Management of Transverse Skeletal Deficiency
Orthopedic Maxillary Expansion vs. Corticotomy Assisted Expansion vs SAME vs Segmental LeFort I
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Audience Question
Difficult Decision
- 13 y.o. female
- Bilateral posterior cross bite
- Retained primary canines
- Congenitally missing lateral incisors
- Impacted permanent canines
- Onset of menses 1 yr. ago, ? Still growing, ? Shoe size changes

Audience Question
How would you manage the transverse maxillary correction in this patient?
- a. Orthodontic expansion with arch wire
- b. Orthopedic Rapid Maxillary Expansion (ORME)
- c. Corticotomy Assisted Maxillary Expansion (CAME)
- d. Surgically Assisted Maxillary Expansion (SAME)
- e. Segmental LeFort I osteotomy (SLeFort)

Goals of Orthopedic Maxillary Expansion
Maxillary expansion accomplished by sutural adjustments in the craniofacial complex in remote regions, rather than by alveolar remodeling or tipping.
Starnbach ‘66, Bell ‘82

OME Unsuccessful
OME
Successful in children
(prior to sutural closure)
- Jack Screw appliances
- Quad helix
OME Case

Pretreatment

Post expansion

OME

- Opens more at the canines than molars (3:2)
- Requires more force as the child ages
- Always is composed of both skeletal (sutural opening) and dental (tipping) changes
- Overcorrection is recommended

Resistance to Expansion

“The major resistance to expansion of the maxilla is acknowledged to stem from the increase in sutural resistance attendant to skeletal maturity.”
Isaacs ’64, Wertz ’70

“The efficacy and long-term stability of OME depend upon the nature of expansion forces used and degree of maturity of the facial skeleton.”
Shetty ’84

OME in Children and Adolescents

Used metal maxillary implants
- Children 50% skeletal 50% dental
- Adolescents 35% skeletal 65% dental

Krebs ’64

OME in Adults

“In adults, overcorrection to offset the lateral tipping of teeth and bending of alveolar bone is frequently frustrated by unpredictable and uncontrolled relapse following appliance removal.”
Moss ’62, Ellenberg ’69

OME in Adults

Unsuccessful
- Inability to activate the appliance
- Pain
- Pressure necrosis of mucosa under expansion device
- Tipping, extrusion of teeth
- Bending of alveolar bone
- Uncontrolled relapse
- Periodontal complications
**Periodontal Complications of OME in Adults**

Pure dental expansion can lead to:
- Thinning, dehiscence, or fenestration of buccal cortical bone
- Gingival inflammation
- Recession
- Dental instability

Vanarsdall ‘91

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**Corticotomy Assisted Orthodontic Treatment**

- Found to accelerate tooth movement by 2-2.5 fold when compared to conventional orthodontic treatment.
- Safe to periodontal health, no or little risk of root resorption
- There is little evidence at this time that COAT enhances transverse expansion


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**Corticotomy Assisted Maxillary Expansion (CAME)**

**Literature search**
- CAME applied to 2 adult patients. 1 true unilateral cross bite and other with asymmetrical bilateral cross bite.
- Case 1 = Buccal and palatal corticotomies only on one side
- Case 2 = Buccal and palatal corticotomies, other side only buccal corticotomies
- Effective asymmetrical expansion was achieved
- Total expansion 3-4 mm molar, 1 mm canine


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**Corticotomy Assisted Maxillary Expansion (CAME)**

“Corticotomy-assisted expansion is an optimal way to treat mild to moderate maxillary transverse deficiency in adults with greater stability without compromising periodontal health.”


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**Case 13 y.o. female, Failed OME SAME**
Distraction Osteogenesis
Work of Ilizarov


Principles from Ilizarov’s Work

- Minimize trauma to periosteu and cancellous bone
- Compress surgical site
- Latency period = 7 days
- Rate = 1 mm/day. slower = premature fusion, faster = fibrous tissue formation
- Rhythm > BID
- Retention > 6/52
- Histologically, bone qualities of epiphyseal and intramembranous ossification

Distraction Osteogenesis

Distraction device must
- Transfer distraction forces directly to bone
- Possess adequate rigidity to allow for osseous consolidation in the retention period.

