Salvage of the Failed Ankle Arthroplasty: Malalignment of the Foot or Leg: What to Do?

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I. Definition
   a. Long axis of tibia is generally perpendicular to articular surface of talus
   b. Any deviation of aforementioned alignment is considered *coronal plane deformity*
   c. Classically, coronal plane deformity >10-15 degrees was considered contraindication to ankle arthroplasty
   d. Prevailing opinion is that coronal plane deformity up to 10 degrees should be manageable with implant system and standard approaches alone
   e. Degree of deformity
      i. Mostly arbitrary
      ii. Based on pre-existing literature and published and predicted failure or recurrence rates
         1. Mild – up to 10 degrees
         2. Moderate – 10-20 degrees
         3. Severe -> 20 degrees

II. Classification of deformity
   a. Varus
      i. Medial foreshortening
      ii. Medial-superior inclination of joint
      iii. Both
      iv. 70% of these deformities are in females
         1. PTT and/or deltoid deficiency
         2. Rheumatoid or other inflammatory arthropathy
   b. Valgus
      i. Lateral foreshortening
      ii. Lateral-superior inclination of joint
      iii. Both
      iv. 70% of these deformities are in males
         1. Cavovarus foot
            a. Neuromuscular??
         2. Chronic ankle instability
            a. May be linked to #1 above
         3. Post-traumatic
   c. Congruent
      i. Relative matching of orientation of tibial plafond and talar dome joint surfaces
      ii. Defined as having < 10 degrees between tibial and talar articular surfaces
      iii. Smallest measureable differences ~ 2 degrees
   d. Incongruent
      i. Relative *mismatching* of tibial plafond and talar dome joint surfaces
      ii. Defined as having > 10 degrees between tibial and talar articular surfaces
      iii. Smallest measureable differences ~ 2 degrees
      iv. Pre-operative incongruity has been shown to have greater degrees of difficulty to regain neutral position and has higher incidence of recurrent deformity

III. Assessment of deformity
a. Clinical
   i. Standing and walking patient
   ii. Important to visualize amount of deformity at ankle but also must see entire limb
   iii. Patient may have confounding factors
      1. Genu varum
      2. Tibia vara
         a. Certain ethnicities predilect eg. Japanese
         b. Metabolic bone disease
      3. Prior trauma leading to tibial or other bony malalignment
      4. Don’t forget rotation!!
      5. Limb length (discrepancy?)
   iv. Contralateral limb
      1. What is “normal”?
         a. Depends on individual, not as much on statistical norms
   v. ROM
      1. Especially of knee, subtalar, transverse tarsal, and even MTP joints to see what effect that has on ankle mechanics

b. Radiographic
   i. Plain x-ray
      1. Central line down tibial vertical axis intersects line parallel to tibial plafond AND talar articular surfaces
      2. In varus tibia, axis may be drawn from line centered on tibial spine and center of plafond
         a. This may NOT bisect the tibial shaft
   ii. Stress x-ray
      1. Manual varus AND valgus
         a. Assess degree of correction BEFORE soft tissue releases/repairs
         b. Do both to ensure no hidden further instability in direction of obvious deformity as well as to demonstrate no instability in opposite direction
            i. Not uncommon in flatfoot where valgus prevails but deformity may cause mechanical deterioration of CFL due to subfibular impingement
   iii. CT
      1. Helpful for bone loss identification particularly in incongruent malalignment
         a. Helps predict amount of resection and alert surgeon to need for possible bone graft/fillers if standard resection won’t achieve goal

IV. Demographic data
   a. 33-44% of all patients presenting for total ankle arthroplasty have some defineable (>10 degree) amount of coronal plane deformity (see bibliography for breakdown)

V. Implications of deformity
   a. Mechanics –Espinosa JBJS ’2010
      i. <2 degrees malalignment - no increase in contact pressure
      ii. > 5 degrees – doubles contact pressure
      iii. increased poly wear with edge loading – Fukuda, Haddad (personal comm..)
b. Instability
   i. Can manifest as ligamentous instability or early wear of components
   ii. May lead to early failure (see below)
c. Edge loading
   i. More rapid polyethylene wear leading to osteolysis and/or component loosening
d. Abnormal joint stresses
   i. Stress overload or stress shielding
      1. May result in formation of osteophytes that impede range of motion and/or cause pain
      2. May result in bony wear and subsidence
      3. May result in malleolar fracture
e. Potential continuum of inadequacies potentially leading to catastrophic failure
   i. A well positioned implant that becomes unstable will lead to asymmetric wear and abnormal stress which in turn can destroy bony integrity as well as dissolve tissue

