

Skeletal Distraction for Mandibular Lengthening with a Completely Intraoral Toothborn Distractor

Yan Razdolsky D.D.S.
Buffalo Grove, IL
Children's Memorial Hospital, Northwestern University,
and Highland Park Hospital, Chicago, IL USA

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INTRODUCTION

What is Distraction Osteogenesis?

Distraction osteogenesis is the process of generating new bone by stretching (intramembranous histogenesis).

In 1905, Codvilla described the concept of osteodistraction¹. Technical problems associated with distraction of long bones were later circumvented by several investigators, most notably, Ilizarov and DeBastiani.^{2, 102} McCarthy et al. in 1992 first described distraction of the hypoplastic mandible in humans^{63, 64}.

The deficiencies that distraction addresses are not isolated to the skeleton but affect the soft tissues, including the skin, musculature and neurovascular structures. As our experience with this technique for correction of facial deformation has expanded we have modified our management of patients presenting with skeletal and soft tissue deformation of the face. Our initial experience with osteodistraction utilized external fixators to achieve bone and soft tissue^{7, 101, 102} elongation. Disadvantages of the procedure were the presence of external scars and the requirement that patients wear a cumbersome device for approximately 8 weeks. In order to circumvent the previous limitations of osteodistraction of the mandible we have developed a distraction device which is totally intraoral and completely toothborne! This report comprises our initial experience with the intraoral and completely toothborne device.



OBJECTIVES

According to McNamara, most of Class II patients we see in orthodontic practice are due to mandibular deficiency. Where in our growing Class II patients, we many times can stimulate mandibular growth with functional appliances (ex. Herbst), we have to resort to camouflaging Class II's in our adult patients thereby compromising facial aesthetics (and sometimes causing root resorption in upper incisors), or performing sagittal split osteotomy to gain proper mandibular length.



Problems associated with sagittal split osteotomy:



- comparatively long procedure (1.5-4 hours)
- has to be done in the hospital
- very costly (\$15,000 - \$20,000)
- insurances in many states classify it as cosmetic surgery and do not compensate for it
- any longer increased potential for complications
- patient has to miss 7-10 days of work or school
- variable results
- hard to control proximal segment
- relapse potential especially with wire fixation, condilar SAG, open-bite
- once performed hard to undo
- advancement more than 10 mm not recommended
- rib or hip graft are needed



The objective of our distraction research was to attain a predictable method of Class II mandibular skeletal deficiency correction for adult patients which causes them less inconvenience, is less costly, and delivers consistant results every time.

MATERIALS AND METHODS

The technique we employ for distraction osteogenesis in the hypoplastic mandible entails four phases:

1. performance of a corticotomy,
2. a period of distraction,
3. remodeling of the regenerate,
4. stabilization.

The number and placement of corticotomies are determined after evaluation of preoperative cephalometrics, three-



dimensional CT scans, panorex and dental models. The corticotomy is performed precisely at the site of skeletal hypoplasia, be it ramus or body.

It is of the utmost importance for the orthodontist to create 3-4 mm interproximally where the corticotomy is anticipated! This will ensure proper intramembranous bone formation during the distraction and preservation of periodontal ligament space on both sides of corticotomy and ensure the roots are not nicked during the surgery.

Mandibular Distraction Protocol with ROD™ Distractor:

1. Preformed stainless steel crowns are placed (fitted in the mandible) over second molars and first bicuspid but other combinations will work also (Ex. second bicuspid and first molar, etc.). We prefer second molar and first bicuspid because osteotomy is performed between second bicuspid and the first molar; and crowns on second molars and first bicuspids do not interfere with surgery! (Osteotomy). Distraction can also be performed distal to the mandibular second molars area!



2. In maxillary distraction stainless steel crowns could be placed anywhere! - Depending on the area of the osteotomy and desired distraction.