McCormick SU, 1997

Surgically Assisted Maxillary Expansion (SAME)

Three Principle Maxillary Buttresses

Nasomaxillary
Zygomaticomaxillary
Pterygomaxillary

Surgical Dilemma

**How much surgery is enough?**

“Choice of maxillary osteotomies is a critical determinant of whether the effects of the expansion appliance are predominantly orthopedic or orthodontic in nature.”

“The surgical dilemma is to reconcile optimal therapeutic outcome with a procedure that is minimally invasive.”

Shetty ‘94
Where to Make Osteotomies?

The diverse maxillary osteotomies that have been empirically proposed to facilitate lateral maxillary expansion reflect the conflicting opinions about the primary areas of resistance in the craniofacial skeleton.

Midpalatal Suture Only

Brown first described SAME in 1938, split only midpalatal suture

Timms ’68 believed that the midpalatal suture was the barrier to mechanical expansion

Only Lateral Maxillary Corticotomies

Horowitz ’69
Glassman “84

Midpalatal Suture and Zygomatic Buttress

Lateral maxillary and midpalatal osteotomies
Lines ’75
Messer ’79
Timms ’81
Albern ’87
Bays ’90, ’92
Pogrel ’92

Zygomaticomaxillary buttresses, Midpalatal suture, Pterygomaxillary junction

Allison ’74
Bell ’76
Turvey ’85
Mossaz ‘92

Indications for SAME

• Correction of maxillomandibular transverse discrepancy
• Orthopedic maxillary expansion unsuccessful
• Allow for non-extraction orthodontic treatment
• Avoidance of extractions in an already small maxilla
• Periodontal involvement of the maxillary dentition
• Large amount of expansion is required
Surgical Technique SAME

Subtotal LeFort I osteotomy
- Osteotomy, bilat. piriform to pterygomaxillary fissure
- Release nasal septum
- Ant. 1.5 mm of lat. nasal wall
- Midline palatal osteotomy
- Release pterygoid plates
- Turn key and check expansion
- Alar cinch and V-Y closure

Cement Device Pre-op

LeFort I Incision

Release Nasal Septum

Section first 1.5 mm of Lateral Nasal Wall

Sectioning of the thin lateral wall of the nasal cavity is superfluous because it offers virtually no resistance to lateral movement of the maxilla. In fact, the lateral walls help maintain the spatial relationship of the mobilized segments.

Shetty ‘94
Midline Palatal and Alveolar Osteotomies

Separation of the Pterygoid Plates from the Maxillary Tuberosity

Unlike the maxillae, the sphenoid is one bone and both pterygoid processes are part of this bone. Therefore, the pterygoid processes must be separated from the maxillae for posterior maxillary expansion to occur.

Separation of the Pterygoid Plates from the Maxillary Tuberosity

Turn Key and Check for Expansion

Device Causes Lateral Expansion

Soft Tissue Closure

Alar Cinch
- Control lower nasal morphology
- Figure of 8 suture

V-Y Closure
- Control of labial morphology
- Preserve vermilion
Research

Expansion
Maxillary expansion following surgery must occur rapidly (within 4-6 weeks) or the osteotomies may heal prematurely.

Symptoms During Expansion
Symptoms of tightness and pain in the maxillofacial and orbital regions after appliance activation are real and can be explained anatomically.

Shetty ‘94

Check Expansion

Red Patch of Atherton
- Immature attached gingival tissue
- Occurs when orthodontic/ skeletal movement exceeds gingival remodeling
- Sign of skeletal expansion
- Should be bilateral and symmetric

Relapse
Dental relapse following osteotomies has been reported to be a consequence of the soft tissue drape and its lack of resilience. In the maxilla, the palatal tissue is quite dense and difficult to stretch, this contributes to the difference between the dental and skeletal expansion.

Bays ‘92, Block ‘95
Soft Tissue Genesis

Slow bone lengthening is accompanied by soft tissue genesis.

Block ‘95

Post operative Stability

Surgical transverse changes are unstable for a longer time period than most other surgical or orthodontic movements.
- Bony gap
- Requires bony fill and therefore longer retention

Retention Following SAME

It takes at least six months to achieve bony continuity in the midpalatal osteotomy following surgically assisted maxillary expansion.

