Surgical Techniques in Charcot Reconstruction

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18th Annual Conference
May 31 - June 02
THE PERIPHERAL EVENT OF THE YEAR
Disclosures

• No Disclosures
Charcot - Etiology

- Diabetes – most common
- Tabes dorsalis – 5-10%, knee
- Spinal cord injury
- Syringomyelia – 20-25%, upper extremity
- Peripheral nerve injury
- Alcoholism – 30% will develop, MTPJ, IPJ
- Polio
- Leprosy
- Meningomyelocele – Charcot in children
- Others:
  - Myelodysplasia, CMT, Spina Bifida, Amyloidosis, TB, MS
Charcot – French Theory

- Neuro-Vascular Theory
- Arthritic changes caused by trophic centers of the anterior horn cells
- Theorized that both neurogenic and circulatory disruption occurred leading to the basis of the French theory
Virchow & Volkmann – German Theory

- Neuro-traumatic theory
- Mechanical theory of repetitive trauma to insensate joints
- Loss of proprioceptive reflexes through the posterior roots resulting in joint changes
Charcot Needs 3 Things:

- A Joint
- Numbness
- Trauma
Goals of Charcot Reconstruction

• Restoration of Alignment
• Restoration of Stability
• Prevent Recurrence of Ulceration
• Prevention of Amputation

ULTIMATE GOAL:
Create a Foot that is Braceable for Supportive Shoe Gear
Operative Considerations

- Advanced Imaging
  - Radiographs
  - CT
  - MRI
- Noninvasive Vascular Studies
  - Arterial Doppler
  - CTA
  - LUNA
- Antibiotics
- DVT Prophylaxis
- Wounds
- Labs
  - Standard
  - HgA1c
  - Prealbumin, Albumin
- Clearance
  - Cardiology
  - Nephrology
  - Endocrinology
  - Vascular
- Team Approach
Brodsky Anatomic Classification

Type 5
Forefoot

Type 4
Multiple Regions

Type 2
Hindfoot

Type 3A
Ankle

Type 3B
Calcaneus

Type 1
Midfoot
Eichenholtz Classification

Stage 0 – Prodromal (Shibata)
Stage I – Development
Stage II – Coalescence
Stage III - Reconstruction
Indications for Surgical Intervention

- Unbraceable deformity
- Recurrent ulceration secondary to:
  - Residual deformity
  - Instability
- *Pain unresponsive to conservative measures*
Knock Off the Bump

• Exostectomy or deformity reduction?
  • Can be used for midfoot correction
  • Consider adjunctive TAL
  • Lateral Column Higher incidence of recurrence
  • Will fail if deformity grossly unstable
Charcot Operative Principles

STABLE CONFIGURATION

OSTECTOMY
Ostectomy
When to Reduce Deformity

• Stage I
  • Traditionally never
  • Can get good results with less degeneration if treated early (Simon, et. al. JBJS-A, 2000)
  • Small Study (Roukis, et. Al. CPMS 2006;23:467-83)
  • Few reports in literature

• Stage II
  • Increasing density

• Stage III
  • More difficult to obtain successful arthrodesis

• Is stage II the best timing?
Eichenholtz Stage 1

- Demineralization
- Soft Bone
- Swelling
- Increased Technical Difficulty
- Infection
- Loss of Fixation (Internal)
- External Fixation
Correction During the Acute Phase

• Goal: “Reduce” acute fracture-dislocation
• Internal fixation likely to fail secondary to bone resorption
• Dynamic reduction with external fixation
• Early weight bearing
• Remove external fixation
• Percutaneous internal fixation at time of frame removal
• Protect in brace after frame removal
Management of Chronic (II?, III) Charcot Deformities

Essentials

- Correction of the deformity at the apex
  - Realignment / Arthrodesis
- Correction in all three planes
- Soft tissue reconstruction as necessary
- Address Equinus
- Application of External Fixation
- AFO, CROW
Realignment / Arthrodesis

• Must have failed braces and shoe gear
• Amputation is usually only other option
• Goal is to restore alignment and stability for bracing and shoe gear
• Prevent skin Breakdown
• Sometimes Surgery is Required to Heal Ulceration

• SHOULD BE LAST RESORT
HARDWARE:

INTERNAL FIXATION

EXTERNAL FIXATION
Fixation Choices

- Screws
  - Solid vs Cannulated vs Headless vs Partial Thread
- Plates
  - Locking vs Non-Locking vs Basic vs Anatomic
- Intramedullary
  - Beams
  - Bolts
  - Nails
- Superconstructs
- All of the above With or Without External Fixation
  - Mini vs Planar vs Ring
Fixation Choices

• Internal Fixation Alone
  • Must protect against unsupported force of weight bearing
• Should use the most rigid internal fixation possible
  • Solid Screws over Cannulated
  • Locking Plates over Non-Locking
  • Intermedullary If possible
  • Additional External Fixation Construct
• Proper indications are critical for successful external fixation
Fixation Choices

• External Fixation Alone
  • In Acute Charcot with callus distraction
  • Used in All Stages
  • If problems with fixator then what?
  • After removal proceed with caution
  • Stabilize with percutaneous fixation @ frame removal
Fixation Choices

• Internal and External
  • Rigid internal fixation
  • External protects against WB forces
• If forced to remove ex-fix then have fall back
• Helps transition to WB without osteopenic pathologic fractures
External Fixation

- Static
- Dynamic
- Stabilization / Offloading
- Taylor Spatial (Computer Assisted)

- Standard Construct
  - Pre-Build
  - Two Tibial Rings attached to Foot Plate
  - Two Olive wires for each Tibial Ring
  - Two Wires into the Calcaneus
  - Two Wires Crossing the Metatarsals
Advantages of External Fixation

