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Early Treatment of Class III Dentofacial Anomalies with Skeletal Anchorage Protocol and Orthopedic Maxillary Expansion-Report of 4 Clinical Cases

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ABSTRACT

The resolution of dentofacial anomalies requires interdisciplinary work, ideally from an early age and with interceptive objectives. There are various surgical and non-surgical orthopaedic techniques described for the timely treatment of maxillomandibular dysmorphisms. Among the surgical alternatives, the use of mini plates and skeletal traction screws has allowed great progress in timely treatment of patients with skeletal class III dentofacial anomalies.

The purpose of this work is to present the results of 4 pre-adolescent patients with a diagnosis of transverse maxillary compression and skeletal class III where the De Clerck technique with MARPE (Minescrew Assisted Rapid Palatal Expansion) therapy was performed; clinically and imaging quantifying the resolution of the pre-existing dentofacial anomaly.

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Introduction

Dento-skeletal anomalies are common in the population. It has been documented that the incidence of Class III malocclusion varies according to ethnic origin. In our country, an epidemiological study carried out by the University of Chile reports an incidence of 86.7%. Depending on the bone base involved, it can present as: normal maxilla with mandibular prognathism (35.6%), maxillary protrusion with mandibular prognathism (22.7%) or maxillary retrusion with mandibular prognathism (13.3%) [1]. Considering that orthognathic surgery in the resolution of this type of anomaly is recommended at the end of facial growth, there are interceptive treatment options, which are ideally performed in a prepubertal period (between 9 and 14 years), with the aim of reducing the magnitude of a functional condition and, in some cases, avoiding more invasive surgical techniques [2].

For many years, orthopaedic devices such as face masks have been used for the treatment of Class III, implemented at an early age (first stage of mixed dentition) [3].

Despite their effectiveness, these devices can generate dental compensations such as proclination of the upper incisors and retroclination of the lower incisors. Furthermore, their use is usually limited to an average of 14 to 22, in an ideal case [4]. Among the new maxillary protraction techniques, the use of Temporary Anchorage Devices (TADs) has gained momentum [5]. Titanium mini-plates used for bone anchorage offer the possibility of applying pure orthopaedic forces between the maxilla and mandible 24 hours a day, avoiding any dentoalveolar compensation [3].

In multiple cases of Class III anomalies, the transverse discrepancy between the arches is associated with a deep and narrow palate. In order to achieve a stable occlusion and to avoid detrimental effects before the end of growth, it is essential to establish a normal transverse skeletal relationship. For this purpose, the Microimplant-Assisted Rapid Palatal Expansion (MARPE) technique is used to open the mid-palatal suture and maximize skeletal effects in, ideally, pre-adolescent patients [6,7]. Overall, the surgical procedure described by Dr. Hugo de Clerck, known as ZAS (Zygoma anchorage system) or BAMP (Bone anchor maxillary protraction) is used, which consists of the positioning of four mini-plates: 2 of them in the maxilla (1 in each zygomatic alveolar process), which generate a vector of forces that pass through the nasomaxillary complex stimulating the circummaxillary sutures [3]. The other 2 plates are installed on each side of the mandible in the parasymphyseal region, caudal to the apices, between the lateral incisor and the permanent canine. It is also possible to perform the technique with 2 mandibular mini-plates, together with the palatal expander [5]. After installation, elastic traction is started with a force of 100 g per side, followed by an increase to 200 g after a month and 250 g after two months. Patients should be instructed to change elastics once a day [2,3]. A significantly greater advancement of the maxillary structures has been demonstrated in subjects treated with bone anchorage compared to subjects treated with a face mask [8]. However, it should be considered that the placement of mini-plates is not always feasible in patients under 13 years of age due to the presence of dental germs and because the speed of bone remodeling is higher in this age group, which hinders the stability of the mini-plates after installation, leading to loss of the osteosynthesis material in some cases [7,9].

