I. Definition of Distraction Osteogenesis
   a. Distraction osteogenesis is a process that results in new bone formation between the surfaces of bone segments gradually separated by incremental traction.

   b. The volume of soft tissue adjacent to the generating bone is also increased
   c. Histiogenesis
      i. occurs in different tissues:
      ii. bone, skin, fascia, blood vessels, nerves, muscle, ligament, cartilage & periosteum.


II. Understanding Distraction Osteogenesis
   a. What it can and can’t do
      i. Can do:
         1. Lengthen bones
         2. Increase volume of bones 3- dimensionally
         3. Increase the soft tissue envelope
         4. Decrease relapse
(below) 3 dimensional volume increase of right side of dog mandible following distraction utilizing the above linear distraction device

images from:

ii. Cannot do:
   1. Make bones shorter
   2. Make bones smaller
   3. Move bones backwards

III. To Distract or not distract is the question
   a. To Distract-When to consider distraction as a treatment modality
      i. If magnitude is too great for any other procedure
      ii. If function demands early and/or large magnitude correction
      iii. If stability is better with DO
      iv. If it sets up the patient for a more stable and precise definitive procedure at skeletal maturity
      v. If skill of the team can deliver an excellent result
   b. Not to Distract-When distraction is not the recommended option
      i. If magnitude is not great and other procedures are more precise.
      ii. If skeletal correction required is to retroposition a bone or decrease skeletal volume
      iii. If no functional deficit
      iv. If other procedures provide good/better stability
      v. If skill of the team cannot deliver an excellent result
         1. Surgical skill/experience inadequate
         2. Skilled orthodontist unavailable for:
            a. Treatment planning
            b. Monitoring the active distraction
            c. Manipulating the distal segment
      vi. If a patient is incapable of cooperation

IV. Team Effort is required to successfully complete distraction
a. Diagnosis
   i. Identifying the deficiency
      1. Skeletal
      2. Soft tissue
   ii. Identify location of the deficiency
   iii. Identify the differences between:
      1. Volume
         a. 3 dimensional value
      2. Location
         a. Advancing a skeletal structure (A-P)
         b. Placing the distal segment in a precise 3 dimensional location
         c. Vertically manipulating the skeletal structure
            i. Improves overall result
            ii. ie: Le Fort III advancement
               1. Improves occlusion-ie closes anterior openbite
               2. Increases orbital volume vertically by lowering the orbital floor
b. Surgical skill
   i. Accuracy in corticotomy/osteotomy

c. Device placement
   i. Accuracy in placement position
   ii. Symmetry-if bilateral device placement
   iii. Ideal vector established

d. Protocol-should be carefully followed to maximize outcome
   i. Ilizarov-1949-1st protocol with low morbidity
      1. Latency period
         a. 5-7 days prior to device activation
         b. Fibrovascular matrix formation

2. Rate/rhythm
   a. 1mm/day
   b. 1mm/day completed by several increments per day
3. Consolidation
   a. Length-Roughly twice the of number of days of activation
   b. When radiographic evidence of bone consolidation

e. Active distraction
   i. 1mm/day
f. Control of distraction is crucial
   i. Preparation
      1. Treatment plan
         a. Determine final position of bone
         b. Determine magnitude of desired distraction in mm
         c. Determine length of distraction device at least 2X that of the desired length of distraction in mm
      2. Orthodontic preparation
         a. Anchorage
            i. To provide the opportunity to manipulate the distal segment
         b. Distraction stabilization appliances
            i. To provide multiple places for elastic traction
            ii. To provide maxillary expansion PRN

g. During distraction-control is crucial
   i. Activation of the distraction device
      1. Millimetric lengthening-linear
      2. Device manipulation only if devices is multidirectional
   ii. Forces/manipulation of the distal segment
      1. Elastic traction
      2. Maxillary expansion

h. After consolidation
   i. Elastic traction
   ii. Maxillary expansion
   iii. Occlusal plane correction via adjusted bite block (figure below)
      1. Sequential adjustment of the biteblock to promote
         sequential eruption of the maxillary posterior teeth
      2. Closes the posterior openbite created by distraction of
         the mandible to the desired vertical by supererupting
         the maxillary posterior teeth to correct the maxillary
         occlusal plane and close the distraction created
         openbite.

Illustration by Dr Barry Grayson

i. Requirements
   i. Cooperation by the patient crucial
   ii. Team treatment-control/forces can be placed by someone
       who will assume that role
       1. Educate patient and family
       2. Monitor closely the advancing/evolving distraction
   iii. Knowledge/experience on how to diagnose, deliver forces and
        monitor

V. Parameters when considering distraction as a treatment option
a. Magnitude
   i. Determining magnitude helps determine the following:
      1. If distraction is the best modality
2. Device type
3. Device length

b. Timing
   i. Timing based on functional need
   ii. Timing because magnitude so great a single definitive procedure would not be successful
   iii. Timing as the first step to a 2 step definitive surgical/orthodontic plan

c. Functional disorders that drive timing
   i. Airway,
   ii. Masticatory function-Chewing/feeding
   iii. Speech
   iv. Facial appearance
   v. Psychosocial development
d. Therapeutic benefit
e. Maxillary DO after alveolar cleft graft as maxilla is single piece post graft

VI. Unique to Distraction
   a. Shape forming effect
   b. Altered phenotypic expression of fibroblasts

   c. Fibroblasts “polarize” orienting parallel to the vector of distraction
      i. Changes the direction of the fibroblast orientation
      ii. This in turn changes the phenotypic expression of the fibroblast
      iii. Which changes the shape of the bone and ultimately the position of the bone
d. Forces placed on the distal segment during distraction

e. Types of forces


i. Distraction device activation or alteration of a multidimensional distraction device
ii. Elastic traction

iii. Headgear
iv. Expansion appliances
v. Distraction stabilization appliances

VII. Maxillary hypoplasia
   a. Le Fort III/midface deficiencies
   b. Le Fort I/maxillary deficiencies

VIII. Unilateral Mandibular distraction
IX. Bilateral Mandibular distraction
**Citations: AAO To Distract or Not Distract**

10. Codvilla, A. On the means of lengthening in the lower limbs, the muscles and


26. Grayson BH, Santiago PE. Treatment planning and biomechanics of distraction osteogenesis from an orthodontic perspective. Semin Orthod 1999;5:9Y24


50. McCarthy JG. The role of distraction osteogenesis in the reconstruction of the
68. Toth BA, Kim JW, Chin M, Cedars M. Distraction osteogenesis and its application to the midface and bony orbit in craniosynostosis syndromes. J