ORIGINAL ARTICLE

Surgical management with osteogenic distraction for midface hypoplasia in a specialized institute in Lima, Peru

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ABSTRACT

Background: Several patients with Crouzon, Apert, or Pfeiffer syndrome, or those with cleft lip and palate, exhibit growth alterations of the craniofacial bones, including midface hypoplasia and exophthalmos that necessitate surgical correction, which is not routinely performed. Currently, bone distraction provides a reliable method for midface advancement through gradual traction of the bone segment.
Objective: To describe the outcomes of osteogenic distraction for the correction of midface hypoplasia in patients treated at a national children's hospital in Lima, Peru.
Methods: A review of medical records was conducted at the institution to identify patients who underwent midfacial distraction surgery between 2016 and 2022.
Results: We identified 22 patients who underwent bilateral midface osteogenic distraction, with a mean age of 15 years. The diagnoses were cleft lip and palate (72.7 %), Crouzon syndrome (22.7 %), and Apert syndrome (4.5 %). The most commonly performed procedure was modified quadrangular Le Fort II distraction in 9 cases (40.9 %). Following surgery, correction of exophthalmos, increased projection of the inferior orbital rim along with the malar and upper jaw, enlargement of the nasopharyngeal space, and advancement of the upper dentition due to bone advancement were observed.
Conclusion: The application of bone distraction is currently the gold standard technique to correct anteroposterior discrepancies greater than 10 mm of the midface, as it improves exophthalmos, the projection of the malar and upper jaw, increases the nasopharyngeal space, and achieves advancement of the upper arch.

Keywords: Osteogenesis distraction; Maxilla; Apert Syndrome; Crouzon Disease; Exophthalmos (Source: MeSH)

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Distracción osteogénica del tercio medio facial en malformaciones cráneo maxilofaciales en un instituto especializado de Lima, Perú

RESUMEN

Introducción: Diversos pacientes con síndromes presentan hipoplasia del tercio medio facial y/o exoftalmos que requieren corrección quirúrgica, la cual no suele realizarse de forma habitual. Actualmente, la distracción ósea ofrece un método fiable para el avance del tercio medio facial.
Objetivo: Describir los resultados de la distracción ósea para la corrección de la hipoplasia del tercio medio facial en pacientes intervenidos en un hospital de referencia nacional en Lima, Perú.
Métodos: Se realizó una revisión de historias clínicas en la institución para identificar a los pacientes que recibieron cirugía de distracción ósea entre 2016 y 2022.
Resultados: Se identificaron 22 pacientes operados mediante distracción osteogénica bilateral del tercio medio facial, con una edad promedio de 15 años. Los diagnósticos fueron fisura labiopalatina (72,7 %), síndrome de Crouzon (22,7 %) y síndrome de Apert (4,5 %). El procedimiento más frecuente fue la distracción Le Fort II cuadrangular modificada en 9 casos (40,9 %). Tras la cirugía, se evidenció la corrección del exoftalmos, el aumento de la proyección del reborde orbitario inferior junto con el malar y el maxilar superior, el aumento del espacio nasofaríngeo y el avance de las piezas dentarias superiores debido al avance óseo.

Conclusión: La distracción ósea es una técnica idónea para corregir discrepancias anteroposteriores mayores de 10 mm del tercio medio facial, ya que mejora el exoftalmos y la proyección del malar y el maxilar superior. Además, promueve un incremento del espacio nasofaríngeo junto con el avance de la arcada superior.

Palabras clave: Osteogénesis por Distracción; Maxilar; Síndrome de Apert; Enfermedad de Crouzon; Exoftalmía (Fuente: DeCS)

INTRODUCTION

Craniofacial syndromes associated with craniosynostosis, such as Crouzon, Apert, and Pfeiffer syndromes, as well as cleft lip and palate, affect facial bone development. These disorders cause breathing and hearing-related problems in patients due to a narrow nasopharynx, as well as difficulties in speech and chewing due to malocclusion. In addition, visual disturbances may occur as a result of incomplete eyelid closure caused by exophthalmos or optic-nerve compression (1).

