified as deformities of the nasal bridge. Primary nasal deformity was classified in term of deficiency in the initial assessment (before surgery) and secondary nasal deformity was classified in term of deformity created by the maxillary movement related to orthographic surgery.

The surgical planning of the orthognathic surgery was done using 3D virtual analysis and 3D print; the 3D maxillary movement and then the nasal base movement was studied following the soft-tissue ratio in orthognathic surgery proposed previously (Olate *et al*., 2016); subsequently, the nasal movement and the potential requirement in the rhinoplastic surgery were estimated.

Surgical Procedure

Orthognathic surgery. In simultaneous surgery, the orthognathic surgery is by mandible first using bilateral sagittal split osteotomy (BSSO) and the 2.0 internal fixation (Enterprises, Artfix Implants, Pinhais, PR, Brazil) using one or two plates (Fig. 1). The maxillary surgery is performed by intraoral approach, developing the Le Fort I type osteotomy as routine (Fig. 2).

After down fracture of maxilla, the approach is made to the septum and vomer to perform the reduction and septoplasty; the turbinectomy via the Le Fort I osteotomy may be indicated in some cases as well; nasal osteotomy was introduced in this approach and completed by the lateral approach in the nasal surgical time if necessary.

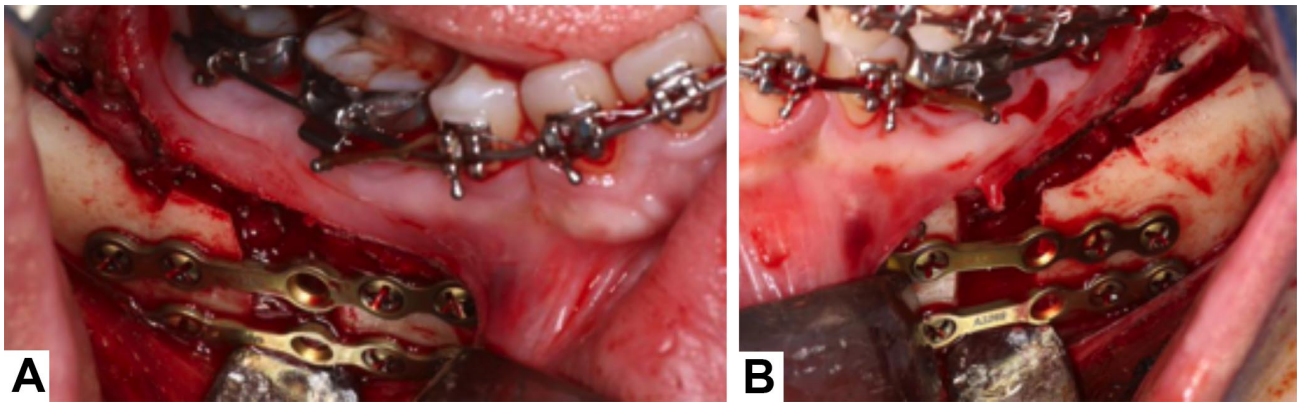

Fig. 1. A case for mandibular advancement. A) BSSO and two plates fixation in the right mandibular ramus; B) BSSO and two plates fixation in the left mandibular ramus.

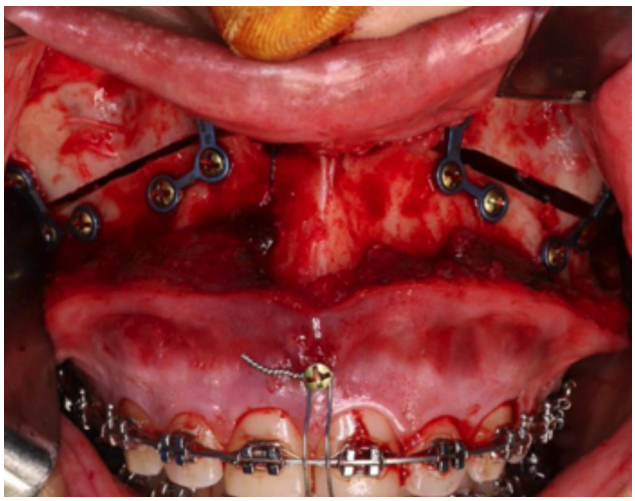

Fig. 2. Le Fort I type osteotomy using internal fixation with four 2.0 system plates and monocortical screws.