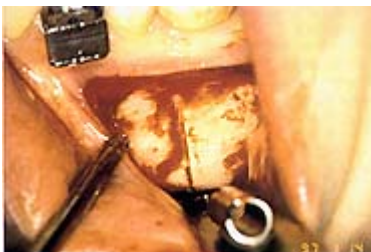


3. Rubber base impressions are then taken; stainless steel crowns are removed from the mouth, placed into impression material, pinned into position and the impression is poured up with green or any heat resistant dental stone material.



4. Model is then produced with stainless steel crowns on it.

5. The paralleling tool is then used to align ROD™ removable attachments and to solder them onto the stainless steel crowns.



6. The model with parallel ROD™ removable attachments is then placed into the ROD™ laboratory tool to have expanders precisely soldered bilaterally (on each buccal side), correctly in 3D as determined from skull, panoramic x-rays, and study models, or other diagnostic materials so that expansion will proceed along a known and **anticipated** vector describing the movement.

7. Once the expanders are soldered, two separate orthodontic wires (gauge .30 or thicker) are soldered to the lingual surfaces of mandibular second molar and mandibular

first bicuspid crowns and adapted to the occlusal surfaces of mandibular first molar and second bicuspid. The adapted wires to mandibular first molar and second bicuspid will later be bonded to the respective teeth in the mouth.

8. The ROD™ appliance is now ready to be cemented into the patient's mouth. ROD™ appliance gets cemented via crowns to the second molars and first bicuspids. Lingual wires (which were soldered to the lingual surface of second molar and first bicuspid crowns) are now bonded to the occlusal surfaces of mandibular first molar and second bicuspid. Two buccal expanders are then removed via ROD™ removable attachments only to be reinserted at the surgery, and to be secured in place with orthodontic or surgical wire via vertical holes through ROD™ removable attachments. Lower anterior teeth are connected to stainless steel crowns on first bicuspid via orthodontic wire or via bonding.



9. Surgical technique: an office procedure under local anesthesia and intravenous sedation as follows:

The mouth is opened with aid of a McKesson mouth prop. Bilateral mandibular block and long buccal block anesthesia are performed using marcaine 0.5% with 1:200,000 epinephrine. In addition, lidocaine 2% with 1:1000,000 epinephrine is infiltrated in the region of the planned osteotomy to help with hemostasis in the surgical site. A horizontal vestibular incision is made 0.5 cm. below the mucogingival line extending from the second molar to the first bicuspid tooth. Next, a full thickness mucoperiosteal flap is created to the inferior border of the mandible. The periosteum is carefully stripped from the bone with a Freer elevator and a Seldin retractor. The Obegeser channel retractor is placed. Using a microreciprocating saw a bone cut through the lateral cortical plate in the space between #29 and #30 is created. This bone cut continues through the inferior cortical plate. A second incision in the gingival sulcus from the second molar to the first bicuspid is made. Again, the mucosa is carefully raised in a subperiosteal fashion until the entire flap is mobilized away from the interproximal dentoalveolar area between #29 and #30. A Sinn retractor is placed and the bone cut was continued through the alveolar bone between these teeth with the saw and small osteotomes. A matching saw cut through the bone of the medial cortical plate is performed through a full thickness mucoperiosteal flap from #31-#27. The Hall drill with a long, side cutting burr is used to channel the inferior border to assure connection of the saw cuts. A small osteotome is placed in the superior aspect of the alveolar bone cut and



with a gentle mallet the osteotomy is completed. The wounds are irrigated with saline solution and the margins were coated with 4(0) vicryl sutures. A similar procedure is performed on the opposite side. Oral Surgeon or Orthodontist then completes the operation by placing the ROD™ appliance and securing it with wire through the vertical hole. Patient is placed on 3 weeks antibiotic regimen.



10. Patient returns to the orthodontist 3-4 days after surgery to begin the distraction at the rate of 0.5 mm - 1.0 mm/day, with a rhythm of four (4) separate turns/day (i.e 1/4 mm per turn) until proper lengthening is attained.

11. The ROD™ appliance is left in place approximately 2 days for each 1mm of expansion, to allow for complete bony union. (We prefer to leave ROD™ in place for five weeks after the last turn).

