Ankle Arthroplasty: When and Who?

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Ankle Arthritis: Evolving Treatment

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Disclosures

- No relevant financial disclosures to report

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Outline

- Ankle anatomy
- Treatment Options
  - Non-surgical
  - Surgical
- Why arthroplasty?
  - Arthroplasty vs Arthrodesis
- Advances in treatment/current challenges

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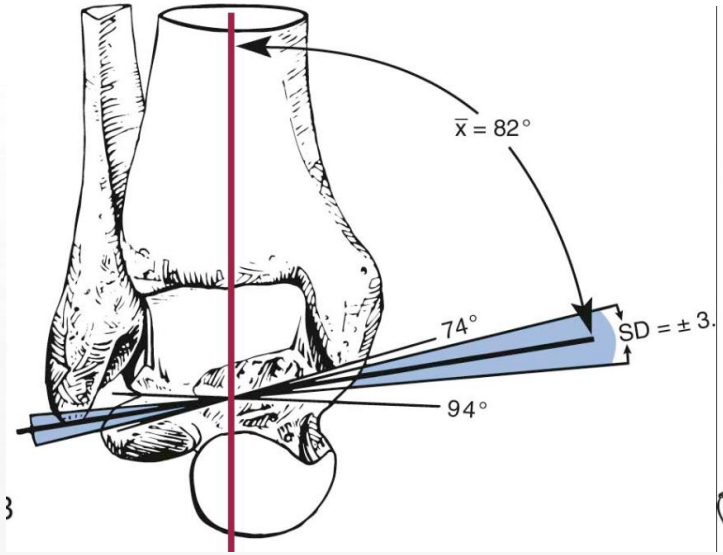
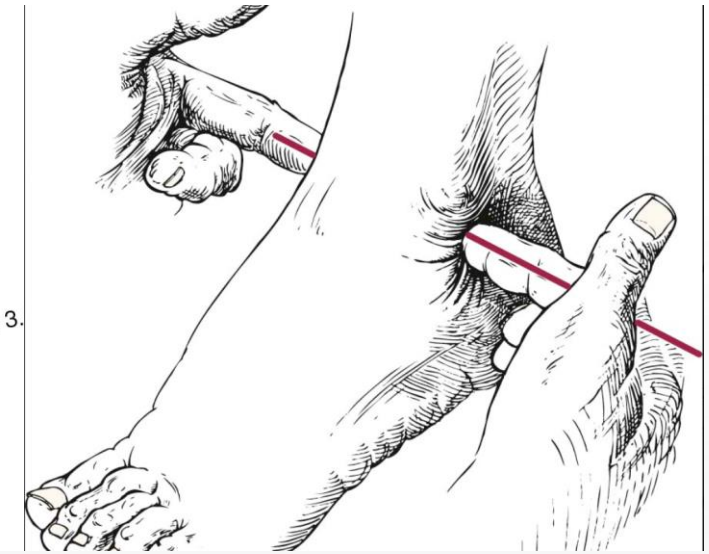
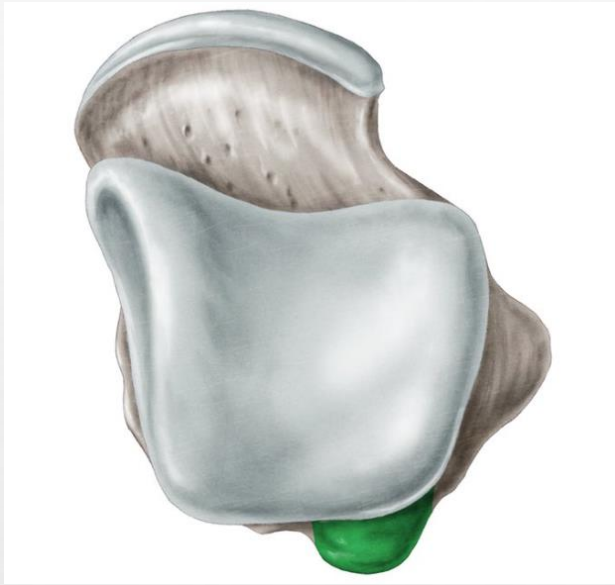
Ankle anatomy

- Ankle joint
  - Tibia, fibula, talus
  - Mortise joint- bone and ligamentous constraints medially and laterally
- Ankle motion
  - Dorsiflexion/plantarflexion
  - Inversion/eversion
  - External rotation (syndesmosis)







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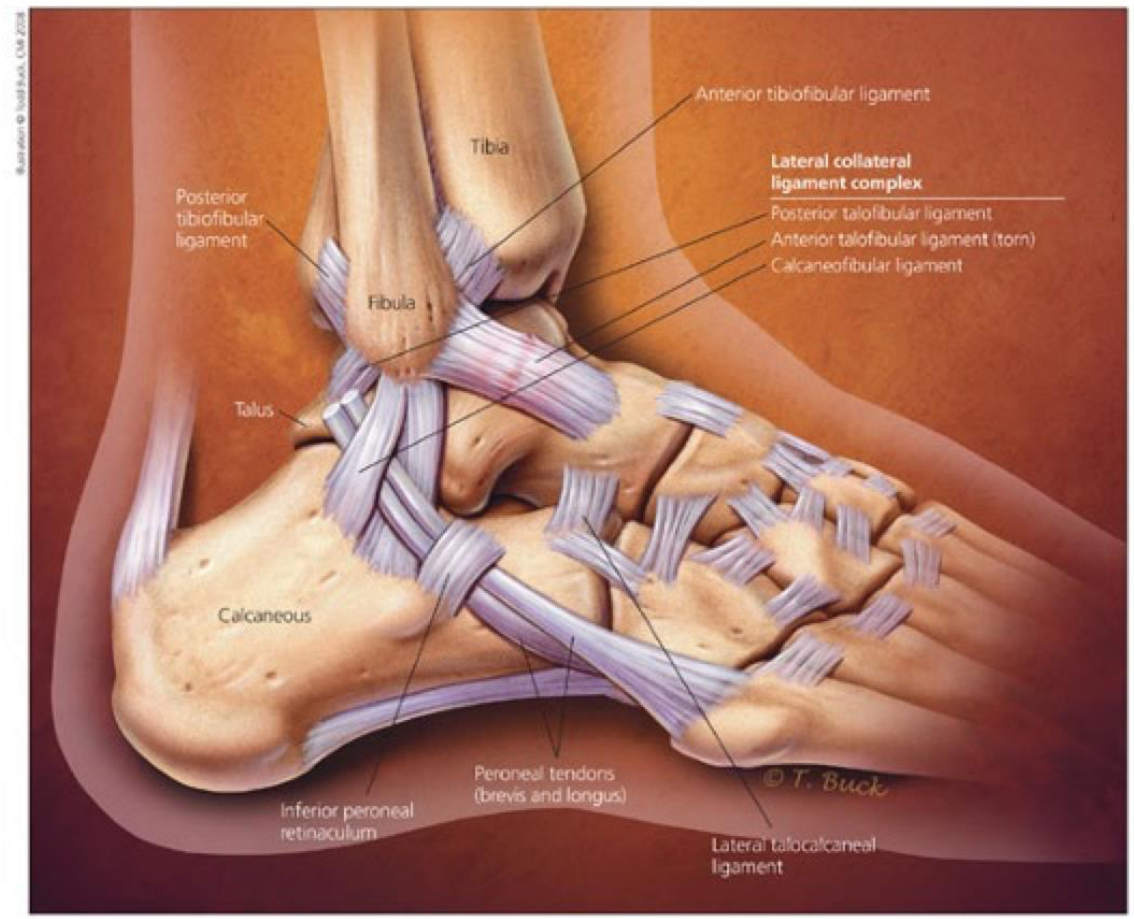
Coughlin MJ, Saltzman CL, Anderson RB. Mann'S Surgery of the Foot and Ankle 9th Ed. Philadelphia, PA. 2014.

