



Osteogenic mandibular distraction in Nager's Syndrome. Case report

Distracción osteogénica mandibular en síndrome de Nager.

Reporte de un caso

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ABSTRACT

Osteogenic distraction is used nowadays for tissue lengthening due to the bone formation that occurs during the progressive segment separation after corticotomy, being very useful in dentofacial anomalies, especially in severe hypoplasia. We present the case report of a patient with Nager's syndrome, acrofacial dysostosis of the preaxial type, severe mandibular hypoplasia and oligodontia who was treated by means of distraction osteogenesis with ramus osteotomies to lengthen the mandible. He was treated with a Spring Bite-type orthopaedic appliance after the osteotomies. We conclude that treatment with mandibular distraction should be comprehensive and supported with the use of miofunctional advices.

Key words: Nager's syndrome, postaxial acrofacial dysostosis, mandibular distraction, mandibular hypoplasia and oligodontia.

Palabras clave: Síndrome de Nager, acrofacial disostosis preaxial, distracción mandibular, hipoplasia mandibular, oligodoncia.

RESUMEN

La distracción osteogénica es actualmente utilizada para el elongamiento tisular, gracias a la neoformación ósea que ocurre durante la separación progresiva de los segmentos después de la corticotomía de los mismos. Se ha utilizado con excelentes resultados en anomalías dentofaciales especialmente en hipoplasias mandibulares severas. Reportamos un paciente con síndrome de Nager, disostosis acrofacial del tipo preaxial con hipoplasia mandibular severa y ageneias dentales, quien fue tratado con distracción mandibular a través de corticotomías en ramas mandibulares y posterior manejo ortopédico funcional con aparatología tipo Spring Bite. Con la presentación de este caso podemos sugerir que el manejo de la distracción mandibular debiera ser apoyado con el uso de aparatología miofuncional.

Nager's syndrome was described for the first time by Nager and De Reynier in 1948; there have been 100 cases reported in the literature up to now.¹⁻³

It belongs to the vast group of otofacial-mandibular dysostosis such as the Treacher Collins Syndrome, Nager's Syndrome, Pierre Robin Anomaly, Hemifacial Microsomia, among others. These are malformations associated with a hypoplasia or agenesis of the earlobe and mandibular hypoplasia among other facial deformities which can be found isolated or in association with other malformations.^{3,4}

Nager's syndrome is a preaxial acrofacial dysostosis that consists in facial malformations associated with radial effects (absence of the radial or tibial axis-first metacarpian and first toe).¹⁻⁵ It has a recessive autosomal genetic pattern and an alteration of the 9q32 chromosome, 1q12q21 deletion with an average neonatal birth rate of 20%, growth delay of 10% and usually normal intelligence.²⁻⁴

With craniofacial characteristics in 25% of the cases, it presents zygomatic and maxillary hypoplasia, severe mandibular micrognathia, outwards and downwards palpebral fissures, absence of the lower

lid eyelashes, lower lid coloboma, broad nasal bridge, depressed tip of the nose, limited mandibular movements secondary to alterations in the mandibular ramus and the temporomandibular joint, macrostomia, cleft lip and palate, soft palate agenesis, short soft palate, high and narrow palate, dysplastic earlobes, atresia of the ear meatus, conductive deafness, enamel hypoplasia and oligodontia. In the muscular skeletal system, it is characterized by radial anomalies, 75% of them being radial hypoplasia or aplasia, sinostosis of the carpal bones, absence of the 5th metacarpian, agenesis of toes and anomalies of pelvic limbs. Cardiovascular anomalies such as Fallot tetralogy

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and/or ventricular septum defect may be present.¹⁻⁵ It can also be associated with vesicoureteral reflux or renal agenesis.³

Acral deformities associated with a facial disostosis allow it to be differentiated from the Treacher Collins syndrome, the Nager syndrome and other dysplasias of the 1st and 2nd facial arch (*Table I*).^{3,4}

OSTEOGENIC DISTRACTION

Osteogenic distraction is a method for bone lengthening that allows the correction of deformities and bone deficiencies with the subsequent correction of the soft tissues⁶ by means of a distracting appliance.

It was first used by Dr. Codevilla in 1905, when he performed femur osteotomies. This technique remained forgotten for several decades until Dr. Ilizarov in 1950 made it popular in the field of trauma and orthopedics.^{8,9} Its clinical and systematic application in craniofacial deformities began with McCarthy in 1992⁹⁻¹¹ mainly by using it in children with hemifacial microsomias for mandibular distraction.¹¹⁻¹⁴ Its indications have broadened for the correction of facial asymmetries of diverse etiologies such as severe maxillary and mandibular retrognathias.^{9,10}

