Total Ankle Arthroplasty/Tibial Tendon/Tibial and Humeral Fractures

Total Ankle Arthroplasty

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Arthroplasty: results — initially poor; pseudarthrosis rate ≤50%; difficult to obtain ideal position; recent studies show better fusion rates; outcomes — decreased gait velocity; tibial stress fractures; ≤50% of patients develop adjacent joint arthritis; loss of 75% of sagittal motion and 70% of inversion and eversion; Buck et al (1987) reported only 1 of 19 patients with ankle fusion experienced no pain; Strasser and Turner (2012) reported 90% union rate in 30 patients >70 yr of age; >33% developed progressive subtalar arthritis; American Orthopaedic Foot and Ankle Society (AOFAS) score 73

Arthroplasty: results — initially poor; Kitaoka and Patzer (1996) reported failure rate >33%; Mayo ankle arthroplasty involved cemented polyethylene component and metal cemented talar component (constrained design); subsidence and anterior ankle impingement at 12-yr follow-up; indications — older patient with multiple joint problems; normal alignment and ligamentous stability; no history of septic arthritis; reasonable patient expectations; contraindications — prior sepsis; osteonecrosis; young, active patient; severe deformity

Ankle fusion vs arthroplasty: Haddad et al (2007) performed meta-analysis comparing arthroplasty and arthrodesis; intermediate results showed similar AOFAS scores and revision rates; Hahn et al (2012) reported better motion with arthroplasty; complication rates and pain reduction similar between arthroplasty and arthrodesis

Total ankle arthroplasty: Gougoulias et al (2010) reported failure rate ≥10% at 5 yr; Queen et al (2012) looked at 51 patients with fixed-bearing total ankle replacement; pain and gait improved at 1- and 2-yr follow-up; no change in ROM; stiffness after surgery remained after surgery; salvage — arthrodesis requires large bone graft; consider amputation; most patients require revision or fusion

Problems with the Posterior Tibial Tendon

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Posterior tibial tendon (PTT): dysfunction occurs from degenerative condition or tendinosis of PTT; primary factor in adult acquired flatfoot; anatomy — PTT inserts on navicular tuberosity; multiple insertions in midfoot; runs behind medial malleolus (hypervascular zone implicated in degenerative changes in tendon); spring ligament (ie, calcaneonavicular ligament) supports arch and head of talus at talonavicular joint; PTT places hindfoot in varus during heel rise to lock midfoot and provide rigid lever arm; problems with push-off create rocking in midfoot

Adult acquired flatfoot: etiology — PTT dysfunction (PTT); preexisting flatfoot; tight Achilles tendon; failure of plantar fascia and spring ligament; risk factors — middle-age women; inflammatory arthritis; obesity; diabetes; congenital flatfoot; presentation — hindfoot valgus with medial ankle pain and swelling; bogginess along PTT; lateral pain in sinus tarsi from impingement; weak push-off; forefoot abduction creates “too many toes” sign; marked weakness of inversion; difficulty with heel rise; evaluate for contractures of Achilles and/or gastrocnemius with Silfverskiold test (positive test shows more ankle flexion with knee flexed than when extended); diagnosis — order weight-bearing radiographs; measure talo-first metatarsal angle and talonavicular angle on anteroposterior (AP) view; diseased foot shows uncoverage of talus and abduction with increased talo-first metatarsal angle and forefoot abduction; talus appears vertical on lateral view; consider advanced imaging in younger patients and those with swelling outside PTT distribution; order computed tomography (CT) to look for arthritis in hindfoot

PTT dysfunction: progressive disease with 4 stages; tenosynovitis with no deformity (stage 1); flexible flatfoot deformity (stage 2); rigid deformity (stage 3); development of tibial talar tilt (stage 4)

Stage 1 of PTTD: often treated as ankle sprain for several months; patients typically younger; associated with seronegative spondyloarthropathies and inflammatory arthritis; use boot and home exercise program; transition to stirrup brace followed by insert with arch support; consider tenosynovectomy if conservative measures fail