12. X-rays are taken to examine the bone union (full ossification)

13. The ROD™ is removed after five weeks, braces are replaced and case is finished



RESULTS

Total of 6 patients underwent lengthening with a totally intraoral (ROD™) toothborne distraction device. Patients with the intraoral (ROD™) toothborne distraction device underwent the procedure in a surgical office setting without being admitted to the hospital and reducing the patient's expense by as much as 80% from the conventional sagittal split osteotomy costs when done in a hospital. Patients with an intraoral (ROD™) toothborne distractor underwent advancements of 10-14mm.



When programmed 3-dimensionally with (ROD™) Laboratory tool, the ROD™ appliance delivers consistent results, provided that Clinicians always:

1. Open space interproximally at the corticotomy site prior to surgery in order to preserve PDL and to facilitate intramembranous healing;
2. Bond all teeth in the distal segment together to prevent segment flexing due to the downward and backward pull of anterior digastric and suprahyoid muscles,
3. Calculate the distraction vector precisely.

Distraction in conjunction with modeling of the regenerate achieves a three-dimensional correction of the hypoplastic mandible, which is a three-dimensional disorder. While we have been able to create new membranous bone at the corticotomy site, it should be noted that the soft tissue and neurovascular structures are augmented as well. Multiplanar skeletal distraction whether with an extraoral device or ROD™ intraoral toothborne appliance are the techniques currently available that serve to augment the soft tissues and neurovascular structures while creating new membranous bone at the site of the deficiency. The technique of a bi-cortical buccal and lingual osteotomy has allowed us to place the site of distraction precisely at the site of bony hypoplasia, optimizing the correction that we were able to achieve.



Intraoral corticotomies performed in conjunction with skeletal distraction appear to offer significant advantages over classical treatment of micrognathia in Class II mandibular deficiency patients. Soft tissues as well as bone are expanded to a normal configuration. Bone of a type native to the region is created and the surgical procedure itself is markedly less traumatic to the patient. There is no donor site morbidity. Surgical occlusion may be adjusted to within 0.25mm. Previously reported disadvantages which centered around the external scars that resulted from external pins during the expansion process and the requirement that patients wear a bulky external device for 8 to 9 weeks appear to have been circumvented by the use of intraoral corticotomies and a completely intraoral (ROD™) toothborne distraction device.

This treatment offers new hope to patients with a broad spectrum of severe facial abnormalities and with Class II mandibular deficiency adult orthodontic patients.

The next generation ROD™ appliances will focus on an intraoral, partially toothborne, partially bony appliance, in an effort to bring the corticotomy site distal to mandibular second molar area.

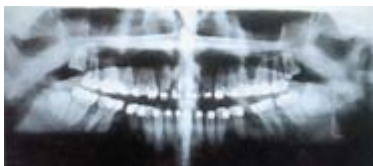


CONCLUSIONS

Why distraction osteogenesis versus sagittal split osteotomy?

- LESS INVASIVE ,

- LESS OPERATING TIME
- EASIER TO CONTROL PROXIMAL SEGMENT
- LESS BLEEDING, SWELLING, POST-SURGICAL COMPLICATIONS,
- LESS TRAUMATIC.
- CAN BE DONE AT ORAL SURGEON'S OFFICE
- NO DONOR SITE MORBIDITY
- BONE OF A TYPE NATIVE TO THE REGION IS CREATED .
- SURGICAL OCCLUSION EASILY CONTROLLED.
- AMOUNT OF DISTRACTION IS "UNLIMITED",
- MUSCULAR READAPTATION WITH SLOW BONE GROWTH.
- HOSPITAL STAY IS NOT NECESSARY
- LESS COSTLY (80% reduction in fees)
- INSURANCE DENIES COVERAGE FOR IN-HOSPITAL SAGGITAL-SPLIT OSTEOTOMY IN MANY STATES
- HARDLY ANY CHANCE FOR NERVE DAMAGE
- NO NEED FOR INTERMAXILLARY or RIGID FIXATION
- NO INTERRUPTION OF PATIENT'S LIFE
- PROXIMAL SEGMENTS/ TMJ' UNTOUCHED



cephalometrics- OLGA L. 18 YRS					
	1-96	N	10-96	2-97	5-97
fac<	78	87	81	83	83
sna	83	81	83	82	82
snb	76	78	77	77	79
anb	7	-2	7	4	3
y-axis	69	59	67	66	66
I	0	3	6	6	6
I	-4	0	-2	2	-8
CO-A	98	94	94	94	94
CO-GN	110	122	110	122	120
ANS-ME	68	71	69	74	73