These patients require multiple surgical interventions throughout their growth and development, ranging from expansive cranioplasty and correction of cleft lip and palate to fronto-orbital advancement, midface distraction during school age, orthognathic surgery with or without mentoplasty, and even septorhinoplasty at skeletal maturity (2,3). Although not all patients require all of these procedures, bone correction of the midface is typically one of the least commonly performed interventions.

Le Fort osteotomies of the midface are typically performed after the patient's bone growth has been completed. However, the osteogenic distraction technique, which entails a precise bone cut to create a callus that is subsequently elongated to generate new tissue and facilitate ossification, can be utilized from mixed dentition into adolescence. This approach effectively corrects or overcorrects the orbitozygomatic and naso-maxillary regions, restoring facial proportions while also expanding the nasopharynx and oropharynx to alleviate respiratory obstruction symptoms when present (3).

The application of bone distraction in craniofacial surgery is a well-documented technique for addressing craniofacial syndromes and conditions such as cleft lip and palate. It is often used in conjunction with Le Fort I, Le Fort II, and Le Fort III osteotomies, as well as segmental bone distraction and monoblock osteotomy. This approach facilitates the reliable advancement of the midface through gradual traction of the bone segment, offering a distinct advantage over conventional techniques that necessitate the use of bone grafts.

In particular, bone distraction applied to Le Fort osteotomies has the advantage of achieving greater movement based on bone gain and less relapse than osteotomies alone, as it overcomes the limitation of movement imposed by the elongation of the soft-tissue envelope in the operated region (4-6) (Figure 1).

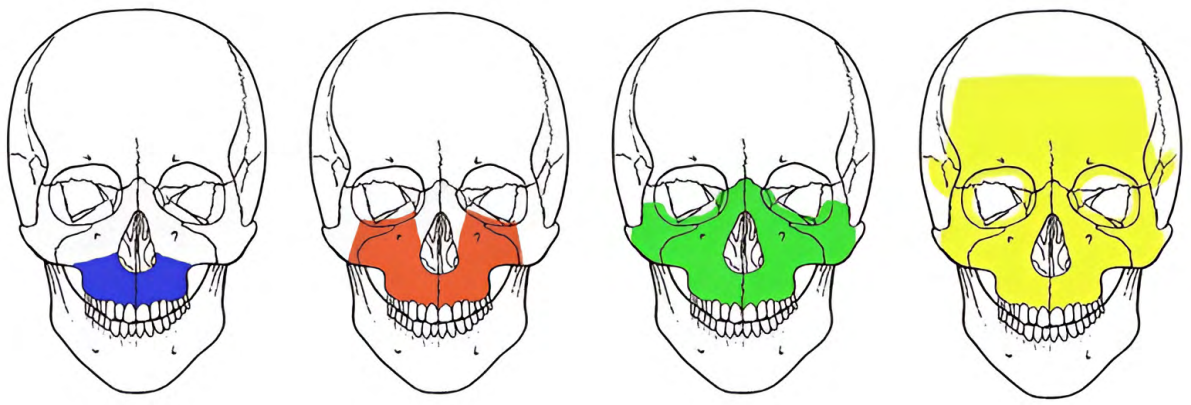


Figure 1. Midface osteotomies for distraction osteogenesis: Le Fort I (blue), Quadrangular Le Fort II (orange), Le Fort III (green), Monobloc (yellow)

Apart from midface hypoplasia, patients may present with corneal exposure, ocular luxation, papilledema, obstructive sleep apnea, require a tracheostomy, swallowing disorders, and Eustachian tube dysfunction (6).

The evaluation of these patients requires multidisciplinary management with specialists in neurosurgery, plastic surgery, otolaryngology, ophthalmology, psychology, orthodontics, pediatric dentistry, and oral and maxillofacial surgery at different stages of their growth and development. Treatment guidelines begin when they present craniosynostosis of the coronal sutures with intracranial hypertension and exophthalmos, conditions that justify surgery to place a ventricular drainage system. It is also possible to perform a fronto-orbital advancement or a monoblock advancement to correct craniosynostosis of the coronal sutures. One year after the frontal-orbital advancement, it is possible to perform a midface advancement, which is usually a Le Fort III

osteotomy in severe hypoplasia, and to correct exophthalmos by increasing the orbital volume. At the end of the growth period, the decision between quadrangular Le Fort II osteotomy or uni-/bimaxillary orthognathic surgery is guided by the goal of achieving functional occlusion and correcting an open bite, gingival smile, maxillary retrusion, midface hypoplasia, or mandibular pseudoprognathism (7-12).