The purpose of the present work is to show the results of 4 patients operated using De Clerck protocol plus MARPE in pre-adolescents between 10 and 14 years old, performing pre- and postsurgical measurements by Cone Beam imaging of the maxillomandibular bone advancement and the oropharyngeal airway after the resolution of the dentofacial anomaly.

Materials and Methods

For three-dimensional measurements in the sagittal plane of the maxilla and mandible, the Frankfort line was used as the true horizontal. At the time of the CBCT exposure, the patients were seated, in maximum intercuspidation, without swallowing and holding their breath at the end of exhalation. The Basion point (midpoint of the anterior border of the occipital foramen) was considered as an anatomical reference to draw a vertical from which horizontal distance measurements were carried out in lines perpendicular to the aforementioned vertical.

Regarding the length of the horizontal lines, the following points were measured in the maxilla: Anterior nasal spine (ENA), Posterior nasal spine (ENP), Nasopalatine (NP) and point A (point of greatest concavity of the maxilla).

The mandibular measurements were carried out with horizontal lines (also perpendicular to the Basion vertical) and considering the points: anterior wall of the right and left mentonian canals (AM R/L) and point B.

The estimation of the changes in the airway of the surgical patients was performed using RadiAnt Viewer 2022.1® computer software after DICOM file export. The evaluation and volumetric measurements of the cone beam scans were performed by the same investigator. For this, the vertical line drawn from the Basion point was again considered as a reference, from which 2 horizontal lines were projected: the first drawn towards the ENA point (anterior nasal spine, considered parallel to the Frankfort plane) of the maxilla, which gave us the upper limit of the airway volume, and a second horizontal line drawn from point B of the mandible, which indicated the lower limit.

It was decided to take the measurements from Basion, because the cone beams were taken in a small window that did not cover the Silla turca, a structure commonly used for cephalometric measurements. This point was considered to be ideal, as it has the characteristic of being a stable structure within the craniofacial massif. The measurement method described above was possible in 3 of the 4 patients studied, since the fourth patient had an even more limited post-surgical cone beam window, where it was not possible to appreciate this structure. Therefore, the measurements of this particular patient were taken from a vertical line obtained from the centre of the C1 vertebra and from where the lines perpendicular to this vertical were drawn, which allowed the results to be obtained.

Both sagittal skeletal measurements and volumetric airway measurements were performed on CBCT preoperative and 18 months post skeletal anchorage surgery.

Case report

Skeletal anchorage surgery with De Clerk protocol was performed in 4 patients with an age range between 10 and 14 years, who were requested a CBCT prior to treatment as a complementary examination for the definitive diagnosis. In the previous clinical and cephalometric evaluation (Ricketts and Delaire), a class III skeletal relationship was observed with hypoplasia of the posteroanterior and transverse maxilla, combined with an increased mandibular size in the 4 studied patients. All patients underwent orthopaedic palatal expansion treatment (MARPE) prior to skeletal anchorage plate installation surgery. The palatal expanders used for correction of maxillary compression (MSE from BMK) were installed 3 weeks prior to the mini-plate fixation (Figure 1). Activation of the expander was immediate and sequential, with daily movements of 0.13 mm, for a period of 15 days. The plate fixation surgeries were performed under general anaesthesia in the city of Santiago de Chile (private practice), between 2020 and 2022. An informed consent was signed by the guardians of the patients who underwent surgery.

Days prior to surgery, stereolithographic models were made where the orthomax - cibey system plates were pre-molded. In 2 of the patients 4 mini-plates were used (in maxilla and mandible) (Figure 2) and in the remaining 2 only 2 mandibular mini-plates were used. Surgical accesses were performed in the maxillary and mandibular vestibular area in a minimally invasive manner. The fixation of the plates to the bone tissue was performed with 7 mm screws, using 3 screws per plate. The incision was closed with Vicryl 4.0 rapid resorbable material. Skeletal traction was initiated 10 days after the installation of the anchorage plates and the results were quantified in 3D studies with CBCT images (Figure 3).

