Principles of triple arthrodesis

Integra™ Ankle Days

Ankle and Hindfoot Training

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BIOMECHANICAL CONSIDERATIONS during the stance phase gait

1. **Heel strike**: inversion of the heel
   - axes talus and calcaneus less parallel to each other
   - **more rigidity** to receive initial load

2. **Body weight forward**: eversion of the heel
   - axes talus and calcaneus more parallel to each other
   - **more flexibility**

3. **Push-off**: inversion (idem)
BIOMECHANICAL CONSIDERATIONS

TN joint = pivotal joint

- Large amount of rotation occur through the TN joint during gait
  - incidence of TN nonunion is higher
  - better function of the foot if TN joint can be spared

- Hindfoot deformity is often fully corrected by including the TN joint * (only subtalar arthrodesis do not correct severe hindfoot deformity and in some cases can make it worse)

## Effect of isolated hindfoot arthrodesis

<table>
<thead>
<tr>
<th>Type of arthrodesis</th>
<th>Diminution ROM subtalar</th>
<th>Diminution ROM TN</th>
<th>Diminution ROM CC</th>
<th>Diminution ROM TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>subtalar</td>
<td>100%</td>
<td>26%</td>
<td>56%</td>
<td>13° loss</td>
</tr>
<tr>
<td>Talo-navicular</td>
<td>&gt;60%</td>
<td>100%</td>
<td>+++</td>
<td>10-15° loss</td>
</tr>
<tr>
<td>Calcaneo-cuboidal</td>
<td>15-35%</td>
<td>&gt;50%</td>
<td>100%</td>
<td>?</td>
</tr>
</tbody>
</table>

_Aston DJ and all, Motion of the hindfoot after simulated arthrodesis, JBJS Am, 1997_
Triple Arthrodesis

- Fusion of ST + TN + CC

- English Triple arthrodesis = French « double arthrodesse »

- Improvement Hindfoot function (no pain and correction of the axial deformations: plantigrade position)
OPTIMAL POSITION FOR FUSION

- Subtalar joint = 5 to 10° varus
- Rotate transverse tarsal joint into a plantigrade position
  - !NO forefoot varus/supination position!
Indications of triple arthrodesis

- Primary Arthritis: *pes planus or pes cavo-varus*
- Posttraumatic Arthritis: *calcaneal or talor fracture*
- Hindfoot Arthritis: *synostosis or residual clubfoot deformities*
- Rheumatoïd Hindfoot Arthritis: *PR, SAA, goutte…*
- PPV and Tibialis posterior dysfunction (Stadium III or more)
- Severe Pes cavus deformities
- Paralytic foot: *Polio, cerebral palsy, Charcot Marie Tooth (Large bone resections)*

Not to be used if soft tissue procedure or osteotomy or isolated arthrodesis are possible
PREOPERATIVE EVALUATION

- **SOFT TISSUE**: previous scars, skin or muscular grafting

- **CIRCULATION**: dorsalis pedis and tib post pulses, ankle-brachial index of 0.75 to 0.5

- **SENSATION**: 5.07 monofilament of Semmes-Weinstein (!diabetic peripheral neuropathy!)

- **ALIGNMENT**: Genu valgum / Genu varum
  - weightbearing = 5 to 7° calcaneal valgus
  - forefoot abduction or adduction
  - rotational position of the forefoot
Pathologie du Pied et de la Cheville, Th Leemrijse et B Valtin, 2009

Forefoot suppination  Forefoot pronation
First correct tibial axis deformation triple arthrodesis later!
FLEXIBILITY OF THE HINDFOOT: Coleman and Chesnut block

Flexible deformities: osteotomy or tendon transfer procedure

Non fixed varus hindfoot deformity
Achilles Tendon tightness

If Triple arthrodesis performed:

peroperative difficulty to correct hindfoot deformity

→ Achilles tendon lengthening procedure
Achilles tendon lengthening procedure
- Supine position
  - sandbag underneath the ipsilateral buttock

- Lateral incision
  (tip fibula to base MT4)
  - Sural nerve inferiorly!
  - Fib Sup nerve superiorly