The septum is fixed with a nylon 3-0 suture to the anterior nasal spine to reduce the mobility of the septum and to obtain more stability for the nose surgery. Once the maxilla is stabilized using 4 type-L plates (Interprises, Artfix Implants, Pinhais, PR, Brasil), the next step is the capture of the alar bases using a bilaterally suture (cinch suture). The suture of the maxillary approach is done conventionally using the V-Y technique with reposition the upper lip. This entire surgery is performed under controlled hypotension.

Change from nasotracheal to orotracheal intubation. From orthognathic surgery to rhinoplasty, the intubation of the patient changes from nasal to oral; the anesthesiologist uses conventional maneuvers considering 1) ventilation 100 % O2, 2) careful removal of the oropharyngeal packing and aspiration, 3) use of a video support system for extubation / intubation (video laryngoscope), 4) introduction of the oral tube in the mouth with in close position to the primary nasotracheal tube, 5) under direct visualization of both tubes (nasal to be removed and new oral tube), the cuff of the nasotracheal tube is deflated, the clinician removes the nasal tube from the cords and the anesthesiologist introduces the oral tube with a curve guide, ensuring the airway quickly and safely, and 6) fixation of the new tube and subsequent full removal of the nasal tube.

Rhinoplasty. A direct analysis of the nasal morphology is realized, looking the potential deformity caused by the maxillary movement. After that, the clinical decision is confirmed, and the nasal time begins with an open or closed approach. Initially, the septoplasty is done with a classic approach to obtain the graft if the initial graft obtained by intra oral approach is not enough.

Using the open structural rhinoplasty technique, the resection of the hump is conservative due to previous movement of the maxilla, that usually shows an increase of the nasal tip cephalically and advancing anteriorly, will render the dorsal deformity less prominent; the amount of final hump reduction is frequently less than the preoperative estimation, to avoid the possibly risk of a saddle effect.

Lateral osteotomies are performed without difficulty through the exposed pyriform edge in the orthognathic surgery time and confirmed in the nasal surgery time. Osteotomy was realized to obtain a reduction in the nasal bridge and symmetric nose, looking for a good nasal valve to maintain a good air flow.

In terms of tip management, the technique does not change from conventional procedures related to structural rhinoplasty. In several cases the spreader grafts were included to obtain a strong structure and stability of the nose; the septal extension graft can be used in some cases with low nasal tip, extending the interdomal distance (Fig. 3).

In some cases the excision of the alar base at lateral level was necessary, to obtain the nasal base narrowing especially in cases of a primary widening due anatomical conditions or secondary widening caused by the orthognathic surgery. PDS 3-0 suture was used for the graft fixation (Fig. 4). Data were analyzed using the chi-square test considering a p value< 0.05 to obtain significant differences.

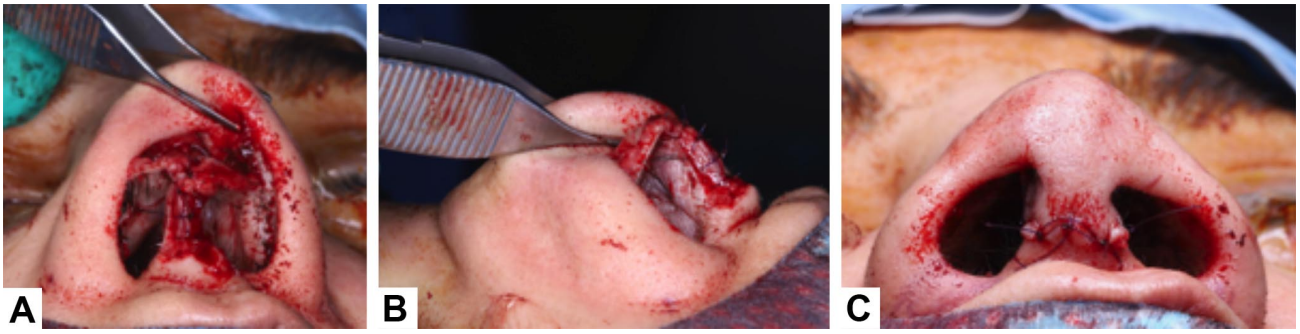

Fig. 3. Surgical process in nasal frame to build a new nasal tip A) suture of the graft to support the new tip B) lateral view showing the new angle for the nasal tip C) suture of the open approach in the skin.

