

18. Distraction Osteogenesis

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DEFINITION

Distraction osteogenesis (DO) is a surgical technique by which new bone is generated in the gap between two bone segments in response to tensile stress across the gap after osteotomies are performed. The overlying soft tissue elongates and undergoes hypertrophy as well.

PHYSIOLOGY¹

Tension-stress effect occurs when normal human tissue that is placed under a consistent, moderate tension responds by regenerating (i.e., forming new tissue of identical type).

BONE

- DO allows generation of **bone** and **soft tissue**.
- Bone gap is created, and, through the continued application of tension across the gap, soft callus does not progress to hard callus and fracture union.
- Bone gap has four zones.
 1. **Fibrous central zone:** New collagen fibers form parallel to the axis of distraction
 2. **Transition zone:** Early formation of bone
 3. **Bone remodeling zone:** Primary mineralization found with bone spicule formation
 4. **Mature bone zone:** Progressive calcification of the primary mineralization front with formation of lamellar bone and marrow elements
- At the cessation of distraction the mineralizing fronts fuse, giving fracture union.
- **The bone formed through the process of DO is indistinguishable from natural mature bone.**

SOFT TISSUE

- Muscles elongate and undergo hypertrophy (*distraction histogenesis*).
- “Soft tissue memory” may result in relapse after removal or cessation of distraction.

DISTRACTION PROCESS¹

- **Corticotomy or osteotomy**
 - Fracture created through cortical bone preserving periosteal attachments and medullary continuity
- **Application of distraction device**
- **Latency**
 - Period between corticotomy or osteotomy and commencement of distraction
 - Usually 5-7 days
 - Allows formation of a bridge of fibrovascular tissue

- **Rate**
 - ▶ Number of millimeters the gap is widened daily
 - ◆ Usually 1 mm/day
 - ▶ Less can lead to premature ossification, local ischemia, or both
- **Rhythm**
 - ▶ Number of times per day the distractor is activated
 - ▶ Usually 0.5 mm twice a day or 0.25 mm four times a day
- **Activation phase**
 - Period between corticotomy and conclusion of distraction
- **Consolidation phase**
 - Period between the conclusion of distraction to evidence of bony remineralization
 - Usually 8 weeks
 - Distractor left in place, although no active distraction occurring
 - Check quality of new bone with radiographs (Fig. 18-1)
- **Removal of distraction device**
 - Performed when cortical outline is seen on postoperative radiograph

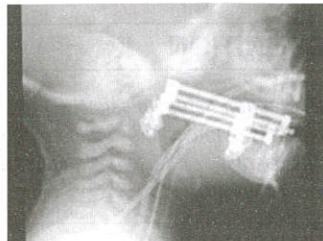


Fig. 18-1 Radiographs can be used to check new bone quality during consolidation phase of mandibular distraction.

INDICATIONS FOR DISTRACTION

- **Mandibular lengthening**
 - Hemifacial microsomia
 - Micrognathia
 - Airway compromise in the newborn secondary to micrognathia
- **Le Fort I advancement**
 - Cleft lip patients with premaxillary retrusion
- **Le Fort III/monobloc advancement**
 - Syndromic patients with midface retrusion

DISTRACTION DEVICES

EXTERNAL

- Uses percutaneous pins and external distractor device
- Can have multiple vectors
- Device removal does not require operation
- Percutaneous scars may require revision

INTERNAL

- Use internal distraction devices placed directly on bone
- Single vector
- Device removal requires operation
- Avoids cutaneous scarring

RESORBABLE

- Available, but not commonly used because of postoperative complications

MANDIBULAR DISTRACTION**GOALS**

- Achieve proper occlusion
- Lengthen the ramus/body
- Reconstruct a mandibular defect
- Reconstruct the temporomandibular joint

OPERATIVE TECHNIQUE

1. Gain adequate exposure of mandible through an intraoral incision.
2. Identify proposed site of osteotomy or osteotomies based on preoperative imaging.

TIP: Avoid disruption of tooth buds through preoperative dental examinations, radiographs, and CT scans.

3. Place the distraction device.
4. Perform the osteotomies.
 - Vertical osteotomy on ramus to give horizontal advancement
 - ▶ Make C-shaped osteotomy to exclude coronoid process (and pull from temporalis) from anterior segment (Fig. 18-2)
 - Oblique osteotomy on lower ramus to give both horizontal and vertical advancement
 - Horizontal osteotomy on ramus to give vertical lengthening
5. Perform closure

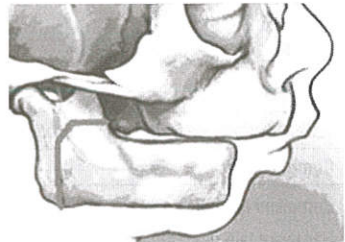


Fig. 18-2 C-shaped mandibular osteotomy.

MIDFACE/MAXILLARY DISTRACTION OSTEOGENESIS**GOALS**

- Achieve proper occlusion
- Correct midface retrusion
 - Useful if more than 1 cm of advancement desired because gradual process with distraction allows soft tissues to accommodate better than if advancement performed immediately
- Improve aesthetic appearance

TIP: Improves hypernasality.

OPERATIVE TECHNIQUE

1. Gain adequate exposure of midface/maxilla through a gingivobuccal incision and/or a coronal incision if necessary.
2. Identify proposed site of osteotomy or osteotomies based on preoperative imaging (Le Fort I, II, or III).

TIP: Again, *always* avoid tooth bud disruption!

3. Mobilize soft tissues.
4. Place the distraction device.
5. Perform closure.

COMPLICATIONS (Table 18-1)

- Scarring (distractor pin site)
- Infection
- Fibrous nonunion
- Premature ossification
- Tooth bud disruption
- Inappropriate vector

Table 18-1 Incidence of Complications in Craniofacial Distraction Osteogenesis

| Complication | Frequency (%) |
|---|---------------|
| Compliance problems | 4.7 |
| Hardware failure | 4.5 |
| Device dislodgement | 3.0 |
| Premature consolidation | 1.9 |
| Pain preventing distraction | 1.0 |
| Fibrous nonunion | 0.5 |
| Inappropriate vector (single vector device) | 8.8 |
| Inappropriate vector (multivector device) | 7.2 |
| Pin tract infection | 5.2 |

From Mofid MM, Manson PN, Robertson BC, et al. Craniofacial distraction osteogenesis: A review of 3278 cases. *Plast Reconstr Surg* 108:1103, 2001.

TIP: Bone grafting may be required if distraction failure occurs.

KEY POINTS

- ✓ Distraction osteogenesis involves corticotomy, latency, activation phase, and consolidation phase.
- ✓ Soft tissue accommodation may prevent relapse as seen in single-stage advancements.

REFERENCE

1. Hunt J, Flood J. Craniofacial anomalies II: Syndromes and surgery. *Sel Read Plast Surg* 9(25), 2002.