Stage 2 of PTTD: nonoperative treatment same as for stage 1; operative treatment — correct deformity and maintain motion; correction based on static weight-bearing AP and lateral radiographs; consider joint-sparring procedures that combine medial soft tissue stabilization with lateral bony procedure

Flexor digitorum longus (FDL) tendon transfer: FDL tendon transferred to navicular to augment or replace PTT; drill hole through navicular; trace tendon down to master knot of Henry for maximal length; pass FDL tendon through navicular from plantar to dorsal; oversee tendon to itself or use biotenodesis screw; procedure does not correct deformity; additional

Educational Objectives

The goal of this program is to improve knowledge about surgical treatment of the arthritic ankle, flatfoot deformity, and fractures involving the tibial plateau and humerus. After hearing and assimilating this program, the clinician will be better able to:

1. Review the evidence for arthroplasty and arthrodesis for treatment of the arthritic ankle.
2. Discuss the classification and treatment of posterior tibial tendon dysfunction.
3. Outline the approach to management of high-energy tibial plateau fractures.
4. List the advantages and disadvantages of using plates vs intramedullary nails for the treatment of humeral fractures.
5. Describe the different surgical approaches used in the treatment of humeral fractures.

Faculty Disclosure

In adherence to ACCME Standards for Commercial Support, Audio-Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, the faculty and planning committee reported nothing to disclose.
lateral bony procedure (medial displacement calcaneal osteotomy [MDCO] or lateral column lengthening) required MDCO: corrects hindfoot valgus; changes pull of Achilles tendon from valgus to varus; perform oblique incision laterally; avoid sural nerve; use oscillating saw and osteotome for osteotomy; shift and fix with 1 or 2 screws, depending on bone quality

Lateral column shortening: lateral column shortened as result of severe forefoot abduction; perform osteotomy and place bone graft toward anterior process of calcaneus to correct forefoot abduction and restore talonavicular coverage; use iliac crest graft in younger patients and allograft in older patients; Bolt et al (2007) showed significant improvement in and maintenance of correction with lateral column lengthening compared to MDCO

Prolonged flatfoot deformity: indications for fusion — plantar gaping or arthritis; procedures stabilize medial arch; procedures — 1) subtalar arthroereisis places screw to block rotation at subtalar joint; 2) perform concomitant spring ligament repair for stage 2 PTTD; 3) fusion procedures for stage 2 PTTD limit hindfoot motion; consider fusion of subtalar joint and FDL tendon transfer in patient with preexisting arthritis; consider fusion for significant deformities or obese patients

Treatment of severe deformity: perform triple arthrodesis to correct rigid stage 3 deformity; procedure eliminates hindfoot motion; correction of hindfoot valgus may result in tight Achilles or gastrocnemius; consider gastrocnemius resection or percutaneous lengthening; no good procedures to restore tibiotar tilt for stage 4 deformities

High-Energy Intra-Articular Fractures of the Distal Tibia: Optimizing Outcomes

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Background: treatment approach — early open reduction and internal fixation (ORIF) produced bad outcomes; place external fixator (ex fix) as traveling traction for high-energy distal tibial fractures, then wait for soft tissue healing; results in lower complication rates; use similar approach for tibial plateau fractures; consider knee-spanning ex fix, bring limb out to length, and grossly realign limb; order CT after ex fix placement; perform open reconstruction after soft tissue heals; goals — anatomic reduction of articular surface; realignment of limb axis; provide mechanical stability; restore biology; provide early motion