Ankle anatomy

- Ligamentous stability
  - Deltoid- primary stabilizer of the ankle
  - Lateral ankle ligaments- ATFL, CFL, PTFL
  - Syndesmosis- AITFL, IOM, PITFL



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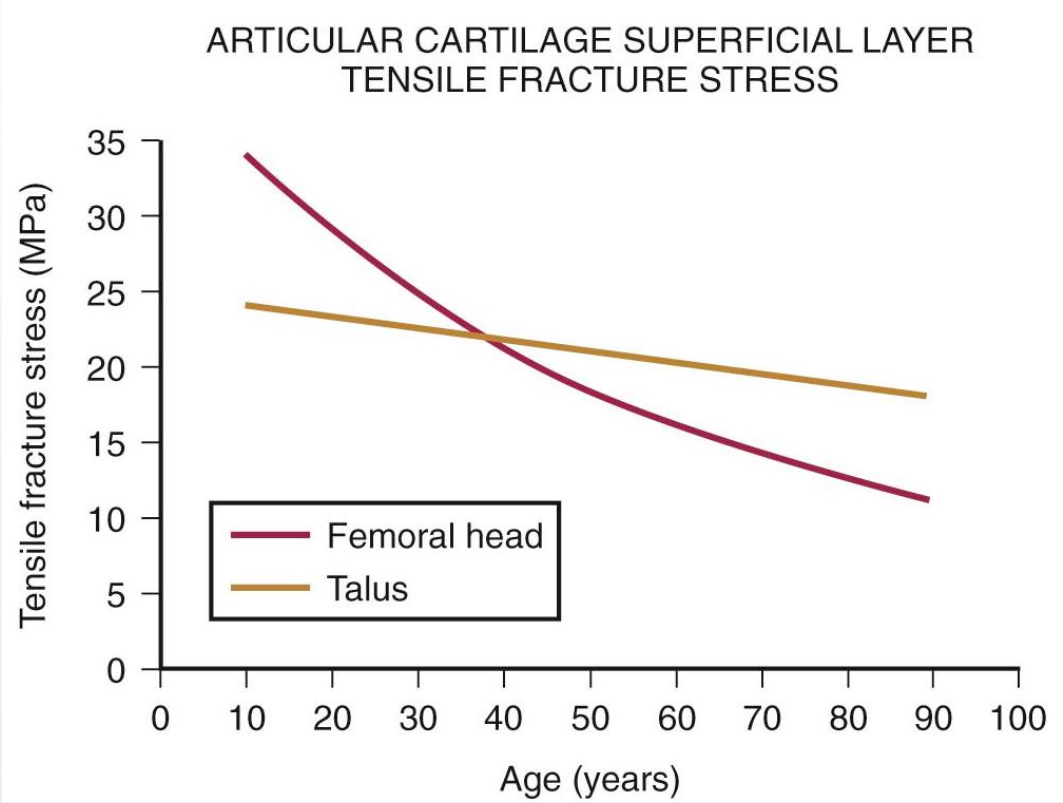
Coughlin MJ, Saltzman CL, Anderson RB. Mann'S Surgery of the Foot and Ankle 9th Ed. Philadelphia, PA. 2014.

Articular Cartilage Studies

- Small surface area (350mm^2 vs 1100mm^2 for hip and knee)
  - Higher peak contact stress
- Cartilage thickness (1-2 mm)
  - Up to 6mm in hip and knee
- Articular cartilage tensile properties more uniform



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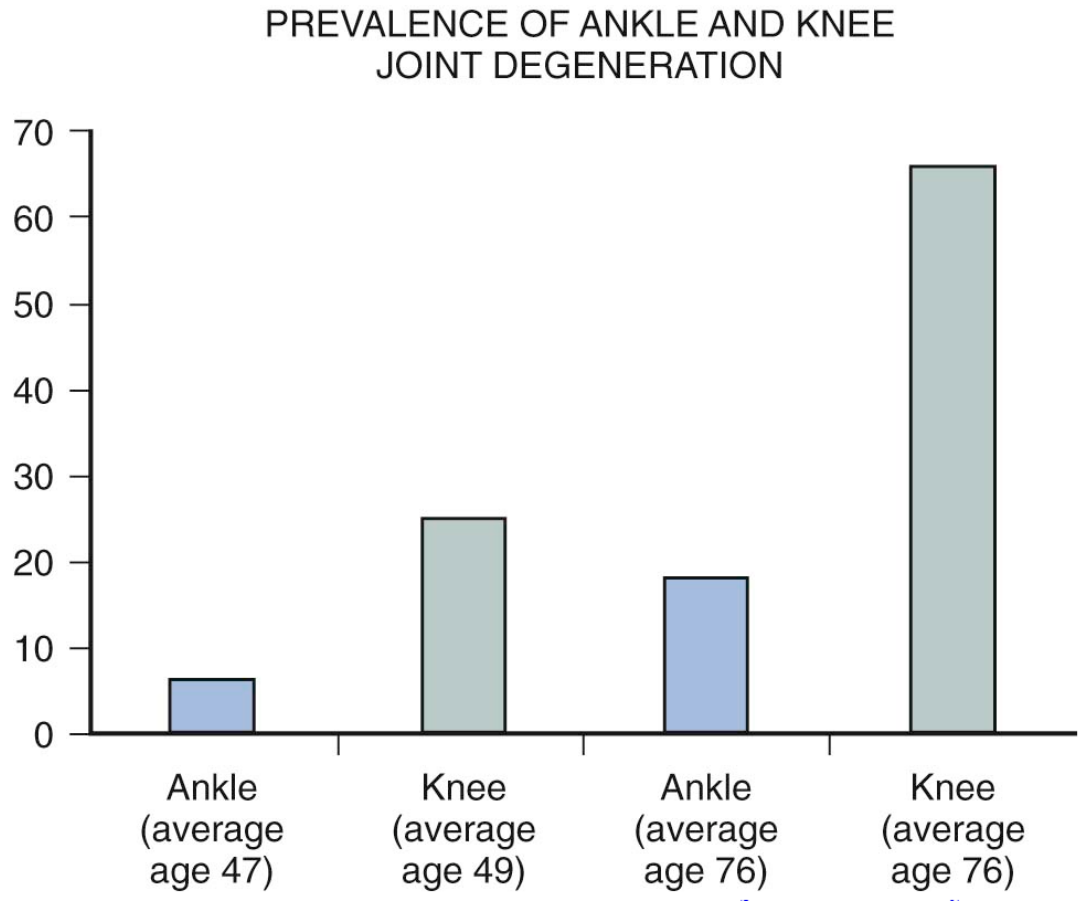
Coughlin MJ, Saltzman CL, Anderson RB. Mann'S Surgery of the Foot and Ankle 9th Ed. Philadelphia, PA. 2014.