Osteogenic distraction is a biological procedure of new bone formation by applying constant traction forces during a period of time. These forces are applied with a distraction device on a bone area that has been previously weakened by corticotomy.⁶⁻⁸ The distraction device is an expansion screw that has been universally graduated in such a way that every 360 degree turn will provide a 0.5 mm^{18,19} movement; all this process is under biological principles such as: vascular preservation, adequate latency period, distraction rhythm and consolidation period. During this last phase the objective is to keep the bone segment immobile to achieve a correct organization and condensation of the elements that will offer the characteristics of resistance to the newly formed tissue.^{6,7,18}

Physiologically, the process of distraction begins when the loading stimulus is detected by the osteoblast thus triggering a fast and continuous signaling cascade; in this process the bone growth and differentiation is established, the osteoblastic proliferation is followed by cell differentiation and finally by the mineralization of the extracellular matrix; also, specific factors have been identified associated with the beta 1 transforming growth factor (TGFB-1), the insulin-like growth factor (IGF-1) and the E2 prostaglandin (PGE2). The created bone gap is initially filled by fibrillar connective tissue with collagen fibers oriented parallel to the force vector of the distraction forces.⁶⁻⁸

Once the tissue neoformation objective has been accomplished, a tissue regeneration phase of this newly formed tissue follows.^{18,19}

The success of the distraction will depend on numerous factors such as: small incisions, preservation of the periosteum and vascularity, latency period without distraction of 5 to 7 days, an expansion rhythm of 1mm once a day, a stabilization period or consolidating phase of 8 to 12 weeks and finally, a remodeling period.¹⁸

On this last period one can have more certainty on the formation of new bone tissue as well as in the histodistraction; in this stage the distraction appliance may be removed. Equally important is to verify this process by periodical imaging techniques to monitor the correct function and evolution of the distraction.¹⁹⁻²²

Difficulties have been found such as the distractor selection, the determination of the direction of the vector, the site for the osteotomy and patient cooperation.^{23,24}

The orthodontist should be present during the complete process of study and treatment of these patients, playing an important role in the diagnosis, treatment planning and postsurgical management.

The wide variety of mandibular anomalies associated with a syndromic deformity makes it difficult to predict the treatment result, in spite of the surgical, orthodontic and physiotherapeutic management. Also relapse appears to be inevitable and overcorrection may not compensate central growth alterations and poor muscular function. Nevertheless, osteogenic distraction has proved to be the most useful method for solving breathing and swallowing problems in patients with severe mandibular hypoplasia besides of improving facial esthetics.^{9,10}

In mandibular retrognathias there is a severe hypoplasia of the mandibular ramus, body and chin so by creating new bone in the posterior part of the mandible (body and ramus) a more anterior positioning of the mandible is obtained, however a more effective chin is not always obtained.^{13, 14} Once growth has ended the convenience of performing only a mentoplasty or mandibular osteotomies must be reconsidered to achieve the esthetic results.

It is so that osteogenic distraction has quickly become the treatment of choice in craniofacial syndromes with severe mandibular deformities because it is possible to perform during childhood opposite to conventional treatments which may only be performed upon completion of growth; this statement has been controversial due to the fact that multiple studies also report successful results by performing mandibular osteotomies in children.^{8,19,25}

Table I. Nager's syndrome associated malformations compared with others with similar phenotype.

Malformation	Propositus	Sx Nager	Sx Miller	Sx. 1 and 2 brachial arch
Cranium	yes	25 %	yes	10% plagiocephalic
Zygomatic bone , maxillary and mandibular hypoplasia	yes, mandible	yes, mandible	yes zygomatic, mandibular	65% skeletal asymmetry Temporal, zygomatic, ramus y condilar hypoplasia
Ectropion	no	no	yes	Blepharoptosis
Long philtrum	yes	no	yes	no
Inclined palpebral fissures	yes	100%	no	Narrow palpebral fissures
Lack of eyelashes	no	80%	no	35% epibulbar Tumors
Lower lid coloboma	no	50%	yes	20 % lower lid coloboma
Broad nasal bridge with descended tip of the nose	yes	constant	no	no
Mandibular Ankylosis	no	25%	no	yes
Macrostomia	no	20%	no	yes
Cleft palate	no	60%	no	15 %
Soft palate agenesis or partial agenesis	no	60%	no	no
Short soft palate	yes	60%	constant	35% paralysis VF insufficiency
High and narrow palate	yes	60%	constant	no
Submucous cleft palate	no	60%	constant	no
Bifid uvula	no	60%	constant	no
Cleft lip	no	10%	constant	no
Hypoplasia oligodontia	yes	constant	No	no
Dysplastic earlobes	yes	80%	constant wine-glass shape	65 % dysmorphic earlobes, microthia, anothia, preauricular appendicis o fissures
Hypoplasia, helix and tragus	no	constant	constant	
CAE Atresia	yes	85%	constant	
Conductive deafness	yes	85%	constant	15%
Muscular skeletal system				
Radial abnormalities	yes	75%	no	10%
Radial hypoplasia or aplasia	no	25%		no
Carpal bones synostosis	no	constant	yes	yes
Absence of the 5 metacarpian	no	no	yes	no
Toe agenesis	no	no	constant	no
Pelvic abnormalities	yes	constant	yes	
Growth delay	yes	10 %	no	
Cardiovascular System				5 a 58 %
Fallot Tetralogy	no	frequent	no	65%
Ventricular-septal defect	no	frequent	no	yes
Genitourinary System	no	frequent	no	no
Vesicular uretral reflux	no	frequent	no	yes
Renal agenesis	no	frequent	no	no
Central Nervous System				Facial paralysis
Normal Intelligence	yes	yes	no	5 a 15 % Mental deficiency
Learning difficulties	yes	constant	no	yes
Cervical vertebrae fussion	no	no	no	60%
Costal abnormalities	no	no	no	30 %
Genetics		9q32 deletion 1q12-q21		5p del 6 q, trisomy 7 mosaicism, del 8q