Recommend
- Expansion device for >3 months
- Another form of retention for 6 to 12 months

Device Removal and Retainer

Palatal Retention for 4-6 Months
- Expansion device
- Palatal coverage retainer

Final Occlusal Scheme
SAME vs. Segmental Maxillary Osteotomy

Must consider segmental osteotomy when a LeFort osteotomy will be necessary to correct another skeletal maxillary deformity.

Differences
- Stability/relapse (long term)
- Pattern of transverse expansion
- Need for maxillary extractions
- Surgical difficulty, length of operation, surgical and post-op morbidity
- Number of general anesthetics

Stability of Transverse Maxillary Correction (SAME)


Byloff FK, Mossaz CF: Skeletal and dental changes following surgically assisted rapid palatal expansion. Er J Orthod 26:403-409, 2004


Prospective SAME Data

Investigational Time Periods
- T1 = Pre-op
- T2 = Appliance removal
- T3 = 6 months post-op
- T4 = 1 year post-op
- T5 = Orthodontic debanding
- T6 = 1 year post debanding

Prospective SAME Data

Clinical/ Cast Measurements
- 3-3 = Canine - canine
- 4-4 = 1st bicuspid - 1st bicuspid
- 5-5 = 2nd bicuspid - 2nd bicuspid
- 6-6 = 1st molar - 1st molar
- 7-7 = 2nd molar - 2nd molar

Radiographic Measurements, Standardized
PA Cephalometric Technique
- J-J = Point Jugale – point Jugale

Prospective SAME Data

• T2-T1 = Skeletal/ dental expansion
• T4-T1 = Skeletal/ dental expansion @ 1 year
• T5-T1 = Skeletal/ dental expansion @ deband
• T5-T2 = Orthodontic treatment relapse
• T6-T5 = Post-treatment relapse

Prospective SAME Mean Data

<table>
<thead>
<tr>
<th>N</th>
<th>T2-T1</th>
<th>T5-T1</th>
<th>T5-T2</th>
<th>T6-T5</th>
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<tr>
<td>3-3</td>
<td>5.9</td>
<td>4.6</td>
<td>-2.8</td>
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<td>8.9</td>
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<tr>
<td>J-J</td>
<td>3.0</td>
<td>3.7</td>
<td>0.5</td>
<td>0.4</td>
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Summary Stability of SAME

• Skeletal maturity of patient
  - More mature, more surgery needed
• Design of surgical procedure
  - Subtotal Le Fort I, most surgery = most stability
• Design of expansion device
  - Håns > Occlusal coverage Hyrax > Hyrax
• Skeletal and Dental relapse (less than SLeFort)
  - Skeletal movements stable, dental tipping unstable
• Overexpansion
  - Leads to orthodontic relapse during treatment

Stability of Transverse Maxillary Correction (Segmental LeFort)


Phillips, 2 Piece LeFort I

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<tr>
<th>Tooth</th>
<th>Expansion</th>
<th>Relapse</th>
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<tr>
<td>C</td>
<td>1.8 +/- 1.4</td>
<td>0.2 +/- 1.5 (11%)</td>
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<tr>
<td>1P</td>
<td>2.6 +/- 1.5</td>
<td>0.7 +/- 1.5 (27%)</td>
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<tr>
<td>2P</td>
<td>3.7 +/- 1.7</td>
<td>1.4 +/- 1.4 (38%)</td>
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<tr>
<td>1M</td>
<td>4.7 +/- 2.4</td>
<td>2.0 +/- 1.6 (43%)</td>
</tr>
<tr>
<td>2M</td>
<td>5.7 +/- 3.0</td>
<td>2.7 +/- 1.4 (47%)</td>
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Phillips, 3 Piece LeFort I