Epidemiology

- Less common: 8-10x
  - 572K THA, 3.48 million TKA by 2030 (Kurtz S et al.; JBJS, 2007)
- Post-traumatic arthritis (70%)
  - Rotational ankle fractures (37%)
  - Ankle instability (28%)
- Rheumatoid arthritis (11%)
- Idiopathic (7%)

- Age of onset- 51 years



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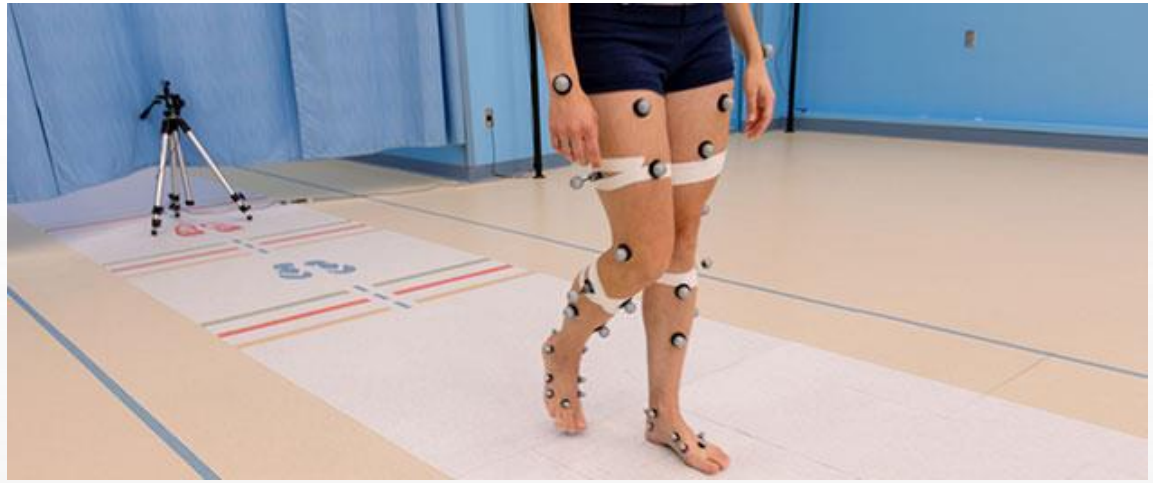
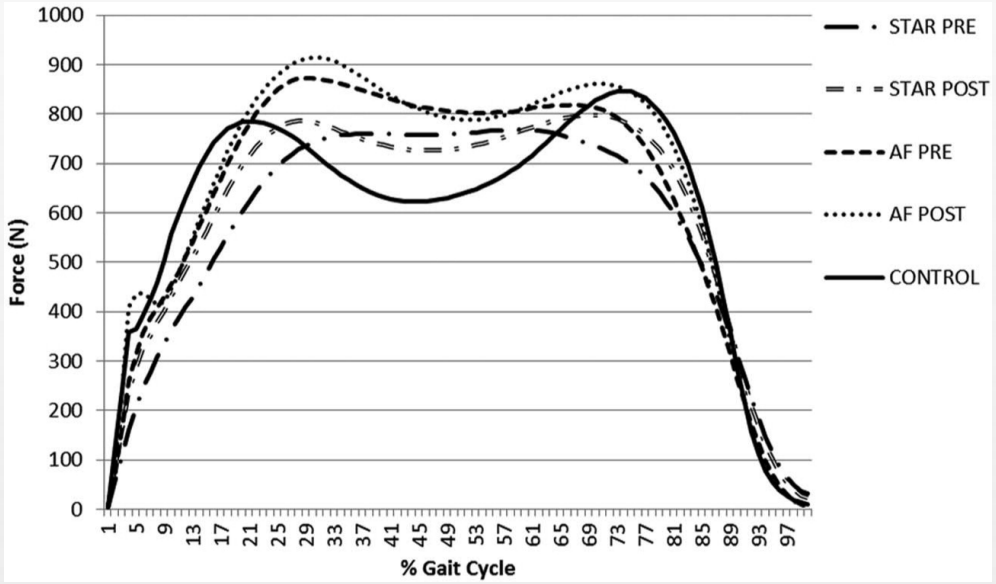
Saltzman CL, Salamon ML, Blanchard GM, et al. Epidemiology of ankle arthritis: report of a consecutive series of 639 patients from a tertiary orthopaedic center. Iowa Orthop J. 2005; 25:44–46.

Patient Impact

- SF-36 scores equivalent to end stage hip arthritis
  - 2 standard deviations below population norms
- Physical function in patients with ankle osteoarthritis is equivalent or worse than that of patients with end stage kidney disease, congestive heart failure, or cervical spine pain with radiculopathy
- Gait studies demonstrate reduced ankle motion, peak ankle power, peak power absorbed compared to contralateral limb
- Decreased stride length, decreased self selected gait velocity compared to population norms