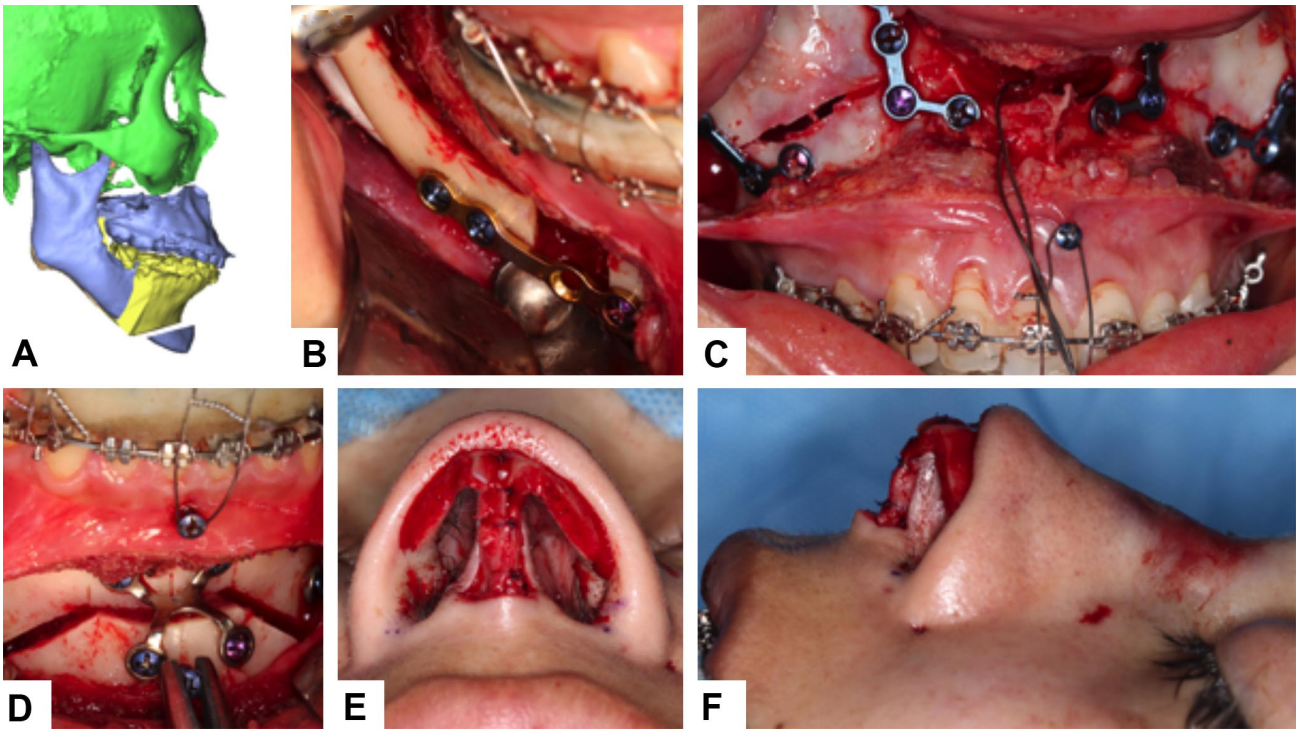

Fig. 4. Workflow in the simultaneous surgery: A) digital planning, B) mandibular osteotomy and fixation, C) maxillary osteotomy and fixation, D) Chin osteotomy and fixation, E) Open rhinoplasty and graft fixation, F) Confirmation of the new angle of the tip.

RESULTS

In this study 35 patients were included and underwent surgery with this technique. For all patients analysis and follow-up of 12 months after surgery or later, was performed (Figs. 5 and 6).

The most frequent FD treated simultaneously to rhinoplasty was type II skeletal deformity (Table I); primary nasal deformity was observed in the 83 % of subjects and was significantly more frequent than secondary nasal deformity (p=0.042). Nasal deformity observed was mainly in the nasal tip and nasal bridge.