Finally, in addition to being controversial it is difficult to predict that a mandibular distraction during childhood will definitely substitute an advancement osteotomy in the adult.^{10,11,13}

MANDIBULAR OSTEOTOMIES

Poswillo and Obwegeser in 1974 stated that surgical trauma in children may alter the mandibular functional matrix and interfere in subsequent facial growth.^{26,27} However, Converse, Horowitz, Coccato and Woodsmith in 1973 recommended mandibular surgery in children pursuing the following objectives:

1. To improve mandibular symmetry by performing bilateral osteotomies in the ramus during the mixed dentition.
2. To provide maxillary growth in response to mandibular growth.
3. To provide an adequate height of the ramus by using an interocclusal splint.
4. By expanding the facial skeleton early, the soft tissues will respond adequately.^{26,27}

In 1941 Converse and Rushton reported the first mandibular osteotomies in children using horizontal osteotomies performed superior to the inferior dental



Figure 1a. Initial phase. Notice the characteristic face of Nager's Syndrome. **1b.** Profile view. **1c.** Post mandibular distraction control 1 year later. **1d.** Profile view 1 year later. **1e.** Post mandibular distraction control 2 years later. **1f.** Profile view 2 years later.

nerve and placing interpositional iliac grafts after the placement of interocclusal splints that increased vertical dimension and thus the augmentation of the mandibular ramus.²⁶

Osborne supported the benefits of mandibular osteotomies performed prior to six years of age. He stated that an early surgery on the mandible provides an opportunity for normal development of the maxilla which is also affected by a hypoplastic mandible.²⁶⁻²⁸

In 1970 Delaire recommended mandibular surgeries even at an earlier stage, between the ages of 4 to 6 elongating a short ramus with inverted L osteotomies and placing a rib interpositional graft.²⁶⁻²⁹

CASE REPORT

We present an eight-year-old male patient diagnosed with acrofacial dysplasia compatible with Nager's syndrome with characteristic phenotype and the following relevant findings: inclined palpebral fissures, broad nasal bridge, severe mandibular hypoplasia, atresia of the acoustic meatus, conductive deafness, protruded earlobes, oligodontia,

excessively short soft palate, brachydactilia and *pes cavus* (claw foot) (Figure 1).^{2,4,5}

An interdisciplinary consult with our service is performed for the evaluation and management of the severe mandibular hypoplasia and the oral hypometria of 20 mm.

A complete study of the case is performed with a clinical facial esthetic analysis and lateral cefalometry in which a severe mandibular hypoplasia with a delayed growth is evident. Temporomandibular joint pathology is discarded (Figure 2).

The patient enters a protocol for mandibular osteogenic distraction in which placement of bilateral extraoral mandibular distractors is suggested. A distraction for a total mandibular advancement of 25 mm is planned (Figure 3).

SURGICAL TECHNIQUE

The procedure is begun under balanced general anesthesia. The patient presented a difficult airway so the use of nasofibroendoscopy was required for an optimum nasotracheal intubation.



Figure 2.

Radiographic study where the short mandibular ramus and the oligodontia can be observed. **2a.** Panoramic radiograph. **2b.** PA radiograph. **2c.** Lateral cephalogram.