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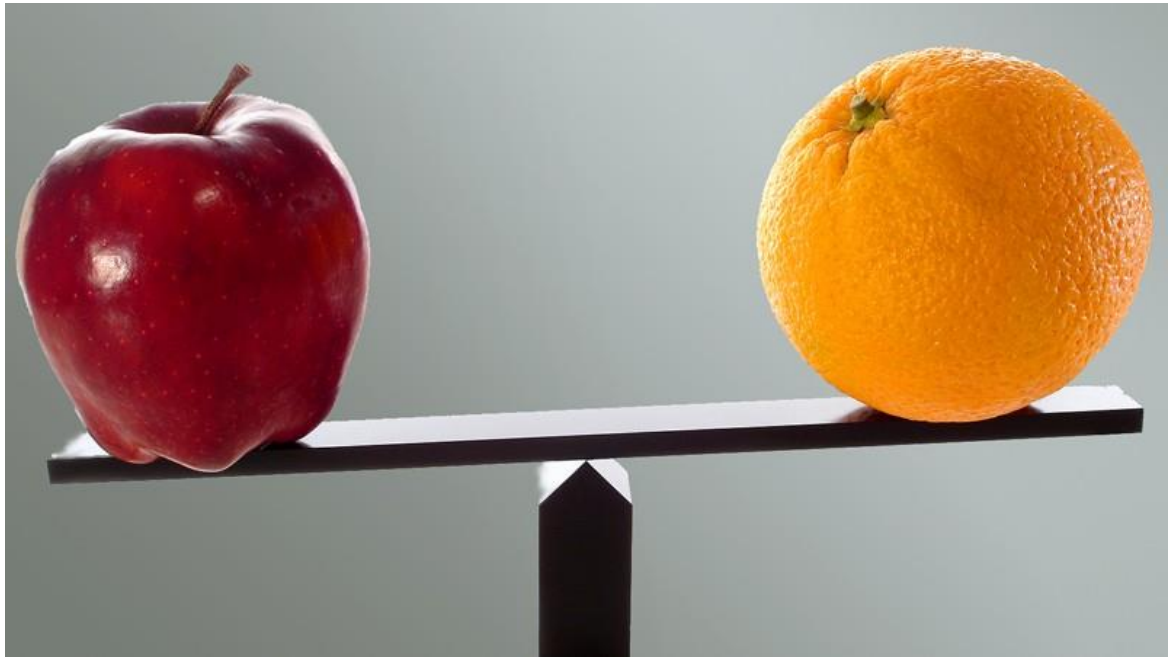
Glazebrook, M, Daniels, T, Younger, A, et al. Comparison of health-related quality of life between patients with end-stage ankle and hip arthrosis. J Bone Joint Surg Am. 2008; 90:499–505. PMID: 18310699

Flavin R, Coleman SC, Tenenbaum S, Brodsky JW. Comparison of gait after total ankle arthroplasty and ankle arthrodesis. Foot Ankle Int. 2013 Oct;34(10):1340-8. doi: 10.1177/1071100713490675. Epub 2013 May 13. PMID: 23669163.

Ankle arthritis is different

- Only 37% end stage ankle arthritis with normal alignment (Valderrabano, CORR 2008)
  - Major adjunct procedures required in 40% cases (Penner, AOFAS 2009)
- Patients affected at a younger age and impact on QoL spans a greater percentage of adult life



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Presentation

- History
  - Location of pain (ankle, hindfoot)
  - Types of activities (uphill, down inclines, uneven ground)
  - Relevant medical history (inflammatory arthropathy, DM, prior trauma)
  - Prior treatment and surgeries

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Exam

- Standing and seated exam
- Standing
  - Alignment
  - Gait
  - Mechanical axis (proximal deformity)
- Seated
  - Neurovascular exam
  - Prior surgical scars
  - Ankle stability
  - Strength and motion
- XR- foot and ankle, hindfoot alignment with deformity

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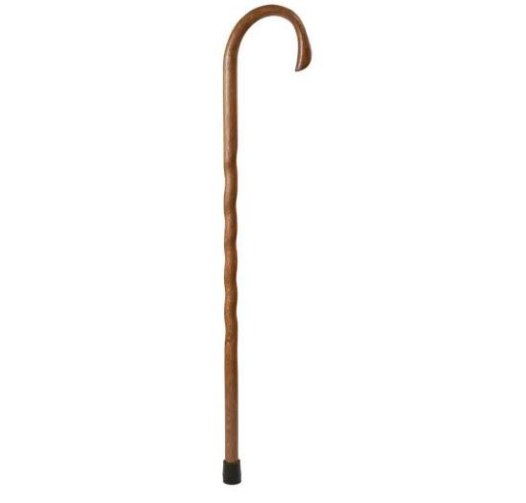
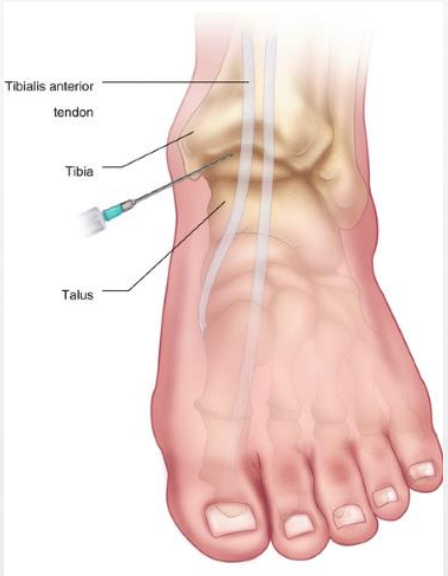
Treatment

- Non-operative
  - Activity modification
  - Assistive devices
  - NSAIDs
  - Injections (steroids, viscosupplementation, biologics)
  - Immobilization (OTC vs custom bracing)





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Treatment

- Operative
  - Ankle scope with debridement
  - Distraction arthroplasty
  - Ankle arthroplasty
  - Ankle arthrodesis

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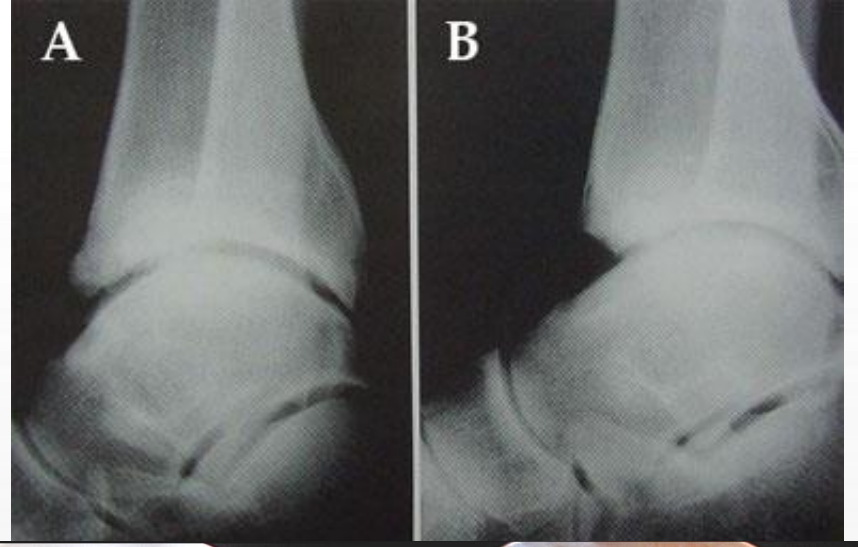
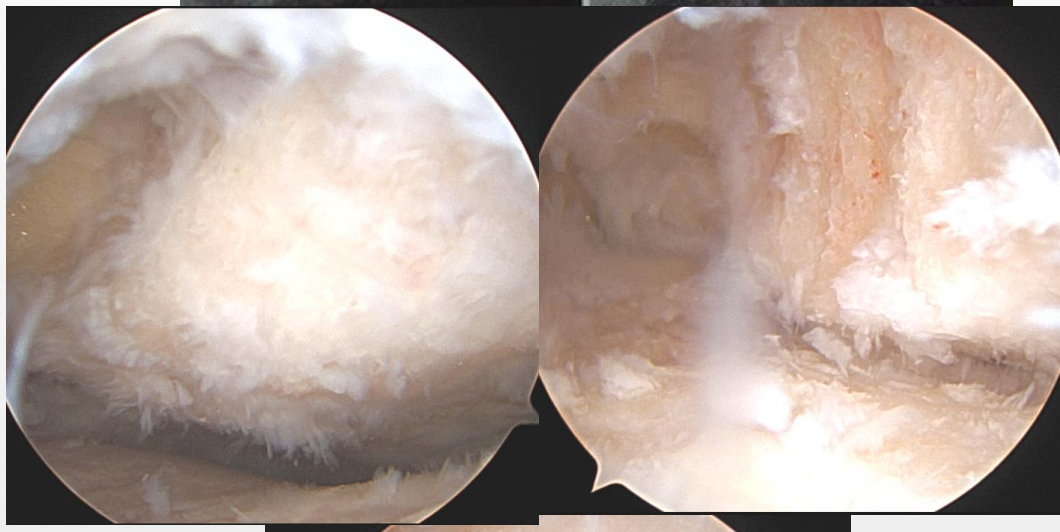
Ankle Scope Debridement