There was no statistical relation between the nasal deformity and FD. Interestingly, asymmetry was present in

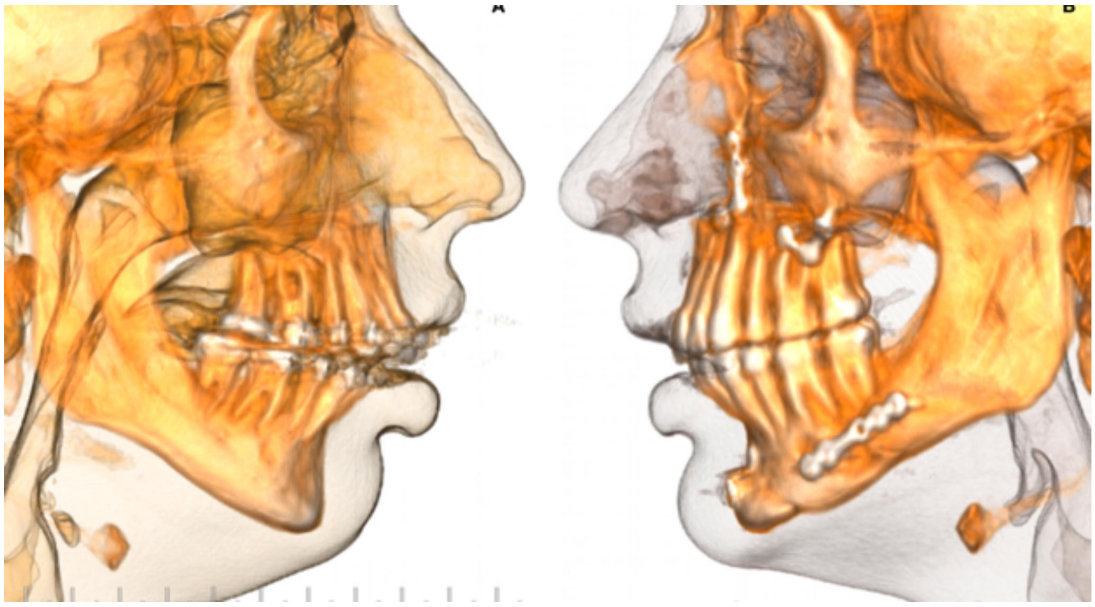

Fig. 5. A) dentofacial deformity with an angle class II, vertical maxillary excess, nasal hump excess and nasal tip drop. B) 1 year after surgery of the combined approach for maxillomandibular and nasal deformity.