New Non-Extraction, Approach to diagnosis and treatment of Class II mandibular deficiency patients: In Class I,II cases with mandibular incisor compensations or crowding, treat non-extraction! Distract the mandible until the lower incisors are in anterior crossbite, if need be, to maximize your skeletal correction and then retract lower anterior teeth into new regenerate bone! In Class II cases with mandibular deficiency and incisors and /or without lower crowding, distract distal to lower second molars! If distracted between the teeth, implants will have to be placed in the created spaces. On the contrary, with sagittal split osteotomies, both lower first bicuspid are normally extracted, lower anterior teeth are retracted and then: THE SURGERY PERFORMED

Corticotomy vs osteotomy

- NO RELAPSE
- ALLOWS TO STOP MANDIBULAR LENGTHENING AT WHATEVER LENGTH PATIENT,
- PARENT OR CLINICIAN DESIRES TO STOP- YOU CAN EVEN SHORTEN (REVERSE) LENGTH IF IT IS CALLED FOR

Special thanks to Mr. Gene Kucher for his contribution to this work.

SUMMARY

Distraction osteogenesis has been successfully employed to gain increased bone and soft tissue mass in patients with a variety of craniofacial deformities or just Class II mandibular deficiency orthodontic patients. Our experience with osteodistraction has evolved since 1992 with 66 osteotomies in 42 patients. The technique we employ for distraction osteogenesis entails four phases:



1. performance of a corticotomy,
2. period of distraction
3. remodelling of regenerate, followed by
4. stabilization.



Patients underwent intraoral corticotomies and application of extraoral or intraoral (ROD™) tooth borne distraction devices to facilitate complex multiplanar distraction as mandated by the patient's specific deformity. Patients underwent gradual bony and soft tissue distraction at a rate and rhythm of 1 mm per day in four divided treatments.



A period of stabilization of at least 2 days for each 1 mm of lengthening was utilized. Morphologic changes were documented with serial radiographs and clinical photography.



All the patients exhibited marked improvement in their postoperative occlusal status effecting amelioration of respiratory and feeding difficulties when present in addition to dramatic aesthetic improvement.

Patients with external distraction devices had a hospital stay of 1.2 ± 0.6 (mean \pm S.D.) days. Thirty seven patients underwent lengthening with an extraoral distraction device with lower jaw advancement of $18.4 \text{ mm} \pm 4.7 \text{ mm}$ (mean \pm S.D). Most recently, 6 patients underwent lengthening with a totally intraoral (ROD™) tooth borne distraction device underwent the procedure in a surgical office setting without admitting them to the hospital and reducing the patient's expense by as much as 80% from the conventional sagittal split osteotomy costs when done in a hospital. Patient with an intraoral (ROD™) tooth borne distractor underwent advancements of 10-14 mm. Intraoral corticotomies performed in conjunction with skeletal distraction appears to offer significant advantages over classical treatment of micrognathia in Class II mandibular deficiency patients. Soft

tissue as well as bone are expanded to a normal configuration. Bone of a type native to the region is created and the surgical procedure itself is markedly less traumatic to the patient. There is no donor site morbidity. Surgical occlusion may be adjusted to within 0.25 mm. Previously reported disadvantages which centered around the external scars that resulted from external pins during the expansion process and the requirement that patients wear a bulky external device for 8 to 9 weeks appear to have been circumvented by the use of intraoral corticotomies and a completely intraoral (ROD™) tooth borne distraction device.



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