- Effective for anterior ankle impingement
- Document severity of arthritic change in the ankle (prognostic)
- Not long term treatment option if advanced arthritic change
  - 28% require major ankle surgery within 5 years (Hassouna et al, 2007)
  - Poor-fair results, only 62% satisfaction, in patients with arthritis vs 88% with primarily impingement symptoms (Ogilvie-Harris et al, 1993)





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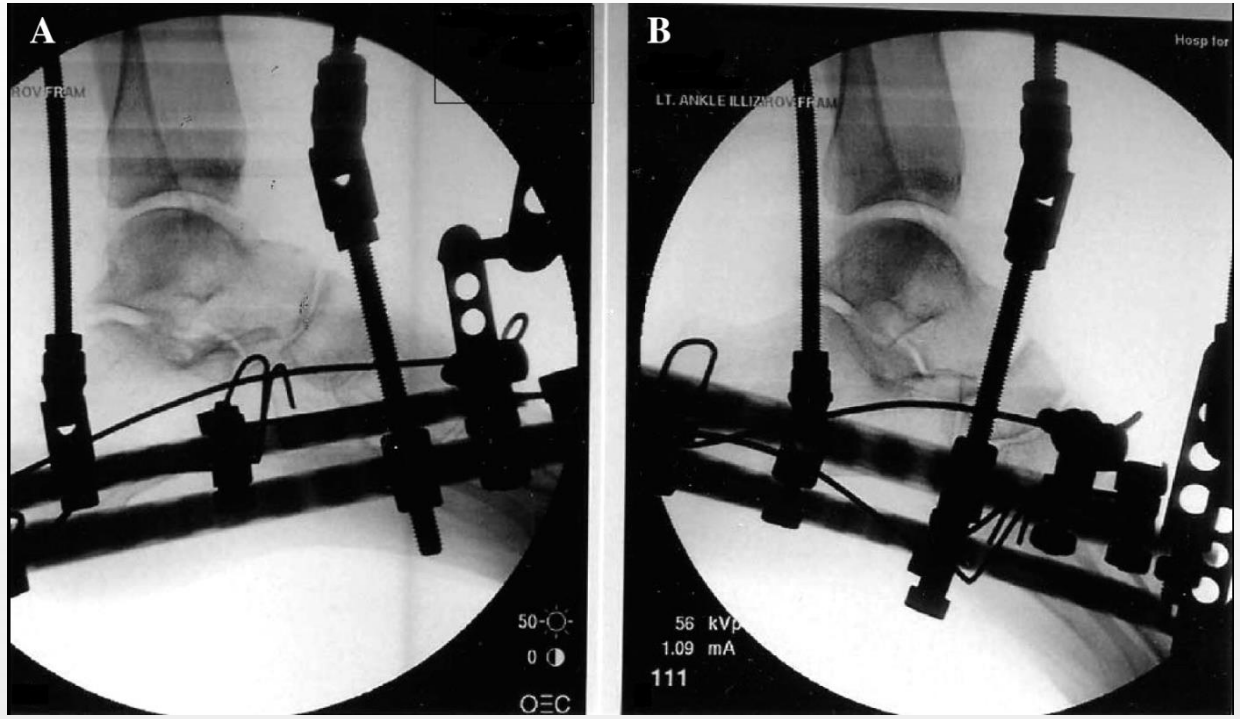
Distraction Arthroplasty

- Limited subset of patient
- Offload joint, allow some cartilage healing, scar formation
- Tellisi et al.
  - 21/25 patients with pain iprovements
  - AOFAS score 55 pre-op to 74 post-op
  - SF-36 scores modest improvement (pain and well being)



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Ankle Arthrodesis

- Historically gold standard for advanced ankle arthritis
  - Inversion and eversion of hindfoot not affected
  - Slight dorsiflexion/plantarflexion at transverse tarsal joints
- Excellent pain relief
- Risk of adjacent joint arthritis over time

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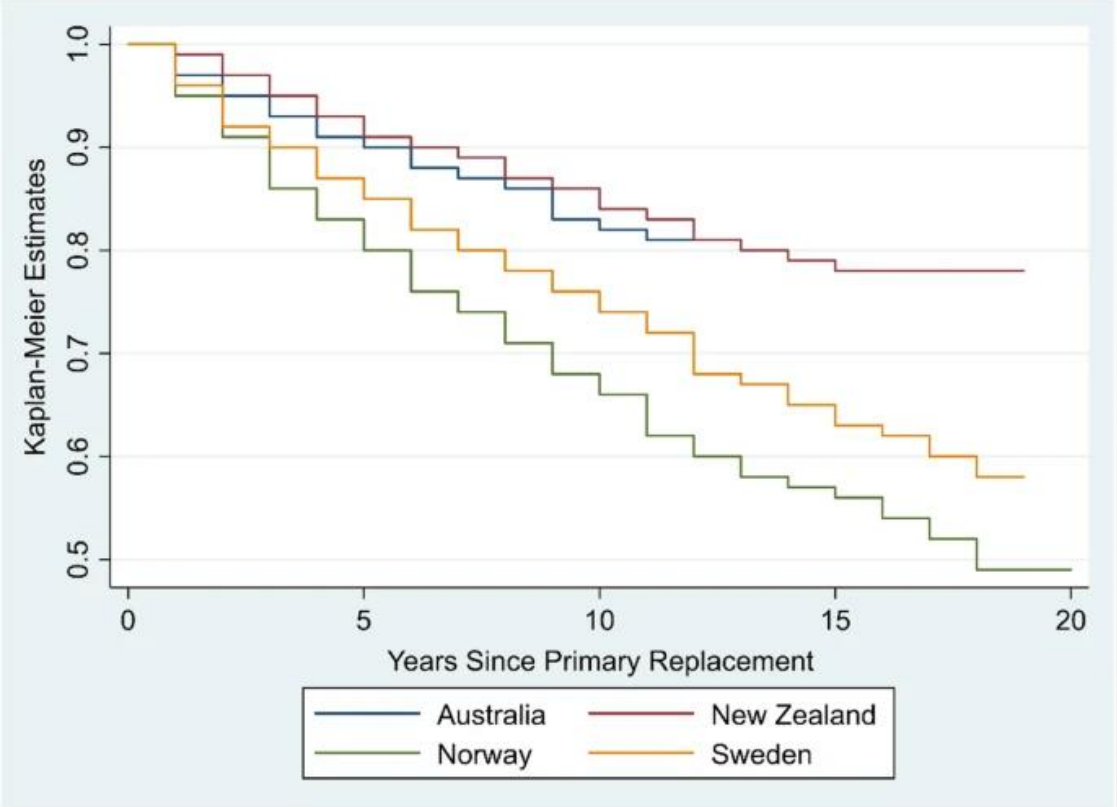
Ankle Arthroplasty