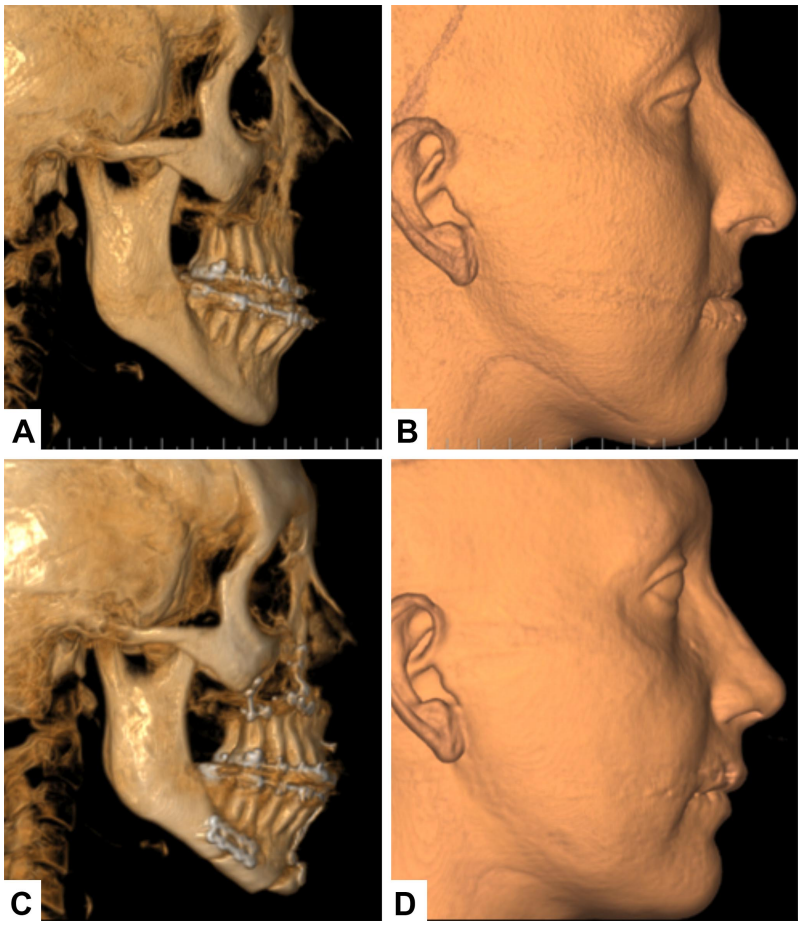

Fig. 6. Angle class III and nasal deformity. Skeletal (A and C) and soft tissue (B and D) related to maxilla mandibular movement before and after simultaneous rhinoplasty and orthognathic surgery.

54 % of the sample (Table II). On other hand, there was a higher rate of bimaxillary surgeries (Table III), where rhinoplasty was frequently performed with osteotomies. Bimaxillary surgery was performed in 31 cases (88 %), maxillary surgery in 3 cases and mandibular surgery in only one case.

In 10 cases a change of the original plan for rhinoplasty was realized due to the maxillary surgery (mainly in class III subjects). No complication was observed in the change of intubation. In term of results, revision orthognathic surgery was not necessary, and stability was observed; for the nose no functional complications were observed (such as valvular deficiencies or respiratory complications), revision rhinoplasty was realized in 5 cases (14 %) mainly due to esthetic problems to modify the nasal tip, the asymmetric nostril or asymmetric nasal tip; the revision surgery was executed in a second surgical time after at least 7 months. The cases for revision were mainly in the initial subjects of this sequence being related to the learning curve for this simultaneous surgery.

Table I. Distribution of 35 subjects treated by primary or secondary nasal deformity with orthognathic surgery.

Nasal Deformity	Skeletal Deformity			Total
	CI	CII	CIII	
Primary	4	12	13	29 (83 %)
Secondary	2	3	1	6 (17 %)
Total	6 (17 %)	15 (43 %)	14 (40 %)	35 (100 %)

CI: Dental and facial class I; CII: Dental and facial class II; CIII: Dental and facial class III.

Table II. Distribution of 35 subjects treated with orthognathic surgery and rhinoplasty in term of nasal deformity and maxillofacial deformity.

Nasal Deformity	Facial Deformity			
	CI	CII	CIII	Total
Nasal tip	4	11	10	25 (71 %)
Nasal bridge	3	11	12	26 (74 %)
Columella deformity	3	9	11	23 (66 %)
Asymmetry	1	7	9	17 (49 %)
Augmented nasal bridge	2	7	11	20 (57 %)
Total	6 (17 %)	15 (43 %)	14 (40 %)	

CI: Dental and facial class I; CII: Dental and facial class II; CIII: Dental and facial class III.

Table III. Distribution of 35 subjects treated with rhinoplasty and orthognathic surgery in term of type of surgery and technique.

Technique	Facial Deformity			
	C I	C II	C III	Total
Le Fort I Osteotomy	6	14	12	32 (91 %)
BSSO	6	15	12	33 (94 %)
Chin Osteotomy	4	13	12	29 (82 %)
Nasal osteotomy	5	12	14	31 (88 %)
Exclusively tip	1	3	0	4 (11 %)
Total	6 (17 %)	15 (43 %)	14 (40 %)	35 (100 %)

CI: Dental and facial class I; CII: Dental and facial class II; CIII: Dental and facial class III.

DISCUSSION

Close to 30 % of our population shows deficiencies in the maxilla or mandibular position, including prognathism or retrognathia and lateral or vertical deficiencies, among others (Olate & Chaves Netto, 2010; Sato, 2014; Joshi *et al*., 2014); thus, the nose is involved in the facial morphology, since the position of the ANS, the nasal floor and the nasal pyramid is related to the position of the maxilla.