Staged protocols: speaker looked at series of high-energy injuries of lower extremity treated with early ex fix, closed reduction, and waiting period with elevation, followed by reconstruction after healing of soft tissue; results — 8-day wait before definitive surgery; low complication rate; temporizing ex fix safe and reasonably effective tool for complex injuries of lower extremity; Ego et al (2005) reviewed complex tibial plateau fractures (mostly Schatzker V and VI) in 60 patients treated with staged protocol; low rates reported for infection, nonunion, and reoperation; ROM reasonable; Western Ontario and McMaster University osteoarthritis index mean score 91

External fixation: indications for tibial plateau fractures unclear; consider ex fix for high-energy axial loading injuries to tibial plafond; perform ORIF early for tibial plateau fractures when possible; use staged protocol when 2- or 3-day wait anticipated with bicondylar fracture pattern, shortening, or knee dislocation; place ex fix before referral for definitive treatment; tips on technique (Collinge et al, 2010) — place knee-spanning ex fix first, then check CT; avoid placing pins where overlap occurs with plate; place distal femur pins and mid to distal tibia pins for tibial plateau fractures; pre-drill and use soft tissue protection; use frame compatible with magnetic resonance imaging; use anterolateral or lateral pin placement for thigh, and direct anterior pin placement for tibia

Fractures of the Humeral Shaft: Open Plating Pearls

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Background: acceptable alignment — ≤20° anterior angulation, ≤30° varus, ≤3 cm of shortening, and ≤15° rotation for isolated diaphyseal humerus fractures

Closed treatment: Sarmiento and Latta (1999) reported 98% union rate, nearly full ROM, and minimal complications with coaptation splint and functional brace; requires close follow-up and correct patient selection; nonunion rate higher for open fractures (indication for surgery); varus position common but acceptable; transverse fractures increase risk for deformity and nonunion; contraindications — massive soft tissue injury; significant bone loss; lack of patient compliance; inability to obtain or maintain acceptable reduction

Surgery: indications — failure of closed treatment (ie, loss of reduction, poor patient tolerance or compliance, obesity, pendulous breasts); open fractures; vascular injury or brachial plexopathy (uncommon); neurologic injury following reduction; isolated or segmental fractures; floating elbow; pathologic fractures; presence of associated injuries; delayed union or nonunion

Radial nerve injury: surgery not indicated for radial nerve palsy sustained at time of injury; transverse midshaft fractures most often associated with radial nerve neurapraxia; spiral distal-third fractures most commonly associated with laceration and/or entrapment of nerve; 70% of nerve injuries recover in 3 to 5 mo, and 90% ultimately recover; indications for surgery — open fractures; Holstein-Lewis fractures; nerve injuries that appear after closed reduction

Surgical options: plate fixation (nonlocking) or bridge plating for severe comminution and segmentation; intramedullary (IM) nails; ex fix useful for severe soft tissue injuries, burns, and wounds with significant contamination; no role for isolated screw fixation

Plate fixation: most acceptable repair strategy; tips — use narrow 4.5-mm plate; add lag screws and compression; use longer plate; indirect reduction preserves biology; use bridge plating for segmented, comminuted fractures; advantages — 96% union rate; immediate stability; early weight bearing; rapid pain reduction

Surgical approaches: anterior and posterior approaches used most often; anterior — extensile; work on lateral side of biceps; avoid musculocutaneous nerve; split brachioradialis; useful for midshaft or proximal fractures; supine position; apply tourniquet if possible; radial nerve not well visualized; lateral — useful with lateral wound from open fracture; shorter plate required; supine position; enter between brachioradialis and triceps; not extensile; posterior — splitting triceps controversial; not extensile; risk damage to triceps; indicated for distal-third fractures; perform in prone or lateral position; poor proximal extension; triceps-sparing posterior approach works on lateral side of triceps and permits full view of radial nerve; useful for most humerus fractures; distal extension of fracture requires posterior approach

Disadvantages: stripping of soft tissue; poor purchase with osteoporotic bone; difficult to use with multifragmented fractures; higher rates of hardware removal