Clinical and imaging controls were performed by the maxillofacial surgery and orthodontic specialties at 1 week, 2 weeks, 3 months, 6 months, 12 months and 18 months post-surgery. After the last check-up at one and a half year, the mini-plates were removed under local anesthesia. Successful results are described, attaining resolution of the dentofacial anomaly in all 4 cases (Figure 4).

Figure 1: (1a): Palatal expander device installed for the MARPE orthopaedic technique
(1b): Anterior view of De Clerck skeletal traction protocol, using 2 mandibular mini-plates and maxillary expansion with elastic activation

Figure 2: Mini maxillary traction plates installed in the right (2a), left (2b) and right (2c) and left (2d) parasymphyseal area.

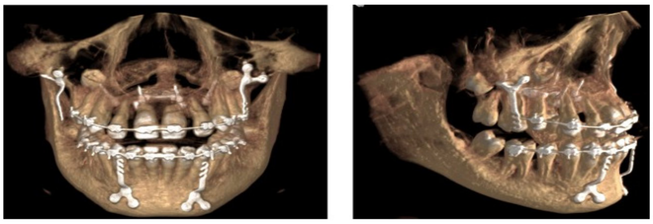

Figure 3: Post-installation imaging control of 4 mini skeletal traction plates.
(3a): Frontal View, (3b): Lateral View.

Figure 4: Pre- and post-surgical after 18 months of treatment with De Clerck protocol
(4a): Pre-Surgical, (4b): Post-Surgical.

Results

Maxillary and Mandibular Bone Changes

In the 4 patients studied, sagittal advancement of the maxilla can be observed. The average advancement of the ENP was 1.7 mm, the CNP advanced an average of 3.3 mm, the ENA advanced an average of 2.1 mm and the A-point advanced an average of 1.3 mm. One patient experienced no variation in point A pre- and post-treatment. The patient who showed advancement in the post-surgical measurement of point B also experienced advancement in point AM. The quantified changes were described for each side, and the variations between pre- and post-surgical measurements are shown in Table 1.

Table 1: Post-Surgical Sagittal Cephalometric Changes

Patients	ENP	CNP	ENA	Point A	Point B	AM (R/L)
Patient 1 -Post- surgical	Advance 2.2 mm	Advance 4 mm	Advance 1.7 mm	Advance 1 mm	Backtracking 5.9 mm	R: Backtracking 6.8 mm L: Backtracking 6.3 mm
Patient 2 -Post- surgical	Advance 1.6 mm	Advance 3.1 mm	Advance 4.2 mm	Advance 2.7 mm	Backtracking 1.8 mm	R: Backtracking 4.1 mm L: Backtracking 1.5 mm
Patient 3 -Post- surgical *	Advance 2.9 mm	Advance 3.7 mm	Advance 1.1 mm	Advance 1.7 mm	Advance 6.1 mm	R: Advance 6.1 mm L: Advance 5.8 mm
Patient 4 -Post- surgical	Advance 0.4 mm	Advance 2.4 mm	Advance 1.7 mm	No changes	Backtracking 6 mm	R: Backtracking 6.2 mm L: Backtracking 4.7 mm

Abbreviations: NPC: Nasopalatine Duct (Anterior Wall), ENA: Anterior Nasal Spine, ENP: Posterior Nasal Spine, AM: Mentonian Foramens, R: Right; L: Left.
*Measured from centre C1 (cone beam window without Basion).

Airway Changes
Regarding the variations experienced by airway volume, the results were as follows
Patient 1 experienced a decrease in airway volume with a difference of -202.21 mm^3 between pre- and post-surgery.

Patient 2 showed an increase in airway volume, with an increase of 366.58 mm^3.

In the case of the third patient, an increase in the studied volume can be seen, which changed by 46.74 mm3. The changes experienced by patient 2 are shown in figure 5.

The fourth patient also experienced an increase in airway volume when comparing the pre- and post-operative. This increase had a 133.85 mm^3 magnitude.

Three of the four patients studied showed an increase in airway volume when the airway was calculated from the maxillary ENA point to the mandibular B point. The average of the patients who showed an increase in volume was of 182.39 mm^3.