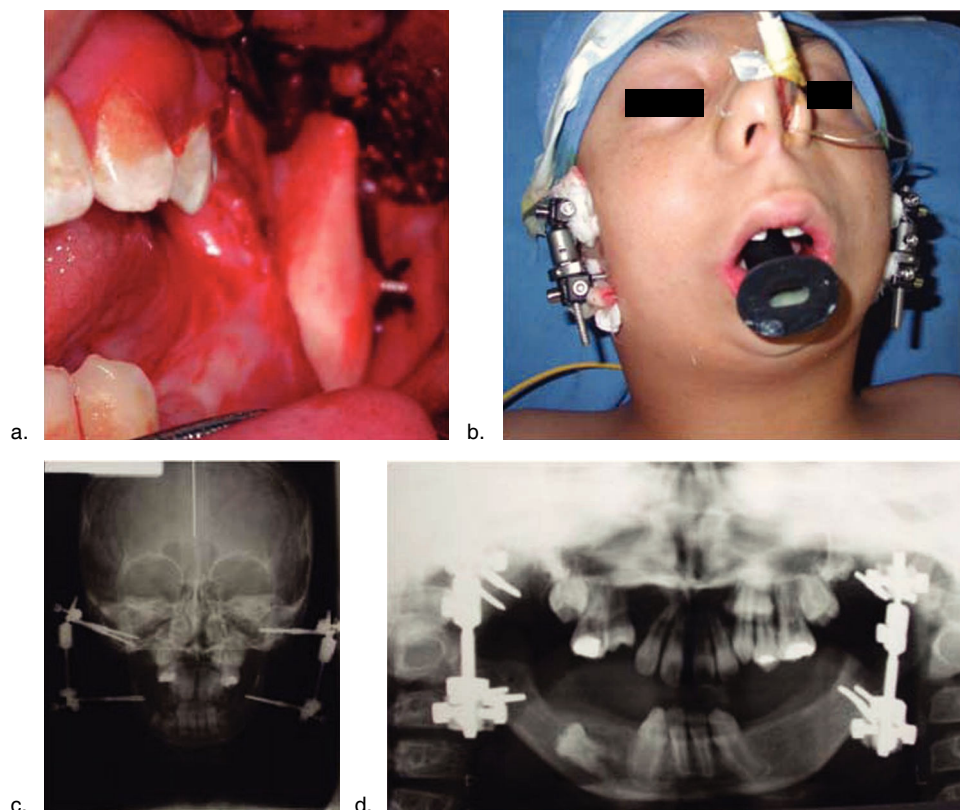


Figure 3.

Surgical procedure. **3a.** Corticotomy of the ramus. **3b.** Extraoral distractors in position. **3c.** PA radiograph with full distraction. **3d.** Panoramic radiograph before distractors removal.

Asepsis of the intervention area was performed and sterile fields were placed.

Through an intraoral approach, a 2 cm incision was performed in the oblique line region, a mucoperiosteal flap was dissected and ramus corticotomies were marked using an oscillating saw (Stryker Corporation, Kalamazoo, Mich. USA). On both sides of the osteotomy two 2.4 x 30 mm bicortical intraosseous screws (w. Lorenz-Bioment Microfixation HTX-Drive Jacksonville FL) were placed percutaneously and attached to the external one-way distractor (25 mm. Eby fix w. Lorenz-Bioment Microfixation HTX-Drive Jacksonville FL). The same procedure is performed on the other side (*Figure 3*).

The position of the screws was determined prior to the surgical procedure taking under consideration the degree of mandibular shortening, the location of the tooth germ and the prediction for mandibular growth (*Figure 3b*).

The distraction process is begun on the 5th day post-surgery, at a 1 mm per day rate for 21 days with a consolidation period of 8 weeks.

Mandibular growth, occlusion and facial symmetry were assessed and regular radiographic controls were performed as well. Myofunctional therapy was continued due to the oral hypometria and also the

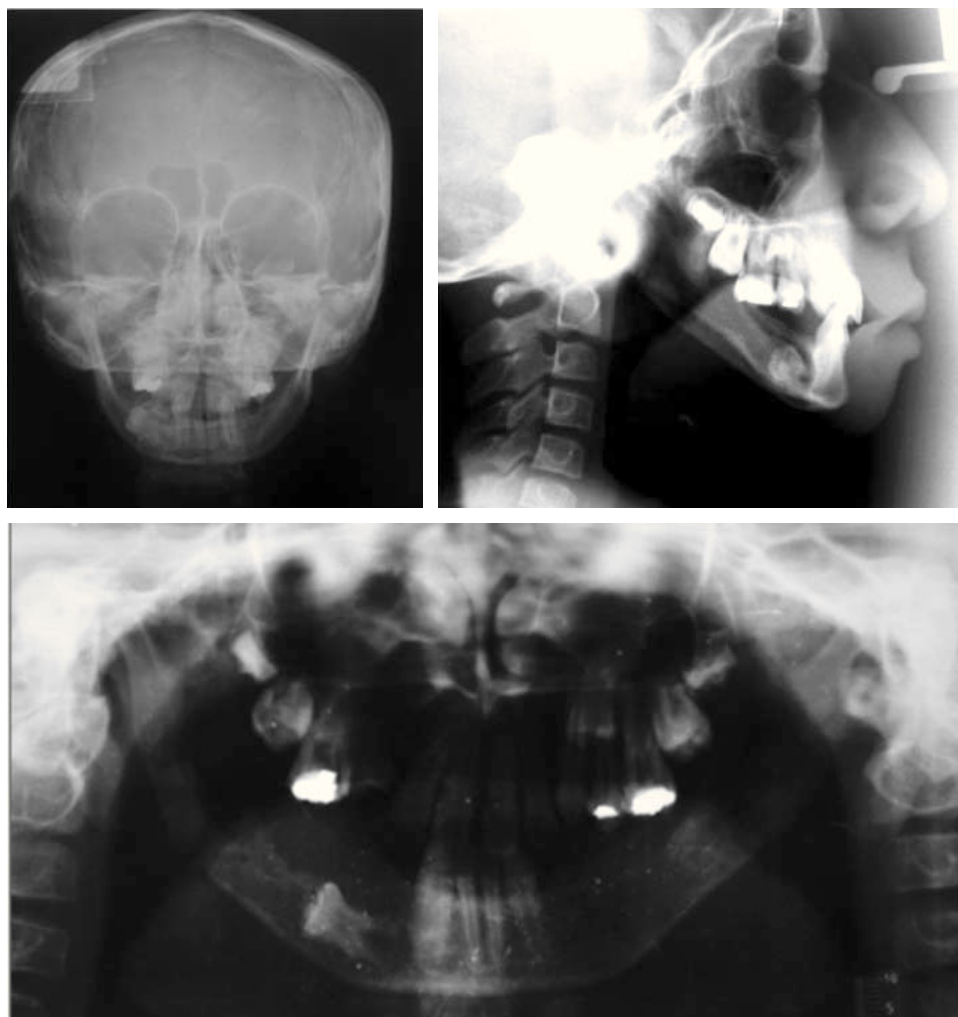
management with excursive movements with a spring bite-type appliance (*Figures 4 and 5*).