- Significant evolution in design and implant survival
- 10 year implant survival between 70 and 90%
- Re-operation free survival 70%
  - Return to OR for cyst grafting, gutter debridement, poly exchange



Perry, T.A., Silman, A., Culliford, D. *et al.* Survival of primary ankle replacements: data from global joint registries. *J Foot Ankle Res* **15**, 33 (2022)

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Ankle Arthrodesis vs Arthroplasty

- How does a standard change?

- What other major joints are treated with arthrodesis?

Prospective Controlled Trial of STAR Total Ankle Replacement Versus Ankle Fusion: Initial Results

Charles L. Saltzman, MD; Roger A. Mann, MD; Jeanette E. Ahrens, PhD; Annunziato Amendola, MD; Robert B. Anderson, MD; Gregory C. Berlet, MD; James W. Brodsky, MD; Loretta B. Chou, MD; Thomas O. Clanton, MD; Jonathan T. Deland, MD; James K. DeOrio, MD; Greg A. Horton, MD; Thomas H. Lee, MD; Jeffrey A. Mann, MD; James A. Nunley, MD; David B. Thordarson, MD; Arthur K. Walling, MD; Keith L. Wapner, MD; Michael J. Coughlin, MD

Boise, ID

FAI. 2009.

- Non-inferiority study, pivotal groups and then continued access
- Major complications and need for secondary procedures higher in arthroplasty subgroups
  - Decreased by half between initial and continued access group (learning curve)
- "On an individual subscale basis, ankle arthroplasty was equal or superior to fusion in all areas of efficacy evaluated"

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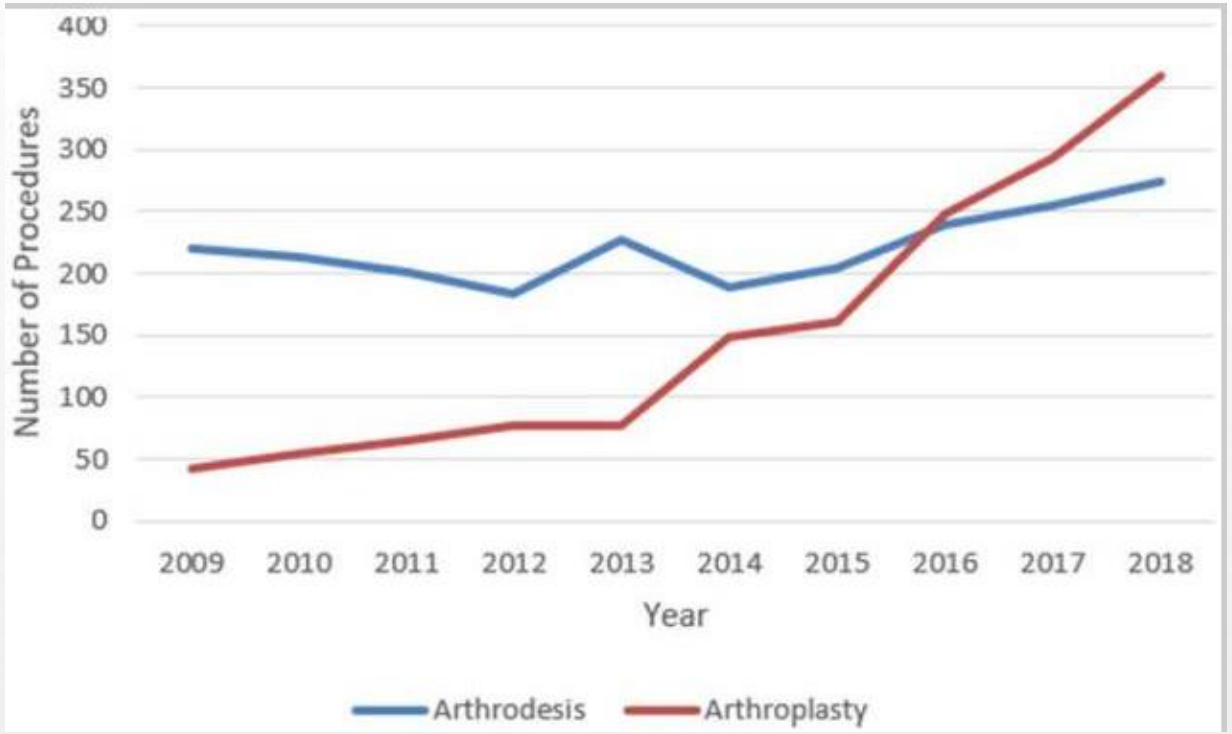
Ankle Arthroplasty vs Arthrodesis

- *BOTH treatments effective for decreasing pain and increasing function across multiple studies*
- Arthrodesis- risk of adjacent joint degeneration
  - Nonunion rates 7-43%
  - Adjacent joint arthritis
    - Radiographic in almost up to 90%
    - Meta-analysis show only 5-6% additional procedures
- Arthroplasty- increased need for subsequent procedures (revision arthroplasty, conversion, poly, grafting, impingement)
  - Implant survival 78% and 77% at 5 and 10 years (Haddad et al., JBJS 2007)
  - Revision 17% at 5.5 years vs 7% for ankle arthrodesis (Daniels et al, JBJS 2014)



Brodeur PG, Modest JM, Walsh DF, Hartnett DA, Gil JA, Cruz A, Hsu RY. Trends and Utilization of Ankle Arthroplasty vs Arthrodesis in the State of New York, 2009-2018. Foot Ankle Orthop. 2022 Nov 10;7(4). PMCID: PMC9660445.