Bone distraction takes place in three phases. The first phase is the latency phase, corresponding to the waiting period for bone-callus formation, which lasts 3 to 7 days, depending on the patient's age and various recommendations from different authors. The second phase is the distraction phase, during which the bone callus is stretched; its duration is variable and depends on the surgical plan. Finally, the consolidation phase is the waiting period until the distractor is removed; its duration is also variable and has been described as six to eight weeks after the distraction phase (3,5,7).

It should be emphasized that bone distraction is not free of possible complications, such as infection, unplanned fracture, incomplete osteotomy, poor fixation of the osteosynthesis material, and pseudoarthrosis, the latter being the most commonly reported (4,9,12).

This article presents the outcomes of bone distraction surgeries performed for the correction of midface hypoplasia at a pediatric reference hospital in Lima, Peru, in addition to detailing subsequent surgical interventions conducted on the treated patients. The relevance of this study is underscored by the current scarcity of bone distraction techniques utilized for managing similar craniofacial disorders within the national context, despite the potential for achieving favorable clinical outcomes as demonstrated in this analysis.

METHODS

Study population

Patients who underwent midface bone-distraction surgery at the Instituto Nacional de Salud del Niño San Borja between January 2016 and December 2022 were included in the study.

Variables of interest

Data were collected on age, sex, signs and symptoms, diagnosis, anteroposterior jaw discrepancy, surgical treatment performed, complications, recurrences, and sequelae.

Statistical analysis

Statistical analysis was performed using SPSS (version 25). Numerical variables were summarized using minimum and maximum values and measures of central tendency, whereas categorical variables were summarized using absolute and relative frequencies.

Ethical considerations

The study adheres to the fundamental ethical principles outlined in the Declaration of Helsinki, including non-maleficence and confidentiality. All collected information was treated as strictly confidential and used exclusively for this study. Written informed consent was obtained from each patient's legal guardian (because the cases involved minors) prior to obtaining postoperative images. The purpose of publication and the anonymization procedures for the images were explained in detail. This study was approved by the Ethics Committee of Instituto Nacional de Salud del Niño San Borja, ensuring that the inclusion of images serves legitimate scientific and educational purposes and avoids undue exposure of patients.

RESULTS

Twenty-two patients who underwent bilateral midface osteogenic distraction during the study period were identified. Fifty-nine-point-one percent (n = 13) of the cases were female (Table 1).

The mean age was 15 years, with a median of 17 years and a range of 5 to 17 years. The age group with the largest number of cases (17) was 13–17 years (77.3%), followed by 6–12 years with 4 cases (18.2%) and <6 years with one case (4.5%).

A diagnosis of cleft lip and palate was observed in 16 cases (72.7%), Crouzon syndrome in 5 cases (22.7%), and Apert syndrome in one case (4.5%).

Midface hypoplasia was present in all patients, followed by pseudoprognathism in 21 patients (95.5 %) and cleft-nose features in 6 cases (27.3 %) (Table 2).

The most common procedure was midface distraction using a quadrangular Le Fort II osteotomy in 9 cases (40.9%), followed by rhinoplasty in 6 cases (27.3%) (Table 3). Quadrangular Le Fort II osteotomy was performed in 7 patients with clefts and 2 syndromic patients whose parents declined Le Fort III because of the required scalp incision: one patient had undergone facial bipartition a year earlier, and the other a Le Fort III eight years earlier. Internal maxillary distractors were used in 5 cases (22.7 %), and external facial distractors in the remaining 17 cases (77.3 %).

All patients spent the postoperative period in the intensive care unit (ICU) with an orotracheal tube and planned extubation between 2 and 3 days.