The only patient who experienced a decrease in volume was male. The airway variations of all patients studied are detailed in Table 2.

Table 2: Airway Changes

Patients	Volume mm^3 (ENA-B)
Patient 1 -Pre- surgical -Post- surgical	8710.23 mm^3 8508.02 mm^3
Patient 2 -Pre- surgical -Post- surgical	8248.35 mm^3 8614.93 mm^3
Patient 3 -Pre- surgical -Post- surgical *	9890.37 mm^3 9937.11 mm^3
Patient 4 -Pre- surgical -Post- surgical	12207.13 mm^3 12340.98 mm^3

*Measured from centre C1 (conebeam window without Basion).

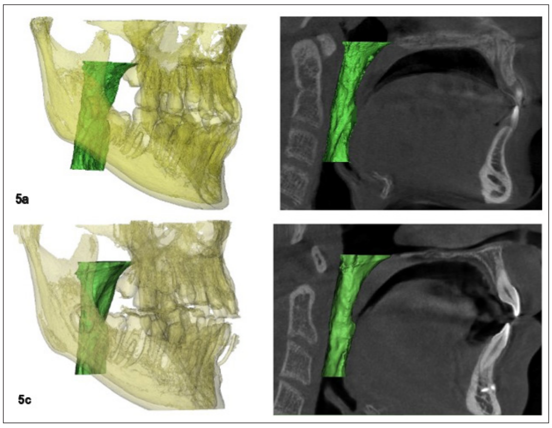

Figure 5: Upper airway Volumetry evaluation, patient 2. Images 5a and 5b corresponding to preoperative evaluation, 5c and 5d corresponding to postoperative evaluation.

Discussion
The high prevalence of malocclusion has become a global public health problem and is currently considered the third priority in oral health [10]. With the skeletal treatment approach, maxillomandibular changes lead to improved sagittal and transverse intermaxillary relationships in patients with skeletal Class III malocclusions, without vertical changes in craniofacial structures or dental compensations, in contrast to the results obtained with orthopaedic treatment performed with face masks [3,7,11].

The results obtained in the present study, which combined MARPE orthopaedic treatments + De Clerck mandibular traction protocol, are considered relevant by the authors, because most of the patients studied experienced maxillary advancement and mandibular recession, satisfactorily resolving their skeletal discrepancy.

One of the main advantages of orthopaedic treatment with miniplates at an early age is the considerable improvement in the facial aesthetics of prepubertal patients, which has a positive impact on their psychosocial development. This could be due to greater adherence to treatment in contrast to the use of face masks, which tend to be uncomfortable in daily use, in contrast to mini-plates and elastics which are installed intraorally and are easy to manipulate. When orthognathic surgery is performed at the end of growth, without previous orthopaedic treatment, it requires the patient to accept the progression and advancement of facial disharmony, which negatively influences their self-esteem and interpersonal relationships at an early age [4].

On the other hand, as limitations of mini-plate treatment, it is described that in children under 10 years of age, skeletal anchorage surgery is not usually indicated, due to the limited alveolar height of the maxilla and the fact that the canines are often not erupted, which increases the risk of damage to the teeth by germs. Financial limitations can also be mentioned, as not all patients can afford these treatments, which often have to be performed in the central ward under general anaesthesia [3,4,9].

Regarding the analysis of skeletal variations in 3D examinations, an interesting point to discuss is the feasibility of performing cephalometric measurements when CBCTs were taken with reduced viewing windows, as occurred in the cases presented in this work. The absence of cephalometric points such as the Silla or Pogonion points, considered essential for performing cephalometry, are in our opinion not entirely indispensable for carrying out satisfactory skeletal measurements. This is because it is feasible to look for alternative anatomical points that are stable and visible in the window available for comparative preoperative and postoperative measurements. Some authors debate the veracity of measurements of points that undergo great remodeling and resorption throughout growth and development, such as points A and B. That is why NP and AM points were considered in this study.

