ALVEOLAR CLEFT REPAIR

History of Alveolar Repair

- Management with bone grafting first described in the early 20th century
  - Lexer 1908, Drachter 1914
- 50 years passed without any progress
- Mid 1950’s increase in primary bone grafting
- 1960’s: Increasing evidence primary bone grafting had negative impact on growth
- 1970’s: Secondary bone grafting introduced by Boyne/Sands and becoming treatment of choice
- 1980-90’s: Continued research in donor sites, alveolar molding, GPP, growth and overall outcomes
- Early 21st Century: rhBMP-2, Stem cells, implants

The Alveolar Defect

- Skeletal
  - Collapse and rotation of the maxillary segments
  - Cleft in alveolus to piriform rim
- Soft Tissue
  - Lack of attached tissue
  - Absent gingival anatomy
  - Oral-nasal fistula
- Dental
  - Missing permanent teeth
  - Malformed teeth
  - Supernumerary teeth
  - Impacted teeth

Goals Of Alveolar Repair

Success Defined By:
1. Grafting must achieve stability of the arch and prevent collapse of the alveolar segments
2. Grafting must preserve the health of the dentition and maintain bony support of teeth adjacent to the cleft
3. Grafting must restore continuity not only of the alveolus but also the anterior hard palate and the maxilla at the piriform rim (support for alar base)
4. Grafting must support the soft tissue closure of the oronasal fistula
5. Grafting must have adequate volume of bone matrix for erupting teeth in the line of the cleft, and for orthodontic movement of the involved teeth into appropriate "nontorqued" position in the dental arch
6. Grafting must allow for the successful placement of dental implant(s)


Timing of Repair

- Early
  - Gingivoperioplasty (with primary lip and/or palate)
  - Primary bone grafting (abandoned)
- Secondary (Traditional)
  - Age 7-13
  - Autogenous Bone v rhBMP-2
- Tertiary Repair (Late)
  - After completion of growth
  - With or without maxillary orthognathic surgery
  - ICBG with and without rhBMP2
- Completion of Repair
  - Bone and soft tissue repair
  - Dental implant placement

Early Repair

- Gingivoperioplasty
  - Originally described in 1965 by Skoog
- Advanced by Millard, Latham, Grayson
- Closes the alveolus with the lip and/or palate
- Combined with dentofacial orthopedic techniques to reduce the cleft width
  - NAM, Latham, Tapping, Lip Adhesion
Gingivoperioplasty

- Success
  - Quantity of bone
  - Quality of bone
  - Normal eruption of permanent dentition
  - Elimination of fistula
- Effect on Growth
  - Dental arch
  - Maxillary
  - Facial

Gingivoperioplasty

- Success on Bone Formation – Unilateral Clefts
  - 60% of GPP cases did not need secondary grafting
    Santiago Cleft Palate-Craniofacial Journal, January 1998, Vol. 35 No. 1
  - 73% of GPP cases did not need secondary grafting
  - Higher incident of secondary grafting needed in the bilateral cleft cases.
    66% need secondary grafts
    Santiago Cleft Palate–Craniofacial Journal, January 1998, Vol. 35 No. 1

Gingivoperioplasty

- Success on Fistula Outcome
  - Overall GPP nearly eliminates fistula

Gingivoperioplasty

- Effect on Growth
  - Early GPP (Skoog)
    Conclusive: Negative Impact
  - Millard and Latham
    Somewhat inconclusive
    Patient follow-up, number of patients, etc
  - Grayson
    No negative growth outcomes
  - Matic
    Potential for growth attenuation

Gingivoperioplasty

- Negative Outcomes
  - Missing primary teeth and alteration in eruption
  - Missing permanent central incisors and higher rate of missing lateral incisors
  - Malformed teeth
- Positive Outcomes
  - Normalized eruption of primary teeth
  - No difference in number of missing teeth
  - Better periodontal health and support for permanent teeth adjacent to the cleft
  - Stabilized arches

Gingivoperioplasty

- Overall
  - Holds promise for superior alveolar repair
  - Requires a dedicated and well trained team for best results
  - Surgeon dependent – technique sensitive
Secondary Bone Grafting

Current preferred method of repair

- **Timing**
  - **Early**
    - Age 7-9: At the time of central incisor eruption
  - **Late**
    - Age 9-11: Canine root 2/3rd formed

- **Autogenous Donor Sites**
  - Iliac Crest
  - Rib
  - Cranium
  - Tibia
  - Mandible
  - rhBMP-2

Secondary Bone Grafting

Donor Sites – Autogenous Bone

- Iliac Crest Bone Graft
  - Boyne 1972 – first introduction of secondary graft
  - Considered the "Gold Standard"
- Mandibular Bone Graft
  - Bosker 1980
- Cranial Bone Graft
  - Tessier 1982
  - J.D. Smith 1973

Difference in Graft Donor Sites

ICBG
- Visible scar
- Pain
- Gait disturbance
- Second surgical field
- Reliable quantity
- Reliable quality
- Reliable success

Mandible
- No visible scar
- Pain
- No gait issues
- Single surgical field
- Quantity?
- Reliable quantity
- Reliable quality
- Reliable success

Cranial
- Visible scar
- Less pain
- No gait issues
- Single surgical field
- Reliable quantity
- Reliable quality
- Successful

Secondary Bone Grafting

Considerations...