After a 7-day latency period on the ward, distraction began. The bone callus was elongated 1 mm per day by turning a distal pin twice (0.5 mm per turn) each morning until the desired advancement of the inferior orbital rim and resolution of exophthalmos were achieved. The anteroposterior discrepancy from the upper to lower incisal cusp had a median of 12.7 mm (range 12–17 mm). After distraction, the anteroposterior increase averaged 16.8 mm (32 % over the initial measurement), with a range of 14–18 mm (Table 4).

A 60-day consolidation period was allowed before distractor removal. Distractors were removed at 3 months in 14 patients (63.6%) and at 4 months in 6 patients (27.3%); in the two infected cases, they were removed 2 weeks post-surgery.

Table 1. Summary of cases with midface hypoplasia

Case	Age (yr)	Clinical features	Diagnosis	Procedures performed
1	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
2	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
3	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
		Drooping nasal tip/ala		Rhinoplasty
4	17	Pseudoprognatismo	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
		Drooping nasal tip/ala		Rhinoplasty
5	7	Exophthalmos, Hypertelorism, Pseudoprognathism	Crouzon syndrome	Monobloc distraction + facial bipartition
6	5	Exophthalmos, Pseudoprognathism	Crouzon syndrome	Monobloc distraction
7	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
				Rhinoplasty
8	16	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
9	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
				Rhinoplasty
10	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
11	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort I distraction osteotomy
12	7	Exophthalmos, Pseudoprognathism, Nasal obstruction, Sleep apnea	Crouzon syndrome	Le Fort III distraction osteotomy
13	12	Exophthalmos, Pseudoprognathism, Anterior open bite, Sleep apnea	Apert syndrome	Le Fort III distraction osteotomy
14	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
		Nasal hump, Drooping tip		Rhinoplasty
15	13	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
16	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
		Nasal hump, Drooping tip		Rhinoplasty
17	16	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
	17	Nasal hump, drooping tip		Rhinoplasty
18	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
		Microgenia		Mentoplasty
19	13	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
20	12	Exophthalmos, hypertelorism, Prognathism, macrogenia	Hypertelorism, Crouzon syndrome	Facial bipartition
	17	Prognathism		Le Fort II distraction osteotomy
		Macrogenia		Mentoplasty
21	17	Pseudoprognathism	Cleft lip-alveolus-palate	Le Fort II distraction osteotomy
		Anterior open bite		Obwegeser osteotomy
22	17	Exophthalmos, Pseudoprognathism	Crouzon syndrome	Le Fort II distraction osteotomy
		Anterior open bite		Obwegeser osteotomy
		Nasal hump, drooping tip		Rhinoplasty

Table 2. Clinical features of patients with midface hypoplasia

Clinical feature	n	%
Midface hypoplasia	22	100
Pseudoprognathism	21	95.5
Cleft nose	16	72.7
Exophthalmos	6	27.3
Anterior open bite	3	13.6
Sleep apnea	2	9.1
Hypertelorism	2	9.1
Macrogenia	1	4.5
Microgenia	1	4.5
Nasal obstruction	1	4.5
Prognathism	1	4.5

Table 3. Overview of surgical procedures performed on patients

Surgery	n	%
Quadrangular Le Fort II distraction	9	40.9
Rhinoplasty	6	27.3
Le Fort I distraction with internal distractors	5	22.7
Le Fort I distraction with external distractor	4	18.2
Le Fort III distraction	2	9.1
Obwegeser osteotomy	2	9.1
Mentoplasty	2	9.1
Monobloc distraction + facial bipartition	1	4.5
Monobloc distraction	1	4.5
Total	**22**	**100**

All patients were assessed every 6 months during the first year and annually thereafter, with up to 3 years of follow-up in one case.

Complications

Complications occurred in both monoblock cases. Each developed acute surgical-site infection at the end of distraction (19 and 21 days post-operatively), with bilateral fronto-palpebral swelling, erythema, fever, pain, and purulent drainage. Management involved surgical debridement under anesthesia, antibiotic therapy (meropenem 20 mg/kg every 8 hours and vancomycin 10 mg/kg every 6 hours for 60 days), and removal of osteosynthesis material adjacent to the infection.

