Hindfoot Arthrodesis
Triple Arthrodesis

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History of Triple Arthrodesis

- Edwin W. Ryerson first described triple arthrodesis in 1923 as a fusion of the TC, TN, and CC joints.
- Goal: Well-aligned, plantigrade, and stable foot that would allow patients with paralytic or deforming conditions to function better.
- Indications: correct lower extremity deformities in children with poliomyelitis, cerebral palsy, Charcot-Marie-Tooth disease, clubfoot, or tuberculosis.
- Remove large blocks of subchondral bone and correct the angular deformities by inserting or removing wedges.
- Corrections maintained by casting.
- Often required manipulation for loss of position.
- K-wires, Steinmann pins, staples.
- Internal fixation with various compression screws has become standard.
Primary Goal

- The creation of a painless, plantigrade foot capable of being fitted into, at the very least, a custom shoe.

Indications for a Triple Arthrodesis

- Deformity: Clubfoot
- Instability of tritarsal complex
- Disability
  - Neurogenic
  - Nonneurogenic
- Arthritis
  - Seropositive
  - Seronegative
  - Post traumatic
- PTD, Hindfoot valgus
- Tarsal coalition
- Malalignment
- Chronic Pain
The Faces of Triple Arthrodesis

- Planovalgus
  - Collapsing pes planovalgus deformity
  - Tibialis posterior tendon dysfunction
  - Tarsal coalition

- Cavovarus
  - CMT
  - Talipes equinovarus
  - Neuromuscular disease

Prerequisites for a Triple Arthrodesis

- Functional integrity of the ankle
- Adequate bone stock
**Radiographic Evaluation**

AP view reveals joint-space narrowing
- Abduction (common in valgus deformity)
- Adduction (common in varus deformity) of the forefoot
- Valgus: Uncovering of the articular surface on the talar head with > 7° displacement=abnormal, abduction of the forefoot

Lateral view:
- Low/collapsed arch indicates a valgus deformity,
- High arch indicates a varus or cavovarus deformity.
Osteophytes at TN and CC joints

**Imaging**

MRIs and CT scans:
- Avascular necrosis of the talus or navicular
- Identifying the extent of an infectious process or Charcot arthropathy.
Coleman Block Test

- Determine if the deformity is in the forefoot or hindfoot
  - Is deformity reducible
- Cavovarus deformities in the rear foot
  - forefoot cavus deformity or
  - isolated plantarflexed first metatarsal
  - Rearfoot compensates by rotating into varus.
  - Forefoot is "off-weighted" by placing a block under the heel so that the rearfoot no longer has to compensate for a forefoot cavus.
  - If the rearfoot normalizes and becomes perpendicular to the ground, the deformity lies in the forefoot and should be addressed as part of the procedure.
  - In rigid cavovarus foot, the deformity does not reduce.

Harris-Beath projection

- Eval posterior facet joint space for pathology as well as the amount of varus or valgus deformity in the rearfoot relative to the tibia
Normal joint

- Lateral view
  - TC angle of 25-50°
  - Talus, first metatarsal angle of 0°
  - Calcaneal inclination angle of 20-25°
- AP view
  - TC angle of 15-50°
  - Talus, first metatarsal angle of 0°
  - Degree of talar head rotation less than 7° from the navicular

Diagnostic Local Anesthesia Blocks

Isolating joint pain from other pain generators with local intra-articular anesthetic blocks.

- Relief of pain after injection confirms the location of the pain generator.
- STJ injections are performed through the sinus tarsi.
- The sinus tarsi is palpated on the lateral aspect of the foot and a 1.5-inch needle is directed toward a point just inferior to the sustentaculum tali on the medial side of the foot.
- The TN and CC joints may be more difficult to inject, especially when osteophytes are present, and may require fluoroscopic guidance.
Adjunctive Procedures

- Neurogenic
  - Tendon transfer
  - Muscle transfer
  - Balancing procedures

- Nonneurogenic

Surgical Approaches

- Lateral incision inferior to the distal tip of the lateral malleolus to the base of the fourth metatarsal
- STJ, CC joint, and the lateral portion of the TN joint exposed
- Avoid branches of the sural and superficial peroneal nerves
- EDB muscle belly muscle belly is flapped distally to expose the CC, lateral TN joint.
- Protect the peroneal tendons
- Contents of the sinus tarsi removed with interosseous ligament, to gain exposure to the anterior portion of the STJ
**Lateral Surgical Approach**

Laminar spreader/Hinterman is placed into the sinus tarsi and used to open the STJ

- Transection of the calcaneofibular (CF) ligament
- Articular cartilage is removed from the anterior, middle, and posterior facets by scraping with a curette or stripping with an osteotome
- The remaining subchondral bone is then fenestrated using a 0.062 K-wire, small drill bit, or power bur, small osteotome or gouge to shingle the surface.
  - CC joint cartilage is denuded, leaving only subchondral bone.
  - Lateral border of the TN joint can be reached after the CC joint is prepared by dissecting directly medially.