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Ankle Arthroplasty vs Arthrodesis

- Outcomes
  - "TAA preserves more anatomic sagittal plane motion and provides greater pain relief and better patient perceived outcomes compared with ankle arthrodesis"
  - Pedowitz, JBJS 2016
- Gait and motion-TAR compared favorably to ankle arthrodesis
  - Faster walking speed
  - Increased forefoot sagittal plane motion, especially dorsiflexion
  - Increased hindfoot sagittal motion, dorsiflexion
  - Stronger ankle plantarflexion power

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Ankle Arthroplasty Gait

- How does gait hold up long term?
  - Significant sustained improvements in multiple gait parameters (cadence, step length, walking speed, sagittal plane motion, maximal plantarflexion) compared to pre-operative function

Functional Outcomes of Total Ankle Arthroplasty at a Mean Follow-up of 7.6 Years

A Prospective, 3-Dimensional Gait Analysis

James W. Brodsky, MD Daniel J. Scott, MD, MBA Samuel Ford, MD Scott Coleman, PhD Yahya Daoud, PhD

JBJS. 2021.

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Ankle Arthroplasty: What Changed?

- Significant evolution in implant design
  - Early implants with very high failure rates (approaching 50%)
  - Fixation across subtalar joint
- Fixed vs mobile bearing designs
- Intramedullary tibial fixation

Design Rationale for Total Ankle Arthroplasty Systems: An Update

Christopher E Gross [1], Ariel A Palanca, James K DeOrio

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Ankle Arthroplasty and the Future

- Patient selection expanding
  - Age
  - Deformity
  - Activity
  - BMI
  - Bone loss
  - "Very few undoable TARs" –W. Hodges Davis, MD
- Revision options and comfort with procedures improving
  - Salvage arthroplasty instead of arthrodesis

Risk Factors for Failure of Total Ankle Arthroplasty With a Minimum Five Years of Follow-up

Elizabeth A. Cody, MD[1], Lorena Bejarano-Pineda, MD[2], James R. Lachman, MD[1], Michel A. Taylor, MD, MSc, FRCSC[1], Elizabeth B. Gausden, MD, MPH[3], James K. DeOrio, MD[4], Mark E. Easley, MD[4], and James A. Nunley II, MD[4]

FAI. 2019.

- 533 total ankles, average 7 years- 6.4% failure rate
- Variables assessed: Age, gender, BMI, smoking, diabetes, indication for TAR, implant, tourniquet time, coronal and sagittal deformity, ipsilateral hindfoot fusion
- Only ipsilateral hindfoot fusion and Inbone I associated with failure

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Ankle Arthroplasty and BMI

- BMI >40 typically cut off
- Kim et al.- stratified by BMI class
  - 18.5-24.9, 25-34.9, >35
  - No association with increased complications
  - Increased BMI reported worse MSK function and QoL (SMFA, SF-36) but no difference in PROs
- Gross et al.
  - No difference in complications, infection, failure rates
  - TAR had lower functional scores, but demonstrated significant improvement compared to pre-operative levels

Total Ankle Arthroplasty: Does Obesity Matter?

Billy I. Kim, BA[1], Albert T. Anastasio, MD[1], Colleen M. Wixted, BS, MBA[1], James K. DeOrio, MD[1], James A. Nunley II, MD[1], Mark E. Easley, MD[1], and Samuel B. Adams Jr, MD[1]

The Effect of Obesity on Functional Outcomes and Complications in Total Ankle Arthroplasty

Christopher E. Gross, MD[1], Alexander Lampley, MD[2], Cynthia L. Green, PhD[3], James K. DeOrio, MD[2], Mark Easley, MD[2], Samuel Adams, MD[2], and James A. Nunley, II, MD[2]

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Ankle Arthroplasty and Coronal Plane Deformity

- Historically, <10 degree coronal plane deformity → TAR
- Lee et al.
  - 148 ankles, mean 74 mos
  - No difference in complication rates, implant survival, AOFAS, AOS, VAS, SF36
- Johnson et al.
  - Significant improvement with both groups, slightly better without pre-operative deformity
  - No difference between the arthrodesis and arthroplasty groups

J Bone Joint Surg Am. 2019 Dec 18;101(24):2203-2211. doi: 10.2106/JBJS.19.00416.

Outcomes of Total Ankle Arthroplasty in Ankles with >20° of Coronal Plane Deformity

Gun-Woo Lee [1], Keun-Bae Lee [1]

The Impact of Coronal Plane Deformity on Ankle Arthrodesis and Arthroplasty

Michael D Johnson [1], Jane B Shofer [2], Sigvard T Hansen Jr [2], William R Ledoux [2], Bruce J Sangeorzan [2]

Addressing varus and valgus deformity of the ankle: Algorithmic approach to total ankle arthroplasty

Helene R Cook [1], Collin Messerly [2], Garret Strand [3], Jason Nowak [4]

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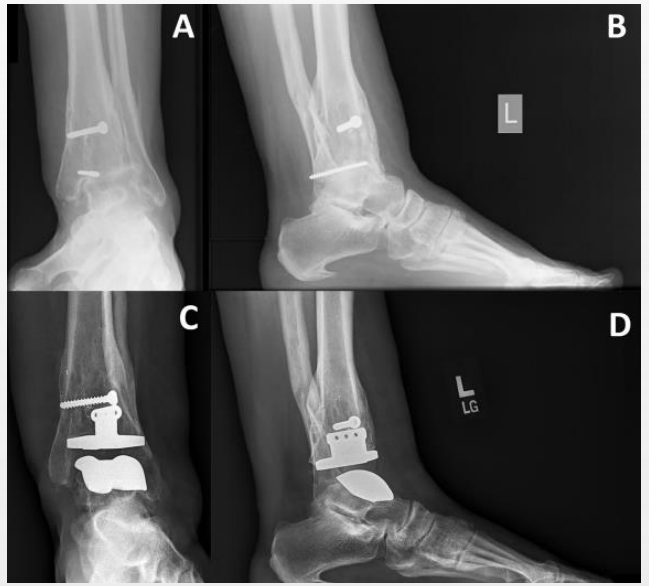
Ankle Arthroplasty- Fusion Takedown

- Primary indication- painful, nonunited or malunited ankle arthrodesis
- Small series' showing promising results
  - AAOS OVT 2021 Video (link below)
  - 21 successful conversions, step-by-step procedure

Takedown of Ankle Fusions and Conversion to Total Ankle Replacements

Anna L. Lundeen, MS, ATC[1], Fernando C. Raduan, MD[2], Rebecca Stone McGaver, MS, ATC[2], Kayla J. Seiffert, BA[2], Jacquelyn E. Fritz, BS[2], M. Russell Giveans, PhD[2], and J. Chris Coetzee, MD[2]



- 51 conversions
- Improvement in VR-12, VAS, AOS disability and pain scores
- "Highly satisfactory outcome at average of 4.2 years"

Fusion Takedown Total Ankle Arthroplasty Surgical Technique

Timothy Rudolf Daniels, MD, FRCSC | Shahin Kayum, MD | Ryan Khan | Sahil Kooner, MD | Andrew Marsh, MD

https://www.aaos.org/videos/video-detail-page/23260__Videos#:~:text=Fusion%20takedown%20total%20ankle%20arthroplasty%20may%20result%20in%20improved%20pain,scores%2C%20and%20range%20of%20motion.&text=We%20have%20used%20this%20technique,takedown%20total%20ankle%20arthroplasty%20procedures.