In the first patient (a 7-year-old), six debridements failed to control the infection. Ultimately, the facial distractor and frontal bone were removed because of positive cultures and imaging/biopsy consistent with acute and chronic osteomyelitis; an ethmoidal bony defect was closed.

The second (5-year-old) patient required a single debridement with removal of the frontal bone and closure of the ethmoidal defect; the facial distractor was removed, and a bilateral zygomatic-malar plate was placed to maintain the achieved midface advancement. In both cases, the frontal bone was lost secondary to infection; only the 7-year-old developed unilateral blindness.

Table 4. Midface retrusion measurements and correction achieved through distraction

Preoperative anteroposterior discrepancy (mm)	n	%
12	1	4.5
13	4	18.2
14	5	22.7
15	4	18.2
16	7	31.8
17	1	4.5
Total	22	100
Mean (mm)	12.7	
Post-distraction anteroposterior distance (mm)	**n**	**%**
14	1	4.5
15	3	13.6
16	5	22.7
17	4	18.2
18	9	40.9
Total	22	100
Mean (mm)	16.8	

Complications occurred only in both cases of monoblock advancement. In both cases, the complications were classified as fronto-orbital abscess leading to acute frontal osteomyelitis and chronic osteomyelitis, which resulted in the loss of the frontal bone in both cases. However, only the 7-year-old case developed blindness in one eyeball.

Surgical technique used for bone distraction

Le Fort III osteotomy is performed using two incisions. The coronal incision is used to expose the zygomatic arch, lateral and medial walls of the orbit, as well as the orbital floor and the frontonasal suture. On the other hand, the maxilla and malar are accessed through incisions in the buccal sulcus.

The osteotomies are performed using a reciprocating saw or a Lindemann burr, following the chosen design. Using an osteotome from the nasion to the posterior nasal spine, the vomer and ethmoid are separated from the cranial base. Finally, the pterygomaxillary separation is performed via the coronal and/or buccal approach. Once the osteotomies have been performed, Rowe forceps are used to perform the down-fracture and verify the complete disjunction of the Le Fort III block, allowing for the placement of plates, screws, and traction wires from the plate to the distractor. Hemostasis is then performed, and the incisions are closed to finally place the external facial distractor and secure the wires to the distractor (Figure 2).

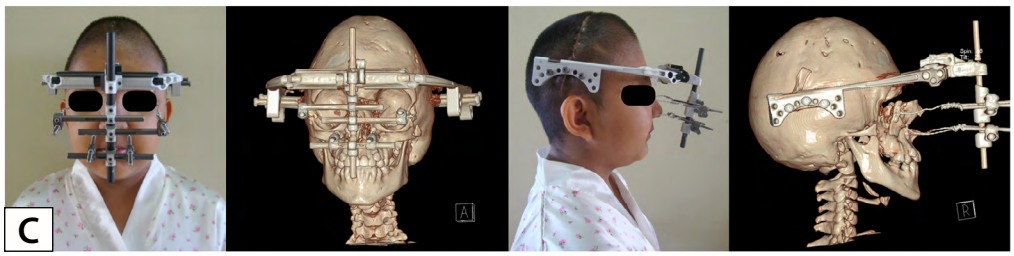
In the quadrangular Le Fort II osteotomy, a subsidiary incision is required to access the orbital floor, and an incision at the buccal sulcus for the lateral and medial osteotomies. With steps similar to the Le Fort III osteotomy, the block is

down-fractured with Rowe forceps, and the disjunction is verified. After verification, the plates, screws, and percutaneous wires are placed, the incisions are closed, and the distractor is attached to the wires (Figure 3).

For Le Fort I osteotomy, only buccal sulcus incisions are required. After dissection, the internal distractors are molded to mark the holes above and below the osteotomy. The osteotomy is performed with a reciprocating saw, and the segment is down-fractured; the internal distractors are placed with screws, and the incisions are closed (Figure 4).