**Medial Incision**

- Anterior to the distal tip of the medial malleolus extending dorsomedially toward the naviculocuneiform joint
- Lies between the anterior and posterior tibial tendons
- Saphenous vein and nerve are dorsal to the incision and retracted
- Capsulotomy of the TN joint is performed in line with the skin incision
- A laminar spreader is inserted for exposure, and the cartilage is removed from the navicular which is usually deeply concave making cartilage excision difficult.
Positioning of the Triple

- Foot manipulated into the corrected position
- Bone on bone contact at each joint is confirmed
- Larger deformities may require wedges to be removed for optimal correction
- Small gaps in joints can be filled with bone graft
- STJ should be placed in about 4° of valgus relative to the ground
- Forefoot is then aligned plantigrade to the floor
- Avoid Varus hindfoot

Fixation Techniques

- STJ fixated with a cannulated 6.5 or larger screw and can be placed from the posterior plantar portion of the calcaneus into the body of the talus or from the neck of the talus into the body of the calcaneus
- AP/Lat of Talus
Fixation Techniques

- TN and CC joints can be fixed with either staples or screws. If staples are used, at least 2 are placed in each joint directed at 90° angles to each other.
- Two or three 4.5 cannulated screws placed parallel to each other in the TN and CC joints
- Screw placement is verified using fluoroscopy, and residual gaps in joints, including the sinus tarsi, are filled with bone graft.

Perioperative Management

- Drains: Medial / Lateral
- Ankle block with 0.5% plain Marcaine is performed to help decrease postoperative pain
- Jones-style compression dressing is applied with a posterior splint
- Dressing change 1 wk
- Sutures out 2 wks
- SLC 5 wks
- Camwalker transfer only 4 wk
- Camwalker PWB 2wk FWB 2wk
Complications

- **Nonunion**
  - TN joint is the most common site, with most literature reporting a rate of 5-10%.

- **Degenerative joint disease**
  - Midfoot DJD can develop with time.

- **Wound healing problems**

- **Nerve injury**
  - Lateral incision lies between the sural and the superficial peroneal nerves.
  - Intermediate dorsal cutaneous nerve, which is an extension of the superficial peroneal, is located very close to the distal portion of this incision.
  - Medial incision is located in proximity to the saphenous nerve as well as the medial dorsal cutaneous nerve at the distal margin of the wound.

Complications

- **Avascular necrosis**
  - Resecting a large portion of the talar head to increase correction of deformity, or excessive dissection of the talar neck while placing a screw from the talus down into the calcaneus.

- **Lateral instability**
  - Malposition of the rearfoot in varus leading to excessive lateral stress on the ankle joint postoperatively.
  - The CF ligament must often be transected for adequate exposure to the STJ. If the ligament does not heal properly, lateral ankle instability can result.

- **Stiff foot**
  - Ankle motion is also affected. One report showed a 13% decrease in dorsiflexion and a 16% decrease in plantarflexion.
Poorly positioned triple

- continued pain
- disability
- gait disturbances
- excessive stress in adjacent joints
- footwear problems.

Lower extremity kinematics and kinetics during level walking and stair climbing in subjects with triple arthrodesis or subtalar fusion.

- Eval walking, stair ascent, stair descent
- Temporal distance, kinematic and kinetic data were collected using a six camera 3-D motion analysis
Results of triple arthrodesis: effect of primary etiology.