• Skeletal stability from a distance
• Wounds/ ulcers
• Versatility in managing variety of bone and soft tissue lesions
• Early weight bearing
• Adjustments of length/alignment after device applied
• Minimal interference with other joints
Medial Column Reconstruction
Talonavicular Joint
Medial Column Reconstruction
Talonavicular Joint
Medial Column Reconstruction
Talonavicular joint
Must Address the Equinus

- Negative Effects Well Documented
- Increases Pressure on the Midfoot, Hindfoot, and Forefoot
- TAL vs Gastroc Recession vs Achilles Tenotomy
  - Increases Calcaneal Inclination Angle
  - Decreases Abnormal Pressures
  - Prevents Ulcerations
- Numerous Techniques
  - Traditional procedures
  - Bauman
  - Using dynamic external fixation
The Levels for Posterior Muscle Group correction secondary to equinus

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Eponym</th>
<th>Anatomical Level</th>
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<tbody>
<tr>
<td>Proximal GT</td>
<td>Silfverskiöld</td>
<td>5</td>
</tr>
<tr>
<td>Deep GSR</td>
<td>Baumann</td>
<td>4</td>
</tr>
<tr>
<td>Distal GT</td>
<td>Strayer</td>
<td>3</td>
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<tr>
<td>Superficial GSR</td>
<td>Vulpian Baker</td>
<td>2</td>
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<tr>
<td>TAL</td>
<td>Hoke White Paley</td>
<td>1</td>
</tr>
</tbody>
</table>

Bradley Lamm, DPM*, Dror Paley, MD* and John E. Herzenberg, MD*
TAL Efficacy for Limb Salvage

Total contact casting (n=33) vs. TAL (n=31)
• TAL group all healed
• Risk of recurrence
  • 75% less at 7 months
  • 52% less at 2 years

Mueller, et.al. JBJS-A 85 (8): 1436-1445
Operative Principles

UNSTABLE CONFIGURATION

STABILIZATION
(REALIGNMENT)
ARTHRODESIS
Midfoot Wedge Osteotomy

- Corrects Deformities in the Sagittal and Transverse Planes
- Full Thickness Incisions
Beaming

- Axial Intramedullary Large Diameter (Screws, Beams, Bolts)
- Midfoot Arthrodesis
- Medial and Lateral Columns
- Used as Rebar (Reinforcement Rods)
- Shares and accepts axial forces of Compression and Tension
- Advantages:
  - Less Dissection (Compared to plate)
  - Prevents Vascular Compromise to the Bone
  - Decreases Rate of Wound Complications
Intramedullary Nail

- Hindfoot / Ankle Charcot Arthropathy
- Higher Rates of Union
- Stable Compression
- Rigid

- IF unable to use secondary to plantar ulceration, recommend locking plates, blade plates and / or external fixation
Hindfoot Reconstruction
Superconstruct

- Arthrodesis extended beyond pathologic zone to involve healthy joints
- Bone resection carried out to shorten limb (deformity and ST tension)
- Strongest construct tolerated by soft tissue envelope
- Placed in a position for maximal mechanical function

Sammarco VJ, Foot Ankle Clin 2009:14;393-407
Biologics

- Autograft or Allograft
- Need Osteogenesis, Osteoinduction, Osteoconduction
- Autograft
  - Increases Procedure Time
  - Increase Chance of Complication?
- DBM
- Hydroxyapatite
- BMP’s
- PRP
- BMA
- Femoral Head Allograft

Charcot Gumbo
Bone Stimulation

• Hanft
• 31 Patients with Acute Charcot
• Offloaded with TCC or CAM
• 21 Patient received Bone Stim
• 12.8 week difference in time for Consolidation

• Saxena
• 26 High Risk Post-Arthrodesis pts
• Internal Bone Stim Applied
• Inclusion DM, BMI >28, Smoking, Alcohol, failed arthrodesis, history of immunosuppression,
• 16 Diagnosed with Charcot
• Radiographic Consolidation 10.3 weeks
Bisphosphonates

• There are some studies on pharmacologic therapies to arrest the active Charcot foot. Bisphosphonates such as pamidronate (Aredia, Novartis) and alendronate (Fosamax, Merck) have shown benefit in some small studies. Pamidronate is a single dose intravenous infusion. Alendronate is a once weekly oral therapy.
  • A recent large population study from the United Kingdom showed no benefit for bisphosphonates.
• Intranasal calcitonin is another option. Patients spray calcitonin in the nostril once daily, alternating nostrils. Advocates have theorized it is a better treatment than bisphosphonates because it has direct action on the RANKL/osteoprotegerin pathway.
Treatment: Operative Realignment/Arthrodesis

Long term immobilization
Duration 2 times normal

3 months strict NWB
1-2 months in WB TCC
12-18 months bracing
Permanent shoe gear

1 ½ year post op
Hindfoot Deformities

- Triple arthrodesis
- Ankle fusion
- Pantalar fusion
- Tibiocalcaneal fusion
Hindfoot Reconstruction

- Osteolysis of talus
- Varus tendency
- *Astragalectomy* vs triple arthrodesis
- Calcaneocuboid fusion
Hindfoot Reconstruction
Hindfoot Reconstruction
Hindfoot Reconstruction
Conclusions

- When deformity has developed but event is in acute stage percutaneous reduction with ex fix is an alternative to accommodation
- Every Patient is Different
- Reduce Deformity
- Stable / Strong Constructs
- Everything Twice as Much Compared to Healthy Patients
- Charcot Gumbo and the Kitchen Sink give you best chances
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