On the other hand, the results obtained for airway volume are quantitatively heterogeneous enough to affirm that there was a relevant difference between the measurement of this variable pre- and postoperative. The authors suggest evaluating this variable in patients who, in addition to presenting skeletal class III malocclusion, may show signs of a sleep disorder, which would allow empirical evaluation of whether there is improvement in this area.

Conclusion

Due to the fact that a large percentage of the population currently prefers not to undergo complex surgical treatment and given the increasing demand for interceptive treatment, orthopaedic techniques have become an excellent therapeutic option for patients presenting with skeletal Class III malocclusion, especially when treatment must be initiated at an early age [7]. Currently, the incorporation of surgically inserted bone anchorage appliances (mini-plates and mini-screws) offers a mixed treatment approach, minimising the undesirable side effects of the compensations achieved with traditional dentofacial orthodontics based on conventional mechanical traction masks [3].

Pure bone-borne orthopaedic forces applied through intermaxillary elastics and mini-plates have been shown to improve midface growth in young patients with maxillary deficiency. This advancement results in harmonisation of the soft tissue profile and anterior displacement of the entire midface [4]. In some cases, this advancement may be sufficient to avoid orthognathic surgery or at least reduce the severity of surgical correction required after completion of growth, as it improves the quality of the bone bases and increases, in most cases, the diameter of the upper airway [5].

References

1. Borja Espinosa DM, Ortega Montoya EA, Cazar Almache ME (2021) Prevalencia de las maloclusiones esqueletales en la población de la provincia del Azuay - Ecuador. Research, Society and Development 10: e24010515022.
2. Huízar González IG, García López E (2016) Protracción maxilar mediante anclaje esqueletal en pacientes clases III en crecimiento. Revisión bibliográfica. Revista Mexicana de Ortodoncia 4: 155-158.
3. Solano-Mendoza B, Iglesias-Linares A, Yañez-Vico R, Mendoza-Mendoza A, Alió-Sanz J, et al. (2012) Maxillary Protraction at Early Ages. The Revolution of New Bone Anchorage Appliances. Journal of Clinical Pediatric Dentistry 37: 219-229.
4. De Clerck HJ, Cornelis MA, Cevidanes LH, Heymann GC, Tulloch CJF (2009) Orthopedic Traction of the Maxilla With Miniplates: A New Perspective for Treatment of Midface Deficiency. Journal of Oral and Maxillofacial Surgery 67: 2123-2129.
5. De Clerck HJ, Proffit WR (2015) Growth modification of the face: A current perspective with emphasis on Class III treatment. American Journal of Orthodontics and Dentofacial Orthopedics 148: 37-46.
6. Kapetanović A, Theodorou CI, Bergé SJ, Schols JGJH, Xi T (2021) Efficacy of Miniscrew-Assisted Rapid Palatal Expansion (MARPE) in late adolescents and adults: a systematic review and meta-analysis. European Journal of Orthodontics 43: 313-323.
7. Silva J, Perez-Flores A (2022) MARPE, Miniscrew Assisted Rapid Palatal Expander, en pacientes adultos jóvenes: Ancho transversal intermolar, ancho transversal de cavidad nasal, complicaciones y otros resultados informados. Revisión sistemática. Odontoestomatología 24: 1-11.
8. Baccetti T, De Clerck HJ, Cevidanes LH, Franchi L (2011) Morphometric analysis of treatment effects of boneanchored maxillary protraction in growing Class III patients. The European Journal of Orthodontics 33: 121-125.
9. Silva E, Meloti F, Pinho S, Gasque CA (2017) CORREÇÃO DA CLASSE III ESQUELÉTICA EM PACIENTES JOVENS - ERTTY GAP III®. https://api.semanticscholar.org/CorpusID:186597946.
10. Akbari M, Lankarani K, Honarvar B, Tabrizi R, Mirhadi H, et al. (2016) Prevalence of malocclusion among Iranian children: A systematic review and meta-analysis. Dental Research Journal 13: 387.
11. Lee KJ, Park YC, Park JY, Hwang WS (2010) Miniscrew-assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism. American Journal of Orthodontics and Dentofacial Orthopedics 137: 830-839.