Current Controversies in Management of Calcaneus Fractures
Background

- Displaced intraarticular calcaneus fractures (DIACFs)
  - 75% of all calcaneus fractures
- Subject of debate
  - Results
    - Unpredictable
    - Relatively poor short- and long-term clinical outcomes
  - Substantial social and economic impact
  - Many remain incapacitated 3 to 5 years after injury
  - Many never return to preinjury employment or level of activity
Background

• Operative management
  • No “one-size-fits-all” or “one size fits many” approach
  • Unique and complex challenges

• Careful consideration
  • Fracture pattern
  • Soft tissue characteristics
  • Timing of surgery
  • Surgical approach

• Concurrent pathology
  • Calcaneocuboid joint (CCJ) involvement
  • Peroneal tendon dislocation

[Image of foot and X-ray]
Pathoanatomy

- Managed nonoperatively or malreduced
  - Disabling long-term sequelae
    - Disruption of posterior facet and residual surface incongruity
      - Painful posttraumatic subtalar arthritis
    - Expansion of lateral wall → Heel widening
      - Difficulty with shoe wear
      - Subfibular impingement
      - Peroneal stenosis, tendonitis, possible dislocation
  - Loss of talar declination angle
    - Anterior tibiotalar impingement
    - Decreased ankle dorsiflexion
  - Residual varus of calcaneal tuberosity
    - Hindfoot varus
    - Painful lateral column overload
Pathoanatomy

• Radiographic evaluation
  • Angle of Gissane
    • Normal: 120 – 145 degrees
  • Bohler’s angle
    • Normal: 20 – 40 degrees
    • Correlates with injury severity
    • Prognostic value: Subject of debate
      • Less than 0
        • Predictive of poor outcomes / Need for late subtalar fusion
      • Newer literature
        • Restoration intraoperatively regardless of initial angle
        • Better predictor of outcomes over time
Operative Versus Nonoperative Treatment

- Short Form (SF)-36 scores 2 years after injury
  - Similar functional levels to those who underwent organ transplantation or suffered from myocardial infarction
Operative Versus Nonoperative Treatment

- Prospective randomized trials
  - Somewhat equivocal results of operative versus nonoperative treatment
- More recent trends in literature
  - Metaanalyses and longer term follow-up studies
  - Anatomic reduction and stable fixation = Better outcomes
    - Early restoration of function
    - Patient satisfaction
    - Minimization of symptomatic posttraumatic arthritis
    - Better results of subtalar fusion in setting of posttraumatic arthritis
Operative Versus Nonoperative Treatment

- Buckley and colleagues
  - Landmark 2002 study
  - Largest randomized controlled clinical trial to date
    - Multicenter
    - 471 DIACFs
    - Minimum follow-up of 2 years
  - Suggested limited benefit to ORIF from a functional standpoint
  - No difference in total SF-36 and visual analog scale (VAS) score
  - Significant difference in rate of arthrodesis
    - Operative (7 of 206)
    - Nonoperative (37 of 218)
  - Subgroup analysis excluding Workers’ Compensation
    - Benefitted from operative intervention / Higher SF-36 scores
      - BA: 0 – 14 degrees
      - Light workload
      - Sanders type II fracture
      - Female gender
- Csizy and colleagues
  - Nonoperative: 6 times more likely to require subtalar fusion
Operative Versus Nonoperative Treatment

- Brauer and colleagues
  - Economic evaluation of same cohort
    - Direct health care costs
    - Indirect costs
    - 4-year time horizon
  - Lower rate of subtalar arthrodesis
  - Shorter duration of time off work
Operative Versus Nonoperative Treatment