<table>
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<th>Tooth</th>
<th>Expansion</th>
<th>Relapse</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>0.2 +/- 0.9</td>
<td>0.1 +/- 1.2 (50%)</td>
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<tr>
<td>1P</td>
<td>2.3 +/- 1.3</td>
<td>0.7 +/- 1.8 (30%)</td>
</tr>
<tr>
<td>2P</td>
<td>1.9 +/- 2.2</td>
<td>1.1 +/- 1.6 (58%)</td>
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<tr>
<td>1M</td>
<td>3.5 +/- 2.6</td>
<td>1.8 +/- 1.4 (51%)</td>
</tr>
<tr>
<td>2M</td>
<td>5.72 +/- 3.01</td>
<td>2.3 +/- 1.5 (44%)</td>
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</table>

Summary Stability of Segmental Le Fort I

- How many segments
  - More segments, less stable
- Retention with rigid fixation, stents
  - Rigid fixation better than wires, longer stent wear beneficial
- Amount of transverse expansion
  - More expansion, more relapse
- Skeletal & dental relapse (More than SAME)
  - Both skeletal and dental relapse
- Limited amount of expansion possible due to palatal tissues

Pattern of Transverse Expansion

SAME – more at canines, less at molars
- Because the maxillae articulate superiorly and posteriorly, the greatest expansion from SAME occurs inferiorly and anteriorly, resulting in a triangular separation with its base positioned anteriorly.

White ’89
Segmental Osteotomy – less at canines, more at molars

Maxillary Extractions

Segmental Osteotomy- often required
SAME- often NOT required
It does not make sense to extract teeth in an already small maxilla

Surgical Difficulty, Length of Operative Procedure and Morbidity

Segmental LeFort I osteotomy- More difficult, longer procedure and higher morbidity.
SAME- Less difficult, shorter procedure, less morbidity.
Number of General Anesthetics
(If LeFort I required for another reason)

Segmental LeFort I osteotomy - one
SAME - two

Treatment Recommendations
Width of transverse correction, does not require LeFort I
• Less than 5mm - orthodontic expansion or CAME
• Greater than 5mm - less than 7 mm, or unilateral CAME
• 7 mm or greater - SAME

Requires LeFort I
• Less than 6 mm - Segmental LeFort I osteotomy
• Greater than 6 mm - SAME followed by one piece LeFort I osteotomy

Standardized PA Cephalometric Technique
• Mark Frankfort horizontal on patient’s face
• Set object-film distance at 13cm (source-object constant)
• Tip head holder back 5 deg., tighten ear rods, line up FH with light beam and position nasal bridge piece (machine = +5, head = 0)
• Tip head holder back to 0 deg. (machine = 0, head = -5 deg.)

Posteroanterior Cephalometric Analysis
Adapted from the Rocky Mountain Analysis

Example PA Ceph. Analysis

Future Directions

Use of rigid fixation, implants, onplants

- Teeth have a periodontal ligament, which in response to tension and compression may result in an undesirable movement of teeth through bone
- Reports of midfacial or craniofacial advancement using skeletal fixation all indicate a 1:1 advancement of device to bone and skeletal stability

Series by Block, et. Al.


- Tooth supported appliance


- Appliance implant supported in posterior


- Appliance implant supported in anterior and posterior

Series by Block, et. al. cont.

- Anterior max. segmental osteotomy
- Mongrel dogs (16, 3, 4)
- Latency period = 7 days
- Rate = 1mm/ day, Rhythm = BID
- Total = 10 mm
- Retention, Tooth = 6/52, Implant = 10/52
- Clinical, radiographic and histological analysis

Results:

- Skeletal relapse, Tooth supported (70%) > Tooth and Implant supported > Implant supported (15%)
- Relapse likely due to palatal tissues

Maxillary Skeletal Expander

- Rigid bone borne expansion device
- Hyrax type expander device held in place with mini-screws (tads)
- Can be incorporated with other orthodontic devices


- 6 mongrel dogs
- Ant. max. segmental osteotomy
- Implant supported device
- Latency = 10 days
- Rate = 1 mm/day, total = 10 mm
- Implants and advancement stable
Future Directions

Research needed to demonstrate

- Ideal latency period
- Ideal rate and rhythm of Distraction
  - ?? Increased rate due to good blood supply of maxilla
  - ?? Continuous distraction
- Ideal retention period
- Use and limitations of CAME
- Use of rigid bone borne expansion devices