If the maxilla is in retrognathic position, the nasal base will show poor support and the ANS will be pushed back, contributing to a dropped nasal tip; if the maxilla is prognathic, the nasal base will show the opposite effect with forward ANS, showing a cephalic rotation (Seah *et al*., 2012). With the maxilla in a lower position, a gingival smile from excessive vertical growth of the maxilla with the ANS in a lower position will be observed; in this case the nasal morphology could be observed with an open naso-labial angle with a narrow base, in some cases with increase of the deformity of the nasal bridge. In other cases, the maxilla is in a higher pattern, showing a vertical growth deficiency (short face), the nose will be vertically small, with a wide alar base and a dropped tip (Olate & Chaves Netto, 2010). The facial morphology is a result of an integrative condition of different areas.

In addition, Le Fort I osteotomy is related to change in nasal morphology, where maxillary advancement increases the interalar width by at least 2.5 mm (Olate *et al*., 2016, 2017), which justifies the use of different techniques to optimize the nasal and labial relation in orthognathic surgery. On other hand, the position of the pronasale after Le Fort I type osteotomy is related to the three-dimensional direction of the movement, however, the soft-to-hard tissue ratio to anticipate the real position of the nose after orthognathic surgery is not clear (Enacar *et al*., 1999; Conley & Boyd, 2007; Mars¸an *et al*., 2009). The same variability is observed in the subnasale area (Lin & Kerr, 1998).

Primary (before orthognathic surgery) or secondary (after orthognathic surgery) nasal deformity shows indication to perform nasal surgery (Jones & Smith, 1996; Güzel *et al*., 2007). In our sample, we observed 83 % with primary nasal deformity and 17 % with secondary nasal deformity because the significant movement of the maxilla acting over the nasal structure leaving to secondary nasal deformity. Seah *et al*. (2012) operated 46 subjects with simultaneous surgery showing significantly more deformity in nasal area than chin area; in their cases, the nasal bridge and nasal tip were the most common deformities with no relation with the FD, in agreement with our results.

Sun & Steinbacher (2018), showed that in the case of significant maxillary movement the simultaneous rhinoplasty (16 %) was statistically less when compared to the staged rhinoplasty (92 %), showing the simultaneous operation in the case of minimum movement as 4 mm in forward movement or 2 mm for vertical reduction of the

maxilla. The authors suggest performing the simultaneous technique in case of a great nasal deformity and minor maxillary movement and go for a two-time stage in the case of great maxillary deformity. In our sequence, simultaneous surgeries were applied when nasal deformity was observed or when a nasal deformity from the orthognathic movement was expected; in this sense, Raffaini *et al*. (2018), showed the limitations to simultaneous approach related to thin nasal bones (higher risk for bleeding), the presence of complication in the orthognathic surgery (complication in occlusion or fixation) and extreme septal deviation with major functional problems (requirement for total or subtotal cartilage rebuilding). In our sample, no complication was observed in the orthognathic surgery time, however in the rhinoplasty time it was observed subjectively with some difficulties 1) to confirm the length in the tip position using cartilage graft, 2) the interdomal sutures to define the tip and 3) the nasal width management, acting conservatively in the nostril treatment with low or any resection.

In the sequence of Waite *et al*. (1988), satisfaction of patient in simultaneous technique for orthognathic surgery was 94 % and for rhinoplasty was 82 %; 84 % of subjects decided the simultaneous surgery because they were at the same surgical time. Similar conclusion was observed by Rafaini *et al*. (2018), who treated 250 subjects under simultaneous procedures showing 98 % of satisfaction score; it is important to note that the requirement for revision rhinoplasty was the same than in the exclusive rhinoplasty surgery cases; in this term, the revision surgery was added to achieve a smaller nose, failure to correct the primary deformity, correction of a new deformity and elimination of the stigmata of rhinoplasty (Daniel, 2009). In our sample, 14 % was submitted to revision rhinoplasty and no revision was observed for orthognathic surgery. The revision rhinoplasty was for nasal asymmetry, drop nasal tip and width nasal bridge.

According to our observations, in cases of rhinoplasty simultaneously to Le Fort I osteotomy, the surgeon has to consider the anatomy of the FD and proportions with the nose (Ravelo *et al*., 2021); in terms of the surgical technique, the nasal septum detached using the Le Fort I has to be fixed to the ANE, using 3-0 nylon suture in the anterior base of the nose; the nasal base position and the tip morphology has to be studied before and after maxillary osteotomy because the nose will be different after Le Fort I mobilization.