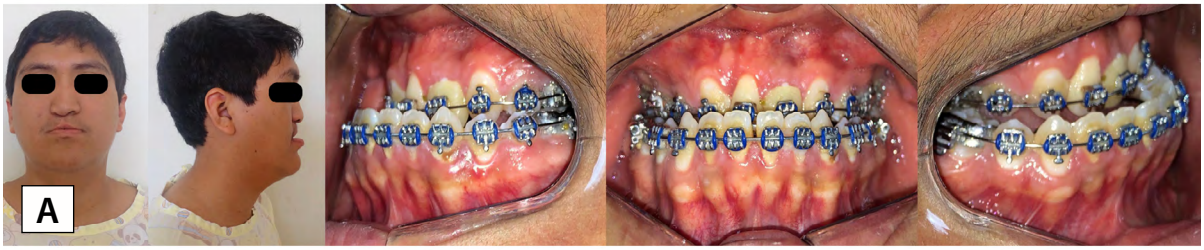
A. Preoperative extraoral and occlusion photographs

B. Postoperative extraoral and occlusion photographs

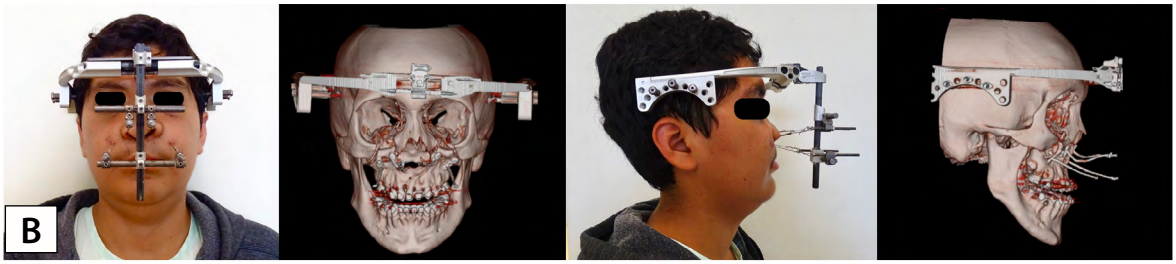


C. Photographs and CT scan with external distractor

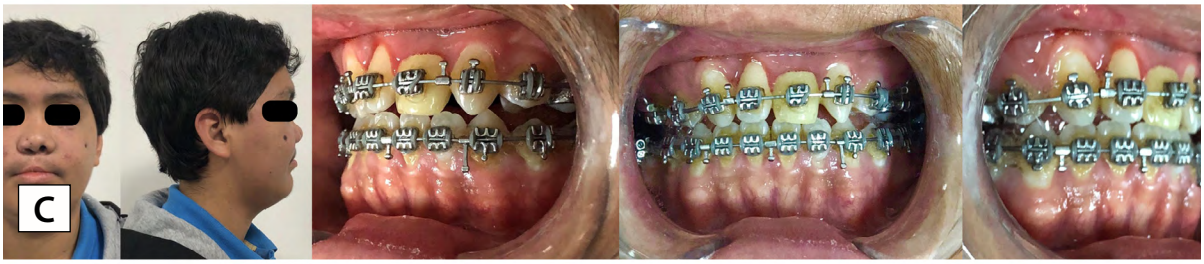
Figure 2. Le Fort III osteotomy in case 9



A. Preoperative extraoral and intraoral photographs



B. Photographs and CT scans with external distractor



C. Postoperative extraoral and intraoral photographs

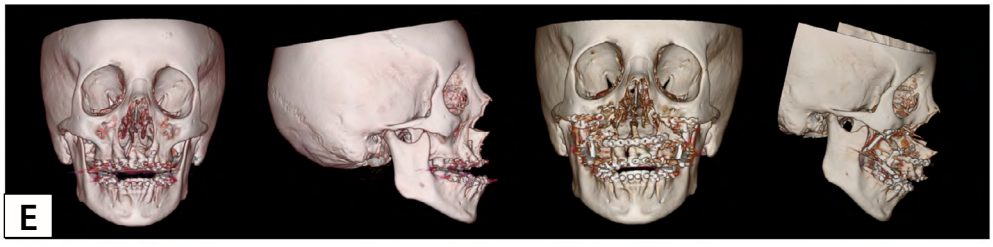
Figure 3. Quadrangular Le Fort II osteotomy in case 11