- 4-year period, 25 feet in 20 patients (average age 24.9 years)
- Neurogenic and nonneurogenic: 2 groups
- (AOFAS) Hindfoot and Ankle Scale, radiography, pedobarography, (Short Form 36, SF-36)
- AOFAS score improved from 24 to 71 postoperatively
- Preoperative AOFAS values of neurogenic cases were significantly lower than those of nonneurogenic cases
- Postoperative AOFAS values lower in neurogenic cases (64.0 vs. 77.6).
- Decreased the use of orthotics postoperatively in both groups
- Neurogenic and nonneurogenic patient groups improved significantly unable to show any significant differences

Triple arthrodesis in rheumatoid arthritis.
Knupp M, et al Department of Orthopaedic Surgery Switzerland Foot Ankle Int. 2008 Mar;29(3):293-7

- 1990-1998, 28 patients with rheumatoid arthritis
- 32 triple arthrodeses 28 patients
- 5.2 (4 to 7) years
- Rigid staple fixation and autologous bone graft.
- Complication; superficial wound slough: 8 patients
- Progression of arthritis in 17 (midfoot)
- Visual analogue scale for pain averaged 47 (range, 3 to 94)
- SMFA scores: 45 (range, 10 to 71) points for dysfunction
- 38 (range, 10 to 72) (p < 0.05) between the SMFA- and the AOFAS-Score.
- Mean Short Form-36 (SF-36) physical component outcomes score was 51 (range, 18 to 98)
- AOFAS score averaged 70 (range, 40 to 94)

- Purpose: Measure intraarticular peak pressures with electronic sensors in 8 anatomical specimens in different areas of the ankle joint and in the naviculocuneiform joint
- Force was applied to extrinsic tendons via cables attached to computer-regulated hydraulic cylinders
- Higher peak pressures in the ankle joint after triple arthrodesis (5.7 Mpa) Talonavicular arthrodesis (5.2 Mpa)

- Triple arthrodeses: higher values in the ankle joint (5.5 MPa/4.6 Mpa) than after talonavicular arthrodesis (5.1 MPa/4.4 Mpa).
- Naviculocuneiform joint, higher peak pressures after triple arthrodesis than after talonavicular arthrodesis
- Lower and more evenly distributed peak pressure load in the ankle joint after talonavicular arthrodesis than after triple arthrodesis
- Selective arthrodesis appears to be more favorable
- Triple arthrodesis leads to an increase in peak pressure in the ankle joint, which may lead to joint degeneration.

- Retrospective review
- Pain, function and alignment of the tibiotalar joint, patient satisfaction, prevalence of osteoarthritis (OA) of the tibiotalar joint after a median follow-up of six years.
- Sixty-one percent (22 patients); good total score on the Ankle-Hindfoot Scale.
- Nineteen patients (53%) satisfied
- 47% had radiographic OA of the tibiotalar joint.
- 61% of the procedures in 36 patients with a triple arthrodesis for OA had a good score on the Ankle-Hindfoot Scale.
- Radiographic OA of the ankle was present in 47% not related to patient satisfaction.


- Retrospective review of 100 consecutive triple arthrodeses.
- All the operations performed by the senior author (TSS).
- Only local bone graft from the excised joint surfaces had been used.
- Mean age: 58 years (18 to 84).
- Mean time to union was 5.1 months (3 to 17).
- 75 good, 20 fair and five poor results.
- 4 cases of nonunion.
- Comparable rates of union are achieved without the need for supplementary bone graft from the iliac crest or other donor site.

- Retrospective review of 8 patients: triple arthrodesis rail external fixator
- Assistive ambulatory equipment was not required
- Mean duration of frame application was 11.5 weeks
- Follow-up averaged 15.9 months
- Fusion occurred in all joints
- One superficial pin-tract infection
- Results: Rail frame: viable fixation alternative for triple arthrodesis

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- 27 patients (thirty-one feet) triple arthrodesis for the treatment of chronic hindfoot pain
- 10 yrs: 22 patients (twenty-six feet)
- Mean age 45; mean duration of follow-up 14
- 21 (93%) satisfied
- 11(41%) perform moderate activity with mild or no pain in the foot and ankle
- 20 (74%) reported moderate-to-severe difficulty with, or an inability to negotiate, uneven surfaces
- (SF-36) outcomes score was 35.2 points, well below the mean of 5 points for the United States
- SF-36 score significantly lower for patients with systemic inflammatory disease
- Average 12 degrees (27%) loss of plantar flexion but no significant loss of dorsiflexion compared with the untreated foot.
- 26 ankles with DJ D, 7 naviculocuneiform joints, 6 tarsometatarsal joints
- 3 required an ankle arthrodesis
- No nonunions or revisions of the triple arthrodeses.
- Triple arthrodesis may provide patients with substantial long-term relief of preoperative symptoms.
Conclusion

Conclusions from the 4th Annual International External Fixation Symposium

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