RESULTS

The final result was assessed at the end of the distraction period, upon removal of the distractor, 1 year and 2 years after the procedure (*Figure 1*). Cephalometric tracings were performed and they showed an overall improvement of the mandibular position. An important mandibular advancement was obtained until a 4 mm overjet was reached (*Figure 5*).

A profile improvement was accomplished, obtaining a mandibular advancement of 20 mm and a 36 mm mouth opening. Due to the use of myofunctional appliances as stimulus for mandibular growth was evident and an adequate vertical dimension was obtained. By doing so, horizontal growth was accomplished despite the use of a one-way distraction in the ramus and the fact that the patient presented dental agenesis which prevented an adequate interocclusal relationship (*Figures 1e and f, 6*).

Facial characteristics and interocclusal relationship as well as the anterior guidance were satisfying, contributing to the esthetic improvement of the patient (*Figures 1c, d, f, and 6*) (*Table II*).

**Figure 4.**

Postsurgical radiographic control.

The patient remains under growth and development control with the intention of overcorrecting his overjet, stimulating mandibular growth and trying to create more interarch space foreseeing the subsequent rehabilitation by means of endosseous dental implants thus achieving a normal vertical dimension and restoring masticatory function.

DISCUSSION

Mandibular hypoplasia is the most commonly found dentofacial deformity.^{11,13,14}

Severe mandibular deficiency maybe non-syndromic, an isolated finding or a morphological component of some dentofacial anomaly, in this case specifically, Nager's syndrome among others.¹⁻⁵

Functional consequences of severe mandibular hypoplasia include airway obstruction, obstructive sleep apnea, speech and feeding difficulties and many times, lack of psychosocial adaptation.^{11,13,14}

On the long term, children who are affected by this condition may suffer a delay in growth, cardiopulmonary changes, (pulmonary hypertension and rightcardiac failure) and in some cases, death.^{9,10}

For many years this dentofacial deformity has been treated with osteotomies of the mandibular body and ramus and interpositional graft placement with acceptable results although some authors state that such osteotomies may alter the functional matrix of the mandible.^{26,17,28,29} Additionally, it is known that mandibular advancements of more than 10 mm. with sagittal and inverted L osteotomy techniques are unpredictable and their long term stability may be compromised.^{25,30}

Since its introduction, osteogenic distraction has proved to possess many advantages for the treatment of severe mandibular hypoplasias, especially when it comes to patients with syndromic-type dysgnathias in whom structural anatomy is altered^{18,19} and the magnitude of the corrective treatment is far greater. In the same manner, the postsurgical stability