- Ollier incision over the sinus tarsi
  - better approach for TN
  - ! Superficial nerve

Pathologie du Pied et de la Cheville, Th Leemrijse et B Valtin, 2009
Remove articular cartilage from the subtalar joint (anterior and posterior facets)

FHL in the postero-medial subtalar joint
Anteromedial approach between Tib Ant and EHL

Hinterman distractor

More extensive if lateral column lengthening (PPV)
1° = REDUCTION AND STABILISATION TN JOINT

- TN = Key joint to allow excellent correction of the 3 joints
  - PPV = Forefoot plantar flexion + adduction
2° = REDUCTION AND STABILISATION TC JOINT

- Subtalar joint = 5 to 10° valgus
Achilles Tendon lengthening if necessary

- Transverse incision fascia gastrocnemius
- Foot is supinated and dorsiflexed to have elongation
Talo Navicular Screws
2 canulated screw 4,5 mm

Talo Calcaneal screw
1 or 2 cannulated screws 6,5 / 7,0 mm
CALCANEO CUBOIDAL?

- Isolated ST fusion: ↓ ROM CC 56%
- Isolated TN fusion: ↓ ROM CC +/- 100%
  
  (Astion DJ and all, Motion of the hindfoot after simulated arthrodesis, JBJS Am, 1997)

- Only if
  - lateral column lengthening is needed (PPV)
  - lateral column shortening is needed (PCV)
  - painful CC arthritis

- Remove cartilage CC
  ! Not extensive if need lateral column lengthening (PPV)
Pes Plano Valgus

Pathologie du Pied et de la Cheville, Th Leemrijse et B Valtin, 2009
Pes Plano Valgus +++

Pathologie du Pied et de la Cheville, Th Leemrijse et B Valtin, 2009
Pes Plano Valgus +++

Pathologie du Pied et de la Cheville, Th Leemrijse et B Valtin, 2009
Pes Cavo Varus

SIFFERT TRIPLE ARTHRODESIS:
- Dorso-Lateral closing wedge in subtalar + mortising Navicular into the Talus head
- Depressing the navicular, cuboid and cuneiforms while allowing elevation of the MT

PLANTAR FASCIA RELEASE (Steindler)
contracture F PI leads to forefoot plantar flexion + calcaneal varus
Pes Cavo Varus
CONCLUSION

- **First correct tibial deformation**
  - genu varum, genu valgum

- **Optimal position: Plantigrade foot!**
  - ST = valgum 5°
  - TN = forefoot NO suppination

- **TN joint = key joint:**
  - 1st TN reduction
  - 2th ST reduction

- **Achilles Tendon Tightness?**
  - Lengthening procedure

- **CC fusion necessary only if**
  - Arthritis
  - Lateral column lenghtening/shortening
Achilles Tendon tightness

If Triple arthrodesis performed:

- peroperative difficulty to correct allignment of the hindfoot

- with correction of the deformity: Achilles tendon will restrict dorsiflexion. **Transverse tarsal joint compensate**

Achilles tendon lengthening procedure
Radiographic evaluation

- X Ray
  - Weightbearing X Ray Foot: antéroposterior, lateral and oblique
  - Weightbearing anteroposterior and mortise Xray of the Ankle
  - Ankle varus and valgus stress views if instability
  - Standing full-lenght radiographs (mechanical axis of the tibia)

- (Arthro) Ct scanner

- MRI

- Scintigraphy
- Resection calcaneal anterior process: better vision anterior facet

- Resection inferior lateral portion of the posterior talar facet: better vision posterior facet
Distraction sinus tarsi: better vision posterior facet
Anteromedial approach

*between* Tib Ant and EHL

**Ps:** Medial incision: tip medial malleolus to the NC joint
- between Tib Ant and Tib Post
- ! Saphenous vein and nerve = just dorsal
cartilage TN removal
! No excessive dissection dorsally (blood supply talar neck)

More extensive to allow lateral column lengthening (PPV)
cartilage navicularis removal

Pridie perforation