- Sanders type III and IV fractures
  - Lack of a statistically significant improvement in functional outcomes with ORIF
  - Risk of wound complication and infection
- Restoration of overall calcaneal shape, alignment and height
  - Avoids many sequelae of calcaneal fracture malunion
  - Decreased rates of symptomatic subtalar arthritis
  - Later subtalar arthrodesis
    - Better outcomes
    - Fewer wound complications
- Acceptable nonoperative treatment criteria
  - Truly nondisplaced
  - Less than 2 mm of articular surface displacement
  - Overall height, length, and width well-preserved
  - No gross varus or valgus alignment of the tuberosity
Primary ORIF (Plus Fusion) Versus ORIF for Sanders Type IV

- Subsequent subtalar fusion rates
  - Sanders IV $\rightarrow$ 73%
  - Sanders III $\rightarrow$ 23%
- Not yet substantiated in literature
- Recent multicenter randomized trial
  - Compared primary ORIF alone with primary ORIF with subtalar fusion
  - No difference in terms of functional outcomes
- Technically challenging
  - Obtain adequate compression
    - Calcaneal shortening
    - Loss of height and alignment
- Not all posttraumatic subtalar arthritis is symptomatic to require fusion
Anatomic Considerations

• 4 key articulations
  • Facets
    • Anterior
    • Middle
    • Posterior
      • Largest
      • Primary load-bearing component of subtalar joint
  • Anterior process (CCJ)
• Sustentaculum tali
  • Supports talar neck
  • “Constant fragment”
    • Superomedial component of spring ligament
    • Tibiocalcaneal component of deltoid ligament
    • Interosseous talocalcaneal ligaments
Anatomic Considerations

• Recent literature
  • Called into question the “constancy”
• Berberian and colleagues
  • Retrospectively reviewed CT scans: 88 patients (100 DIACFs)
    • Sustentacular displacement and/or angulation
    • Gapping and intraarticular displacement of middle facet
  • Displaced → 42
    • >50% of posterior facet (Sanders B and C type fractures)
Anatomic Considerations

- Gitajn and colleagues
  - Sustentacular fractures in 94 of 212 calcaneal fractures
  - 20.3% → Subluxation of articulation between sustentaculum and talus
Anatomic Considerations

• Combined medial and lateral approaches?
  • Data to support is scant
  • No studies have directly assessed utility of combined approach
Extensile versus “Minimally Invasive”

- Extensile L-shaped lateral approach
  - Traditional approach
  - Most frequently used last 3 decades
  - Excellent fracture exposure
- Disadvantages
  - Wound complication / infection rates: 20 - 37%
    - Disruption of lateral calcaneal branch of the peroneal artery
    - Primary vascular supply to overlying fasciocutaneous flap
  - Devascularization of fracture fragments
  - Larger surgical field
  - Increased operative time

Low Wound Complication Rates for the Lateral Extensile Approach for Calcaneal ORIF When the Lateral Calcaneal Artery Is Patent

Christopher Bibbo, DO, FACS\(^1,2\), David A. Ehrlich, MD\(^3\), Hoang M.L. Nguyen, MD\(^1\), L. Scott Levin, MD, FACS\(^1,2\), and Stephen J. Kovach, MD\(^1,2\)
Extensile versus “Minimally Invasive”

• Sinus tarsi approach
  • Tip of fibula → Base of fourth metatarsal
  • Excellent visualization
    • Posterior facet
    • Anterolateral fragment
    • CCJ
    • Lateral wall
    • Peroneal tendons
  • Can be used at later date for subtalar arthrodesis or peroneal tendon disorders
  • Advantages
    • Decreased operative time
    • Minimization of soft tissue disruption
    • Fewer wound complications
Extensile versus “Minimally Invasive”

- Kline and colleagues
  - Retrospective review
  - 112 operatively treated calcaneus fractures
    - 79 → Lateral extensile
    - 33 → Sinus tarsi
  - Fracture severity relatively equally distributed
  - No differences in terms of sex, age, tobacco use, or diabetes
  - Wound complication rate
    - Lateral extensile (29%)
    - Sinus tarsi 6%

Minimally Invasive Technique Versus an Extensile Lateral Approach for Intra-Articular Calcaneal Fractures