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Ankle Arthroplasty- Total Talus

- AVN of the talus difficult to manage
  - Ankle arthritis with talar collapse?
  - Nonunion rate 18% with avascular talus (Gross et al, 2014)

Total Ankle Total Talus Replacement Using a 3D Printed Talus Component: A Case Report

Craig C Akoh [1], Jie Chen [2], Samuel B Adams [3] JFAS. 2020.

Combined Total Talus Replacement and Total Ankle Arthroplasty

Lorena Bejarano-Pineda [1], James K DeOrio [1], Selene G Parekh [1] JS Ort Adv. 2020.

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https://www.ortho.ufl.edu/news/2023/07/06/dr-toussaint-uses-3d-printing-technology-total-talus-and-ankle-replacement-surgery

Revision Ankle Arthroplasty

- Revision TAA failure rate of 26.9%
  - Increased in cases of periprosthetic joint infection
- Conversion to arthrodesis failure 13%
  - Nonunion rate, bone loss

- Revision arthroplasty can be an effective procedure, but has considerable risks of failure and reoperation, particularly in the setting of infection

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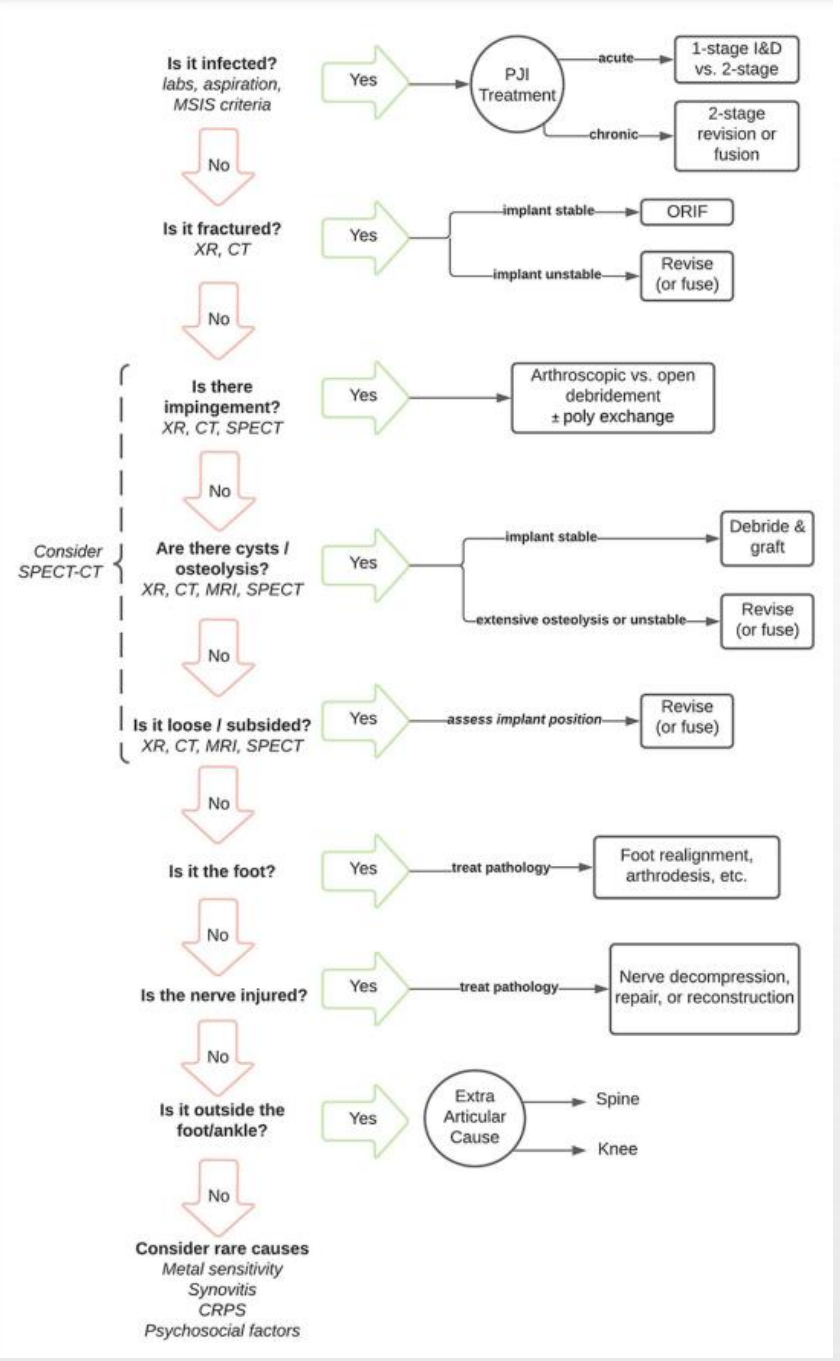
Evaluating the painful TAR

Evaluating and Managing the Painful Total Ankle Replacement

Jensen K. Henry, MD[1], Carson Rider, MD[1], Elizabeth Cody, MD[1], Scott J. Ellis, MD[1], and Constantine Demetracopoulos, MD[1]

FAI. 2021.

- As prevalence of TAR increases, so does the likelihood of encountering complications, need for additional procedures
- Stepwise approach to workup and management



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Ankle Arthroplasty- Patient Selection

- Age- candid conversation about re-operation risks
- Deformity- increased complexity (stemmed implant, ligament balancing and reconstruction, staging procedures)
- Pre-operative planning
  - Weight bearing CT
  - Patient specific cutting guides

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Ankle Arthroplasty vs Arthrodesis- Return to Sport

- Participation in sports improved greater than 10% after treatment with TAR (41%→59%)
- Remained high after treatment with ankle arthrodesis (73%→70%)
- Most common sports swimming, hiking, cycling and skiing
- High impact sports- tennis, soccer, running- consistently limited after either treatment

Frequent	Unclear	Limited
Cycling	Skiing (downhill and cross-country)	Tennis
Dancing	Snowboarding	Running
Hiking	Gymnastics	Basketball
Swimming		Soccer
Golf		Hockey
		Rugby
		Mountain Biking

Johns WL, Sowers CB, Walley KC, et al. Return to Sports and Activity After Total Ankle Arthroplasty and Arthrodesis: A Systematic Review. *Foot & Ankle International*. 2020;41(8):916-929

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Take Home

- Ankle arthritis is different
  - Younger, active, post-traumatic
- Impact on QoL is significant
- Gold standard has been ankle arthrodesis, though treatment strategy evolving and TAR becoming possible for more patients

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