- **Impact on Growth**
  - Timing of the graft: important
  - Operative technique?
  - Selection criteria?
    - Significant growth retardation – need orthognathic surgery – wait to graft?
    - Absence of lateral incisor/impacted canine – wait to graft?
    - Large, unfavorable clefts – 2 stage repair? Single stage with tongue flap?

Secondary Bone Grafting

Further Topics of Consideration

- Flap design – degree of periosteal elevation
- BCLCP – stage repair?
- Splinting post repair
- Dressing
- PO diet
- Antibiotics

Secondary Bone Grafting

Facial Growth Outcomes in the Grafted Patient

Ross (1987) – multicenter comparison of UCLCP grafted patients age 4-10.
- Marked deficiency in anterior upper facial height compared to non-grafted patients at age 15
- Grafted group age 9-11 showed no difference in non-grafted group.
- Confounded study

Brattstrom et al. (1992) – comparison of 85 UCLCP pts with primary graft, secondary graft, and no graft
- Primary – poor growth
- Secondary – after incisors before canine had better growth
- Non-grafted patients had the best growth
Secondary Bone Grafting
Facial Growth Outcomes in the Grafted Patient
Semb (1988) – National Center of Logopedics, Oslo, Norway
- no difference in growth among UCLCP children grafted between the ages of 8 and 12 compared to non-grafted patients

Conclusions
- Secondary bone grafting in the UCLCP patient in the age range 8-13yrs of age does not seem to negatively impact the vertical or AP maxillary growth and development.

Secondary Bone Grafting
- rhBMP-2
  - Recombinant Human Bone Morphogenic Protein 2
  - First discovered in 1965 by Dr. Marshall Urist
  - Now available for clinical use via Medtronic as Infuse® Bone Graft

rhBMP-2
- Growth Factor
  - From the superfamily TGF-B
  - Several different BMPs induce bone formation
  - 2, 4, 7
  - BMP-2 acts early in the cascade of events and directly triggers mesenchymal cells to become osteoblasts
**rhBMP-2**

- The bovine ACS (absorbable collagen sponge) is important for the clinical effects of BMP-2. Binds 95% in 15 minutes. Elutes the BMP-2 for 8-10 days. Fully resorbed in 4-10 weeks.

**Important steps to success**
- Create appropriate space for rhBMP 2 + ACS
  - The ACS cannot maintain the space alone
- Must ensure access to cells
  - Periosteum
  - Adjacent bleeding bone
- Proper preparation of the material

**rhBMP-2**

- **The Science in Alveolar Clefts**

  **Bone Morphogenetic Protein-Induced Repair of the Premaxillary Cleft**

  \[ \text{Bone Morphogenetic Protein-Induced Repair of the Premaxillary Cleft} \]

  \[ \text{Bone Morphogenetic Protein-Induced Repair of the Premaxillary Cleft} \]

  \[ \text{Bone Morphogenetic Protein-Induced Repair of the Premaxillary Cleft} \]

**Average Bone Fill**

- ICBG: 78% bone fill
- rhBMP-2: 72% bone fill

**rhBMP-2**

- **Benefits**
  - Eliminates need for second (donor) surgical site
  - Eliminates donor site morbidity
  - Decreased OR time
  - Decreased hospital LOS
  - Decreased healthcare cost

**Reduced Morbidity and Improved Healing with Bone Morphogenetic Protein-2 in Older Patients with Alveolar Cleft Defects**

\[ \text{Reduced Morbidity and Improved Healing with Bone Morphogenetic Protein-2 in Older Patients with Alveolar Cleft Defects} \]

\[ \text{Reduced Morbidity and Improved Healing with Bone Morphogenetic Protein-2 in Older Patients with Alveolar Cleft Defects} \]

\[ \text{Reduced Morbidity and Improved Healing with Bone Morphogenetic Protein-2 in Older Patients with Alveolar Cleft Defects} \]
Conclusions are the same as JOMS 2007
- Eliminates need for second (donor) surgical site
- Eliminates donor site morbidity
- Decrease in surgical site complications
- Decreased OR time
- Decreased hospital LOS
- Decreased health care cost

Secondary Soft Tissue Management
- Keratinized grafting in cleft site
  - Improve peri-implant tissue health
- Scar revision
  - Improve vestibule characteristics
- Connective tissue grafting
  - Improve prosthetic appearance

Retrospective study
- 23 implants placed in 21 patients
  - 5 patients not eligible for inclusion
- 16 patients (8 male, 8 female)