Alex J. Kline, MD\textsuperscript{1}, Robert B. Anderson, MD\textsuperscript{2}, W. Hodges Davis, MD\textsuperscript{3}, Carroll P. Jones, MD\textsuperscript{4}, and Bruce E. Cohen, MD\textsuperscript{5}
Extensile versus “Minimally Invasive”

• Xia and colleagues
  • Randomized prospective trial
  • 117 patients
  • Sinus tarsi group
    • Significantly decreased operative times (62 vs 93 minutes)
    • Lower rate of wound complication (0% vs 16.3%)
  • Postoperative radiographic parameters of calcaneal reduction equivalent

Open reduction and internal fixation with conventional plate via L-shaped lateral approach versus internal fixation with percutaneous plate via a sinus tarsi approach for calcaneal fractures – A randomized controlled trial

Shengli Xia*, Yaogang Lu, Huizhong Wang, Zuming Wu, Ziping Wang
Extensile versus “Minimally Invasive”

- Recent literature supports use of sinus tarsi approach in Sanders types II and III
- Few studies investigated use and complications in Sanders type IV
- Kwon and colleagues
  - Retrospective review
  - 405 operatively treated DIACFs
  - Examined risk of wound complications
    - Fracture severity
    - Operative approach
    - Time to fixation
  - Decreased overall risk with minimally invasive approaches
  - Increased risk overall in Sanders types III and IV
  - Increased risk with operative delay beyond 14 days when using minimally invasive approaches
- Caution
  - 24 different surgeons
  - Absence of standardized operative technique and surgeon experience
Extensile versus “Minimally Invasive”

- Percutaneous
  - Limited number of retrospective studies and case series
  - Mixed results
    - Quality of articular reduction
- Arthroscopically assisted techniques
  - Limited literature supporting routine use of arthroscopic-assisted reduction of posterior facet in conjunction with percutaneous fixation techniques
Restoration of Articular Surfaces

- Importance of restoring anatomy of posterior facet
  - Well-documented
- Reduction of calcaneocuboid surface
  - Important to optimization of outcomes?
  - Restoration of lateral column function
- Incidence of CCJ involvement: 50%
  - Range: 33 - 76%
Restoration of Articular Surfaces

- Correlation between CCJ involvement and clinical outcomes not yet definitively established
- Gallino and colleagues
  - Comparative analysis outcomes of DIACFs involving CCJ versus those that did not
  - No difference in VAS and SF-36 scores at mean of 2.3 years postoperatively
  - No difference in outcome scores between those patients with CCJ arthritis and those without

The outcome of displaced intra-articular calcaneal fractures that involve the calcaneocuboid joint

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Restoration of Articular Surfaces

- Kinner and colleagues
  - Involvement of the CCJ played a more significant role in functional outcomes
  - Cohort of 44 DIACFs
  - Postoperative stepoff or gap of CCJ >2 mm
    - Significantly worse AOFAS hindfoot activity scores and SF-36 scores
    - Significantly more difficulty walking on rough surfaces

Calcaneocuboid Joint Involvement in Calcaneal Fractures

Bernd Kinner, MD, PhD, Sarah Schieder, MD, Franz Müller, MD, Anja Pannek, MD, and Christina Roll, MD, PhD
Addressing Associated Pathology: Peroneal Tendons

- Subluxation and dislocation of the peroneal tendons
- Joint depression more frequently than tongue-type
- Toussaint and colleagues
  - 421 CT scans
  - Tendon displacement identified in 118 (28%)
    - Only 12 were noted in original radiology reports
Addressing Associated Pathology: Peroneal Tendons

- Kitz and colleagues
  - 47 of 155 (30%) peroneal tendon displacement on preoperative CT scan
  - Only 18 of 155 (11.6%) had true peroneal subluxation or dislocation on intraoperative examination

Peroneal Tendon Instability in Intra-Articular Calcaneus Fractures: A Retrospective Comparative Study and a New Surgical Technique

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Questions?