VI. Treatment
a. Correct with prosthesis alone
   i. Reputed to work for almost any congruent deformity regardless of degree
      1. Be careful with this rule – it’s not entirely true at higher levels of deformity
      2. Must assess subtalar joint compensation and determine if foot is truly plantigrade in face of joint deformity
b. Prosthesis and adjunctive soft tissue releases/repair/reconstructions
   i. Deltoid release
      1. Mann, Mann FAI 2011
         a. <18 degrees varus – no deltoid releases – no recurrences
         b. >18 degrees varus – all needed deltoid released to restore neutral alignment
         c. no need for lateral ligament repair after adequate deltoid release according to this data
   ii. Lateral ligament repair
      1. Traditional anatomic repair may not be possible due to osteophyte formation on lateral shoulder of talus or surgical dissection to clear lateral gutter of debris
      2. If tissue is present, ATFL can be reattached to fibula through anterior approach with anchors
      3. Question reliability and durability
         a. Works best for cases of mild varus laxity post implantation (<5-10 degrees – my opinion)
   iii. Lateral ligament reconstruction
      1. Coetzee, Alvine
         a. Stage 1
            i. Medial joint erosion
            ii. Minimal ligamentous laxity, ectopic bone
            iii. Typically managed by implant alone with corrective cuts
         b. Stage 2
            i. Combined pathology
1. Shortened medial malleolus
2. Eroded medial joint
3. Contractures of deltoid, medial capsule, and Tib. Post. tendon

ii. Necessitates aggressive and sometimes extensive approach
1. Deltoid and capsular releases, calcaneal osteotomy and possible 1st ray dorsiflexion osteotomy
2. Lateral ligament reconstruction by Evans, peroneus brevis tenodesis to tibia supplemented by Brostrom(Coetzee) or auto-, allograft weave

iv. Achilles lengthening procedures
1. These can be quite helpful to allow for last few degrees of correction in stubborn joint esp. valgus oriented as it relieves the lateral pull of the tendo-Achilles from the calcaneus

c. Prosthesis and osteotomy
i. Supramalleolar(Hintermann, Knupp)
   1. Opening vs closing wedge or dome
   2. Powerful correction of tibial deformity
      a. Incision is already there for convenience
   3. Concern over vascularity of plafond segment leading to delayed or non-union, or lack of bony ingrowth
      a. Also large hardware load potentially causing wound difficulties

ii. Medial malleolar(Doets)
   1. Vertical “wafer” of medial malleolus attached to deltoid that allows distal migration and is self seating once ankle is corrected to neutral. Then fixed in new more distal position to relieve medial tightness and balance ligament tension

iii. Calcaneal tuberosity
   1. Dwyer or valgus producing for varus ankle
   2. MDCO or varus producing for valgus ankle
   3. Probably among the safest and most reliable of the osteotomies
      a. Often can be performed simultaneously if desired or necessary
      b. Incision far enough away to be safe as well

iv. Calcaneal neck
   1. For lateral column lengthening
   2. More challenging depending on implant type
   3. Incision closer to ankle incision
   4. Produces more swelling

v. Medial cuneiform
   1. Opening wedge for forefoot varus residual
   2. Can be done by extending anterior ankle incision distal
      a. Simple, quick, often helpful if needed

vi. First metatarsal
   1. Typically dorsiflexion for forefoot driven hindfoot varus
   2. Small incision, closing wedge, so stable
3. Helpful for balancing entire foot
   vii. Cuboid??
      1. Often for rotational control of midfoot in either forefoot varus or valgus
      2. Adjunct that is helpful but adds time and morbidity
      3. If you’re doing this, you probably should (have) stage(d) it because the
         implication is for larger deformity

d. Prosthesis and arthrodesis
   i. Triple
      1. Often staged
         a. Too much surgery and too many incisions to reproducibly avoid
            trouble
         b. Triple first allows later installation of straightforward TAA
   ii. Subtalar
      1. Concomitant arthritis is most common indication, but deformity
         correction with this is recognized and useful
         a. Also provides more bone stock for implant especially if there
            has been some flattening of the talar dome
         b. Avoid anterior dissection forward of sinus tarsi to help reduce
            chance of AVN
   iii. Transverse tarsal
      1. Can access TN from TAA central incision but CC joint is more difficult.
         Requires separate incision
         a. Helps to address mid, forefoot issues in cavus or planus foot
         i. Increased risk due to surgical time and exposures
   iv. (1st) tarsometatarsal
      1. Useful with unstable first ray
      2. Typically flatfoot deformity with valgus ankle
         a. Plantarflexion 1st ray arthrodesis can support the new position of
            the ankle (“forefoot drive hindfoot stabilizer”)
   v. Syndesmosis
      1. Standard with Agility regardless of deformity or not
      2. Can provide much needed lateral stability if fibula is short or distal tibial
         bonestock is poor nd there’s a fear of subsidence after correction

   e. Some combination of the above
      i. Best to individualize based on patients needs and future predicted success of
         implant

Beware the incongruent joint over 25 degrees, particularly varus!!

Related readings
Coetzee, JC: Surgical strategies: Lateral ligament reconstruction as part of the management of varus
Doets HC, et al.: Medial malleolar osteotomy for the correction of varus deformity during total ankle
arthroplasty: Results in 15 patients. FAI (29)2 171-9, 2008.
Easley, ME: Results of total ankle arthroplasty. JBJS (A) 93(15):1455-68, 2011.
Mann RA, Mann JA, et al.: Correction of moderate to severe plane coronal deformity with the STAR prosthesis. FAI 32(7) 659-64, 2011.

NOTES