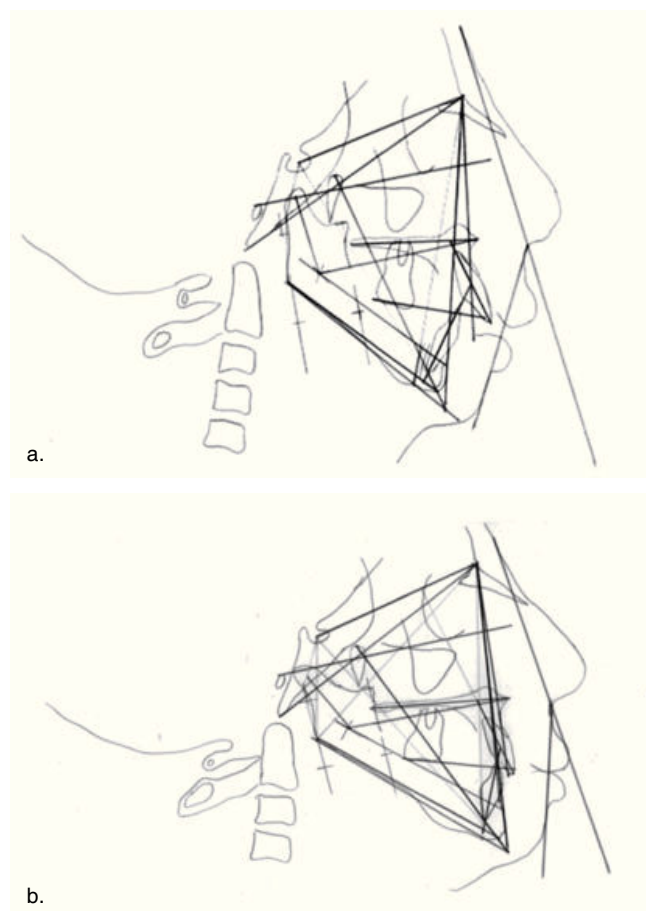


Figure 5. Cephalometric tracings. **5a.** Initial. **5b.** Final.

Table II. Cephalometric tracing measurements, multiple authors (Rickets, Jarabak, Steiner, Epker).

	Cephalometry		
	RANK	June 20, 2005	Sep 22, 2007
Maxillary depth	90 ± 3°	84	85
Mandibular depth	88 ± 3°	82	87
Facial depth	86 ± 3°	83	86
Facial axis angle	90 ± 3°	83	87
Mandibular body length	71 mm ± 5	64	76
Ramus length	44 ± 5	21	26
SNA	82°	70	71
SNB	80°	65	69
ANB	2°	5	2
Overjet	2mm	12	4
Overbite	2mm	7	3

favorable by distraction, which is not only of the bones but of the soft tissues as well, could be superior to that of osteotomies in some specific cases.^{9,10}

A disadvantage of maxillofacial distraction is its incapacity to achieve precise movements just as the ones achieved with bilateral distractors as well as the management of vectors.^{23,24}

In the case report hereby presented, the following were achieved: increase in mandibular body and ramus length in addition to the soft tissues, all thanks to the use of osteogenic distraction and orthopedic therapy, promoting a counterclockwise rotation of the mandible and thus achieving a better interocclusal relationship.

Nevertheless, using osteogenic distraction as the only method for achieving a functional and harmonic occlusion is still a controversy.^{15,17}

It has also been reported that one of the late complications of osteogenic distraction is the correct management of vectors, with an incidence between 7.2 to 8.8% and even more with the use of a one-way distractor.^{23,24}

In children younger than six years old, osteogenic distraction techniques have been able to achieve very satisfying mandibular advancements that could have been very difficult to accomplish previously.

Osteogenic distraction and conventional osteotomies may be viable options for mandibular advancement depending on the specific case to treat. Therefore, it is necessary to take under consideration other factors such as mandibular morphology, bone quality, the surrounding soft tissue and the developing dentition.^{9-14,30}

Finally, this patient obtained an improvement in oral hypometria due to the increase in the ramus growth and a better positioning of the mandibular body and secondly, the effect on muscular relationships. Still, the effect of myofunctional appliances over muscular relationships remains controversial.¹⁵⁻¹⁷

In the same manner, mandibular advancement during early childhood does not eliminate the need for orthognathic surgery when the patient has reached its skeletal maturity, thus it is necessary to reevaluate the case once the last peak of growth has ended.^{9,10,30}

CONCLUSIONS

At present there are very well known protocols that describe the process of osteogenic distraction, establishing its latency period, rate, frequency and remodeling period. Still there are no treatment protocols which include the use of myofunctional