IM nailing: advantages — preserves soft tissues and local blood supply; leaves fracture hematoma undisturbed; smaller incisions; offers load sharing; disadvantages — higher complication rate (19%); shoulder pain in ≤40% of patients; distal humerus comminution with retrograde nails; IM nails associated with lower union rate, and higher rates of shoulder pain and complications (more reoperations) compared to plates

Indications: segmental, pathologic, highly comminuted, and/or osteoporotic fractures
Surgical pearls: avoid distal nail placement because of narrowing in distal third of humerus; use beach chair or supine position; split deltoid; watch rotator cuff

**IM nails vs Plates:** reoperation rate 18% for antegrade nails vs 6% for plates (66% risk reduction); Chapman et al (2000) reported similar nonunion rates; higher shoulder pain for nails; higher elbow pain for plates; McCormack et al (2000) reported more impingement, complications, and reoperations with IM nails

**Humeral nonunion:** defined as lack of healing after 24 wk; nonunion rate 2% to 10% for closed treatment and ≤5% with ORIF (historically 15%); risk factors — high-energy injury; bone loss; soft tissue interposition; segmental fractures; impaired blood supply; infection; treatment with hanging arm cast; obesity; osteoporosis; malnutrition; smoking; noncompliance; treatment — compression plating with autogenous bone graft; large segmental defects need vascularized graft

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Total Ankle Arthroplasty/Tibial Tendon/Tibial and Humeral Fractures

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1. Outcomes associated with ankle arthrodesis include:
   1. Decreased gait velocity
   2. Tibial stress fractures
   3. Adjacent joint arthritis in >70% of patients
   4. Significant loss of sagittal motion
   
   (A) 1,3,4  (B) 1,2,4  (C) 2,3  (D) 1,2,3,4

2. Which of the following is an indication for ankle arthroplasty?
   (A) Older patient with multiple joint problems
   (B) Severe ankle deformity
   (C) Arthritic ankle with ligamentous instability
   (D) History of septic arthritis

3. Etiology of adult acquired flatfoot includes all the following, except:
   (A) Posterior tibial tendon dysfunction
   (B) Tight Achilles tendon
   (C) Lateral column hypermobility
   (D) Spring ligament insufficiency

4. The flexor digitorum longus tendon transfer procedure augments or replaces the posterior tibial tendon (PTT), and corrects the deformity in stage 2 PTT dysfunction.

   (A) True  (B) False

5. Which tibial plateau fractures may not require treatment with a staged protocol?
   (A) Low-energy, unicondylar fractures
   (B) Bicondylar fracture patterns
   (C) Fractures with extensive soft tissue injury
   (D) Fractures associated with knee dislocation

6. Computed tomography should be performed before placement of an external fixator for high-energy tibial plateau fractures.

   (A) True  (B) False

7. Which of the following are considered acceptable for alignment in the treatment of humeral shaft fractures?
   1. ≤20° anterior angulation
   2. ≤30° varus
   3. ≤3 cm of shortening
   4. ≤15° rotation

   (A) 1,3  (B) 2,4  (C) 1,2,4  (D) 1,2,3,4

8. Choose the correct statement about radial nerve injuries.
   (A) Surgery is not indicated for radial nerve palsy sustained at the time of injury
   (B) Spiral distal-third fractures are most often associated with radial nerve neurapraxia
   (C) Transverse midshaft fractures are most commonly associated with laceration and/or entrapment of nerve
   (D) <50% of radial nerve injuries ultimately recover

9. Which of the following surgical approaches is the best for distal humerus fractures?
   (A) Anterior  (B) Posterior  (C) Lateral  (D) Medial

10. Compared to plates, use of intramedullary nails are associated with:
    (A) Lower union rate  (C) Higher rate of complications
    (B) Higher rate of shoulder pain  (D) All the above

Answers to Audio-Digest Orthopaedics Volume 37, Issue 03: 1-D, 2-D, 3-C, 4-B, 5-A, 6-A, 7-D, 8-C, 9-D, 10-A