A. Preoperative extraoral photographs

B. Preoperative intraoral photographs

C. Postoperative extraoral photographs

D. Postoperative intraoral photographs

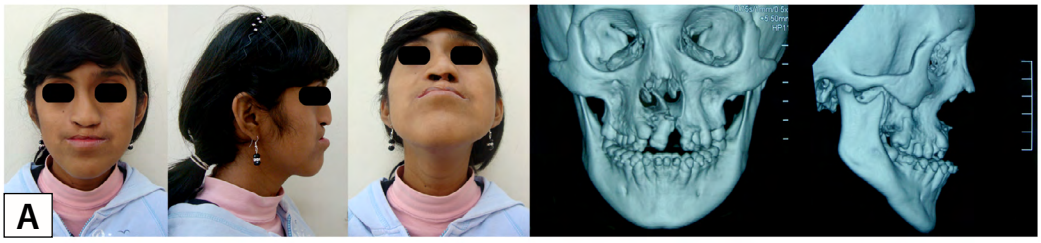


E. Preoperative frontal and lateral CT scans, and frontal and lateral CT scans with distractors

Figure 4. Le Fort I osteotomy with internal distractors in case 10

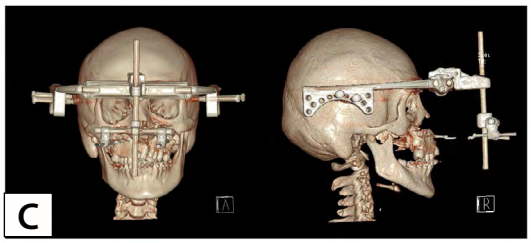
Le Fort I osteotomy can also be performed at a more superior level using an external distractor to overcome anatomical limitations in the placement of the internal distractor (Figure 5).

Monoblock advancement requires a bifrontal craniotomy to separate the anterior cranial base (orbital roof and ethmoid bones) from the rest of the skull. The frontal craniotomy, the fronto-orbital strip, and the Le Fort III osteotomy are joined with plates and screws to maintain a single bone block for distraction (Figure 6).



A. Preoperative extraoral photographs and frontal and lateral CT scans

B. Postoperative extraoral photographs and frontal and lateral CT scans



C. Postoperative photographs with external distractor at the end of the distraction phase

Figure 5. Le Fort I osteotomy with external distractor

Preoperative CT scan, preoperative photograph, postoperative CT scan

Figure 6. Monobloc osteotomy in case 6

DISCUSSION

Midface hypoplasia is identifiable at birth in the craniofacial syndromes described or may manifest progressively during growth in patients with clefts (1,3,11). Although early surgery (craniosynostosis correction and cleft repair) is a priority, corrective osteotomies of the midface can be performed over a broad time window (1, 2). In our study, most patients (77.3%) underwent surgery during adolescence (13–17 years), which coincided with the stage of permanent dentition. However, we also included cases in mixed dentition and one in deciduous dentition, where the severity of exophthalmos and facial retrusion justified earlier intervention (3,4).

The six cases with significant exophthalmos corresponded to patients with Crouzon and Apert syndromes, a typical feature which, together with midfacial hypoplasia, constitutes a clear indication for surgery. In these syndromic pathologies, the degree of primary advancement required is usually determined by the retrusion of the upper midface (naso-orbital region) rather than by retrusion at the occlusal level, which may require orthodontic/orthopedic management and secondary surgeries (5).

The most commonly performed surgery in our series was modified quadrangular Le Fort II osteotomy, similar to that described by Wagner et al. (9), which allows both the occlusal segment to be advanced and the malar and infra-orbital region to be projected without significantly altering the nasal base, making it useful in selected cleft or syndromic patients.