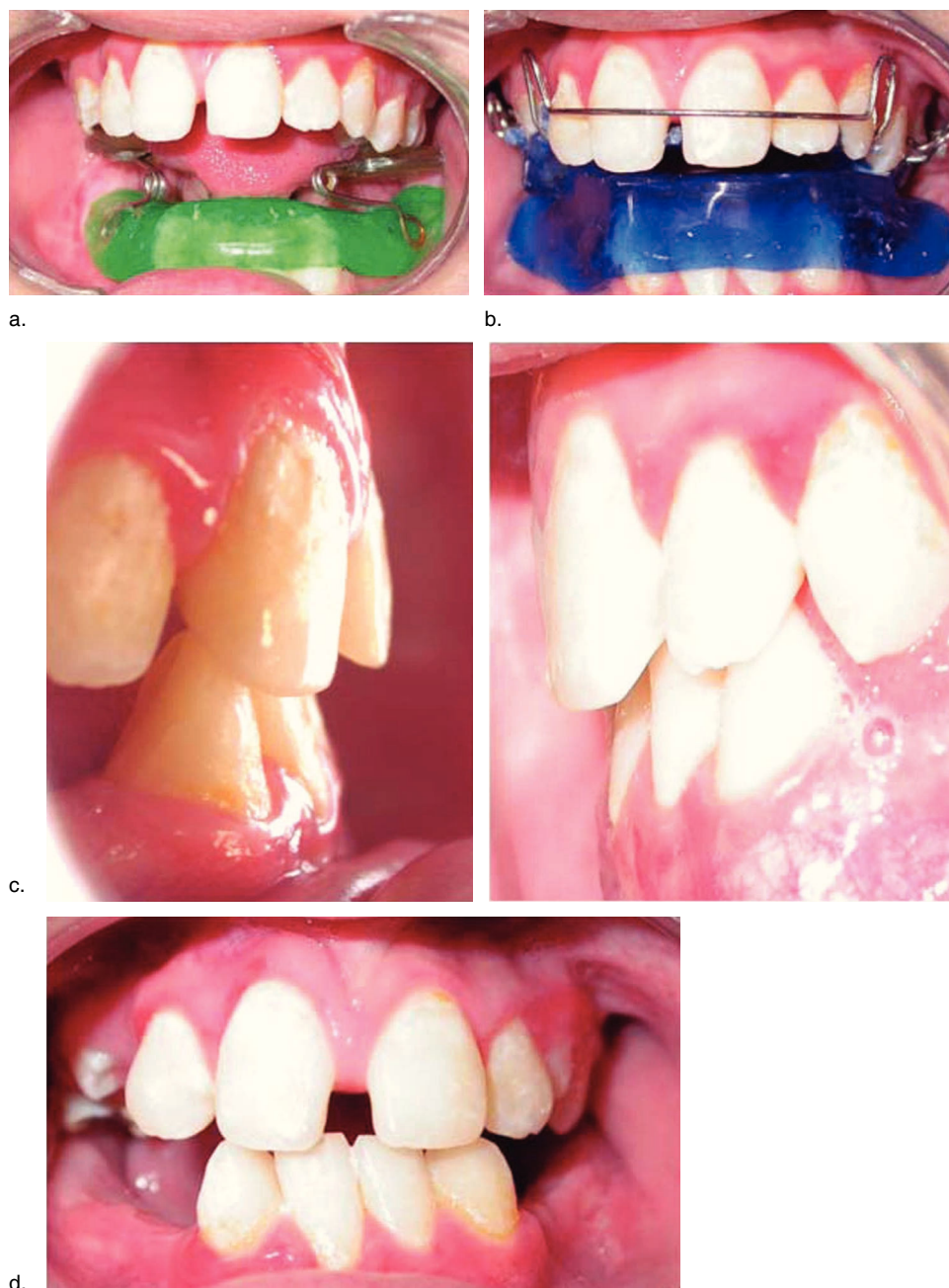


Figure 6.

Final occlusion control. **6a y b.** Monomaxillary and bimaxillary Spring bite. **6c.** Overjet and overbite

appliances at an early stage after performing the mandibular distractions.

This type of treatment must be considered in patients with severe mandibular deficiencies, significant oral hypometria, oligodontia and lack of appropriate interocclusal relationships that would allow an adequate vertical dimension. All of these factors contribute to a more difficult direction of the vector, even more if we are dealing with one-way distractors.^{23,24}

In this specific case, the patient will remain under growth and development control so that once the last

peak of growth has concluded we can reassess the mandibular projection and determine the need for mandibular advancement osteotomies or just a sliding mentoplasty for better chin projection. Equally important is the need for an adequate interocclusal relationship so that endosseous dental implants can be placed.