The selection for the combined surgery is an important analysis in the preoperative consultation. There are cases with nasal deformities improved by maxillary movement, mainly in the advancement and short maxillar impactation surgery, with no rhinoplasty requirements. In other cases, the nose must be treated simultaneously to orthognathic surgery or delayed, because of primary or secondary deformity (Seah & Ilankovan, 2023). The final decision has to be made by the patient and the physician; however, staged rhinoplasty can be indicated in complex maxillary osteotomies, complex facial movement (Waite *et al*., 1988). Skin of the nose could be another variable to be included in the clinical decision.

Interestingly, the perception of the nose will change in subjects treated with orthognathic surgery; Liu *et al*. (2022) showed that in the preoperative stage, the patient´s attention is on the lower third of the face, but after orthognathic surgery, the patient´s attention is on the nose and 4o in nasal deviation could be a potential problem for the patient. For that reason, the nose has to be included in the potential facial results after orthognathic surgery. In syndromic patients or in cleft lip palate patients, the orthognathic surgery and later rhinoplasty could enhance the overall outcome (Eldesouky & Elbarbary, 2022), and in non-syndromic patients, the same considerations can be realized in a simultaneous or staged treatment.

The sample included in this research was healthy with no diagnosis of systemic conditions. The oldest patient included was 45 years old; systemic disorders and systemic treatment needs many considerations for a decision in surgery and must be included in a different strategy for clinical decisions (Rosso *et al*., 1997; D'Orto *et al*., 2022). On the other hand, postoperative conditions including oral hygiene and physiotherapy are an important topic in these cases; postoperative care in term of hygiene must be included in this type of surgeries (Tecco *et al*., 2018).

Limitation of this study, such as the low number in the sample and the requirement for a more extensive follow up must be considered in our results. The ethnic condition in the sample is another important topic, mainly in the nose characteristics, that must be addressed in the future for new research in this area.

CONCLUSION

We can conclude that maxillo mandibular osteotomies and rhinoplasty could be performed safely. The protocol described for rhinoplasty and orthognathic surgery simultaneously show low complications. Larger studies are necessary to understand the best choice regarding simultaneous procedures and soft tissue response.

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RESUMEN: La cirugía ortognática y la rinoplastia muestran sinergia en términos de resultados funcionales y estéticos. EL objetivo de esta investigación es analizar variables relacionadas con la cirugía ortognática y rinoplastia ejecutada de forma simultanea. Fueron incluidos hombres y mujeres entre 18 y 45 años de edad. EL diagnóstico fue en base a la morfología nasal (punta bífida, rotada, cuadrada u otras así como alteraciones del ala nasal y columela), deformidad facial (deformidad sagital y vertical), tipo de cirugía (técnica de rinoplastia y cirugía ortognática) y complicaciones asociadas. El seguimiento mínimo fue de 12 meses; se utilizo las prueba t test y chi cuadrado para definir relaciones estadísticas considerando un valor de $p< 0,05$ para obtener diferencias significativas. La deformidad clase III fue observada en el 40 % de los sujetos y la deformidad facial de clase II se presento en el 43 %. Para la deformidad nasal, las alteraciones de a punta nasal y nasal fueron mas prevalentes; la deformidad nasal primaria se presentó en el 83 % de los sujetos y fue significativamente mayor que la deformidad nasal secundaria ($p=0,042$). La cirugía bimaxilar se realizó en 31 casos (88 %); en 10 casos se realizó el cambio del plan quirúrgico inicial de la rinoplastia debido a cambios generados en la cirugía maxilar previa, mayormente en deformidad facial de clase III, sin presentar diferencias significativas. La rinoplastia de revisión fue realizada en 5 casos (14 %) y no fue relacionada con ninguna variable de tipo quirúrgica; la revisión de cirugía ortognática no fue realizada en ningún caso de esta serie. La rinoplastia y la cirugía ortognática simultanea mostraron bajas complicaciones y resultados predecibles. Se puede concluir que la osteotomía maxilo mandibular y la rinoplastia son seguras; sin embargo, estudios de mayor volumen son necesarios para entender la mejor opción y variables relacionadas con procedimientos simultáneos y la respuesta de tejidos blandos faciales.

PALABRAS CLAVE: Cirugía ortognática; Rinoplastia; Cirugía facial.

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