Le Fort III osteotomy was performed on two patients (aged 7 and 12 years) with syndromes and marked retrusion, with the primary objective of correcting severe exophthalmos, in line with the description by Engel et al. (12). An older syndromic patient underwent a quadrangular Le Fort II despite having a theoretical indication for Le Fort III, due to previous surgeries and parental preference.

The monobloc advancement was reserved for two syndromic patients with severe retrusion of both the middle and upper thirds of the face and prominent exophthalmos. Unfortunately, both cases suffered serious infectious complications that required multiple interventions and prolonged antibiotic treatment and resulted in significant sequelae (loss of the frontal flap and unilateral blindness in one case). These complications underscore the risks associated with such extensive procedures in this population.

Intraoral distractors (Depuy Synthes®) were used in five patients with Le Fort I osteotomy. Their removal was technically more demanding due to limited access to the proximal screws after bone advancement. For the remaining osteotomies (Le Fort II, III, monobloc), an external facial distractor (Depuy Synthes®) was used, which was easier to remove. Our findings are consistent with Meling et al. (11) regarding the stability of external anchorage and the absence of displacement of the associated material.

Regarding secondary surgeries, two adolescent patients with residual open bites after distraction underwent bimaxillary orthognathic surgery, including Obwegeser sagittal split of the mandibular ramus, for final correction. Another younger patient with an open bite is anticipated to require orthodontic treatment and potentially orthognathic surgery at the end of growth. Secondary rhinoplasty was performed in three patients to correct nasal deformities associated with cleft lip/palate and in one patient with Crouzon syndrome to enhance nasal aesthetics.

There is currently no consensus on the residual growth potential of the midface after early distraction; therefore, the decision to intervene before skeletal maturity should be based on clear functional or aesthetic indications (severe exophthalmos, respiratory obstruction, psychosocial disturbance). There is also no unanimous agreement on the magnitude of relapse or lack of subsequent harmonious growth in patients operated on in childhood and the predictable need for a second major surgery upon reaching maturity (1,3-5).

Publications such as those by Massenburg et al. (2) and Sandor et al. (4), as well as other reviews, support the use of osteogenic distraction to achieve significant advances (> 10–12 mm), which often exceed what is feasible or stable with conventional single-stage orthognathic surgery at growth completion.

We consider the retrospective nature of this study, the relatively small sample size, and the variability in follow-up duration to be important limitations. In addition, we recognize that there may be under-representation due to delayed referral stemming from limited awareness of growth-phase therapeutic options. As a strength, we highlight that performing these complex surgeries requires an experienced multidisciplinary team and adequate infrastructure, both of which are present at the Instituto Nacional de Salud del Niño San Borja.

CONCLUSION

The authors present their experience with bilateral midface distraction osteogenesis as the primary treatment for patients with significant hypoplasia in this region. By employing various osteotomy designs (Le Fort I, II, III) tailored to individual clinical characteristics and adhering to the principles of osteogenic distraction (latency, activation, consolidation), a substantial anteroposterior increase in the midface was achieved.

This resulted clinically in the improvement of exophthalmos, increased projection of the inferior orbital rim, malar, and maxilla, as well as enlargement of the nasopharyngeal space (mainly with Le Fort II and III), and advancement of the upper dentition (with all Le Fort types). Long-term treatment success often necessitates the integration of these surgeries with complementary interventions (orthodontics, secondary orthognathic surgery, rhinoplasty) to optimize occlusion and enhance facial aesthetics.

We conclude that distraction osteogenesis is an effective and often preferred surgical technique for correcting anteroposterior discrepancies > 10 mm in the midface, especially in patients with complex craniofacial syndromes.

The principal recommendation derived from this study is the importance of early multidisciplinary evaluation and follow-up. Functional and aesthetic improvements are achievable through planned, staged interventions; therefore, early referral to specialized centers, ideally from preschool age, for evaluation, therapeutic planning, and family education on surgical options and timing is crucial.

Author contributions

JFOA conceptualized, designed, and implemented the study methodology. All authors analyzed the data, drafted the initial manuscript, and reviewed and edited the final version. All authors approved the version submitted for publication.

Conflicts of interest

The authors declare no conflicts of interest.

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