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REFERENCES

1. Bowen P, Harley F. Mandibulo-facial dysostosis with limb malformations (Nager's acrofacial dysostosis). *Birth Defects Orig Art Ser.* 1974; X(5): 109-115.
2. Zori R, Gray B, Bent-Williams A, Zackowski J. Preaxial acrofacial dysostosis (Nager syndrome) associated with an inherited and apparently balanced X;9 translocation: prenatal and postnatal late replication studies. *Am J Med Genet.* 1993; 46: 379-383.
3. Gorlin RJ, Cohen M. Syndromes of the head and neck. 4ta Ed. OXFORD, University Press; 2001.
4. Burglen L, Soupre V, Diner M. Dysplasies oto-mandibulaires : génétique et nomenclature des formes syndromiques. *Ann Chir Plast Esthét.* 2001; 46: 400-409.
5. Herrmann B, Karzon R, Molter D. Otologic and audiological features of Nager acrofacial dysostosis. *International Journal of Pediatric Otorhinolaryngology.* 2005; 69: 1053-1059.
6. Swennen S, Dempf R. Cranio-Facial Distraction Osteogenesis: A review of the literature. Part II Experimental Studies. *Int J Oral Maxillofac Surg.* 2002; 31: 89-103.
7. Kessler P, Neukama F, Wilfang B. Effects Of Distraction On Bony Regeneration. *British J Oral Maxillofac Surg.* 2005; 43: 392-398.
8. Milloro M. Peterson's *Principles of Oral and Maxillofacial Surgery*, 2da Ed, Bc Decker Inc. 2004.
9. Ruiz R, Turvey T, Costello B. Mandibular Distraction Osteogenesis in Children. *Oral Maxillofacial Surg Clin N Am.* 2005; 17: 475-484.
10. Sancho MA, Parri F, Rivera F. Elongación ósea progresiva del área máxilo-facial: Distracción mandibular. *Cir Pediatr.* 2000; 13: 167-169.
11. Fuente del Campo A, Castro M, Yudovich M, Distracción osteogénica de la mandíbula. Principios e indicaciones. *Rev Hosp Gral Dr. M Gea González* Vol 3, No. 1 Enero-Marzo 2000: Págs. 7-12.
12. Molina F. Combined Maxillary and Mandibular Distraction Osteogenesis. *Seminars in Orthodontics*, Vol 5, No i (March), 1999: pp 41-45.
13. Kisnisci R, Fowel S, Epker Bruce N. Distraction osteogenesis in Silver Russell syndrome to expand the mandible. *Am J Orthod Dentofacial Orthop.* 1999;116:25-30.
14. Friedrich R., Hermann F. Seven years clinical experience with mandibular distraction in children. *Journal of Cranio-Maxillofacial Surgery.* 1998; 26: 197-8.
15. Kevin O'Brien, Jean Wright. Effectiveness of early orthodontic treatment with the Twin-block appliance: A multicenter, randomized, controlled trial. Part 1: Dental and skeletal effects. *Am J Orthod Dentofacial Orthop.* 2003; 124: 234-43.
16. Kumar A, Duggal R, Parkashc J. Skeletal and dentoalveolar effects of Twinblock and bionator appliances in the treatment of Class II malocclusion: A comparative study. *Am J Orthod Dentofacial Orthop.* 2006;130:594-602.
17. Trenouth J. Ortopedia funcional de los maxilares con el aparato Twin Block (Bloques Gemelos). *Ortodoncia Clínica.* 2001;4(2):86-93.
18. Suhr M, Kreusch Th. Technical considerations in distraction osteogenesis. *Int J Oral Maxillofac Surg.* 2004; 33: 89-94.
19. Ulrich M, Kleinheinz J. Biomechanical and Clinical Implications of Distraction Osteogenesis in Craniofacial Surgery. *Journal of Cranio-Maxillo-Facial Surgery.* 2005; 32: 140-149.
20. Wiens J, Forte R, Wien J. The use of distraction osteogenesis to treat hemifacial microsomia: A clinical report, *J Prosthet Dent.* 2003;89:11-4.
21. GR Swennen, C Euzler, F Schutser. Assesment Of the Distraction Regenerate Using Three Dimensional Quantitative Computer Tomography. *Int J Oral Maxillofac Surg.* 2005; 34: 64-73.
22. Pcer F, Alavanse M, Wangerin H. Distraction Osteogenesis of the Mandible: Evaluation Of Callus Distraction by Scan Ultrasonography. *Journal of Cranio-Maxillo- Facial Surgery.* 2002; 30: 286-291.
23. Juson B, Milkhaill L. Biomechanics of Mandibular distractor Orientation: An animal Model Analysis, *J Oral Maxillofacial Surg.* 1999; 57: 952-962.
24. Demann E., Haug R, Do posicion And Soft Tissue Affect Distraction Vector? An in Vitro Investigation. *J Oral Maxillofacial Surg.* 2002; 60: 149-155.
25. Proffit WR, Turvey TA, Phillips C. Orthognathic surgery: a hierarchy of stability. *Int J Adult Orthod Orthogn Surg.* 1996;11:191-204.
26. Converse M, Mc Carthy J. *Reconstructive Plastic Surgery*, Vol 4, 2Ed, W.B Saunders. N.Y, 1977.
27. Kaban L, Padwa B, Mulliken J, Surgical correction of Mandibular Hypoplasia in Hemifacial Microsomia. *J Oral Maxillofacial Surg.* 1998; 56: 628-638.
28. Posnik Jc. Surgical Correction Of Mandibular Hypoplasia In Hemifacial Microsomia. *J Oral Maxillofacial Surg.* 1998; 56: 639-650.
29. Svensson B, Feldmann G, Rindler A. Early surgical-orthodontic treatment of the mandibular hypoplasia in juvenile chronic arthritis. *Journal of Cranio-Maxillo- Facial Surgery.* 1993; 21: 67-75.
30. Van Strijen PJ, Breuning KH, Becking A G. Cost, operation and hospitalization times in distraction osteogenesis versus sagittal split osteotomy *Journal of Cranio-Maxillofacial Surgery.* 2003; 31: 42-45.

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