

3D Printing For Foot and Ankle Limb Salvage



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Disclosures



- Consulting fees from Arthrex, Inc
 - Minimally invasive foot and ankle surgery
- No conflicts with this presentation

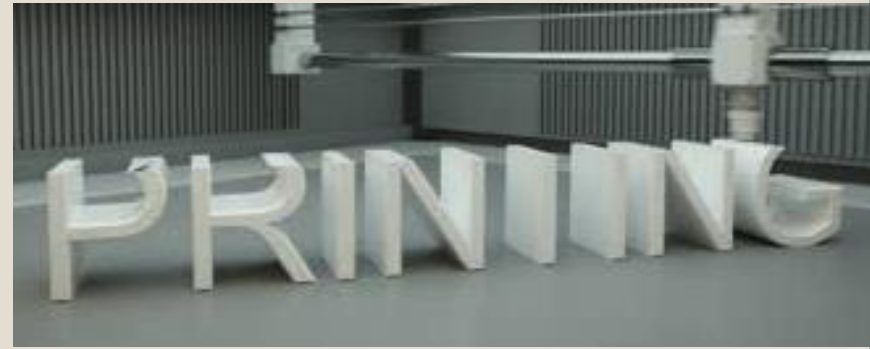
What is 3D Printing



- Many names
 - 3D Printing
 - Rapid Prototyping
 - Stereolithography
- Additive Manufacturing
 - Process of creating an object by printing successive layers

VS

- Traditional Manufacturing
 - Casting, molding, forging, etc



What now?



Case 1: Talar Extrusion



- 20 yo female
- MVC
 - Restrained passenger vs car
- Talar body extrusion
 - Not recovered at scene
- I&D, ex-fix, antibiotic spacer



Case 1: Talar Extrusion



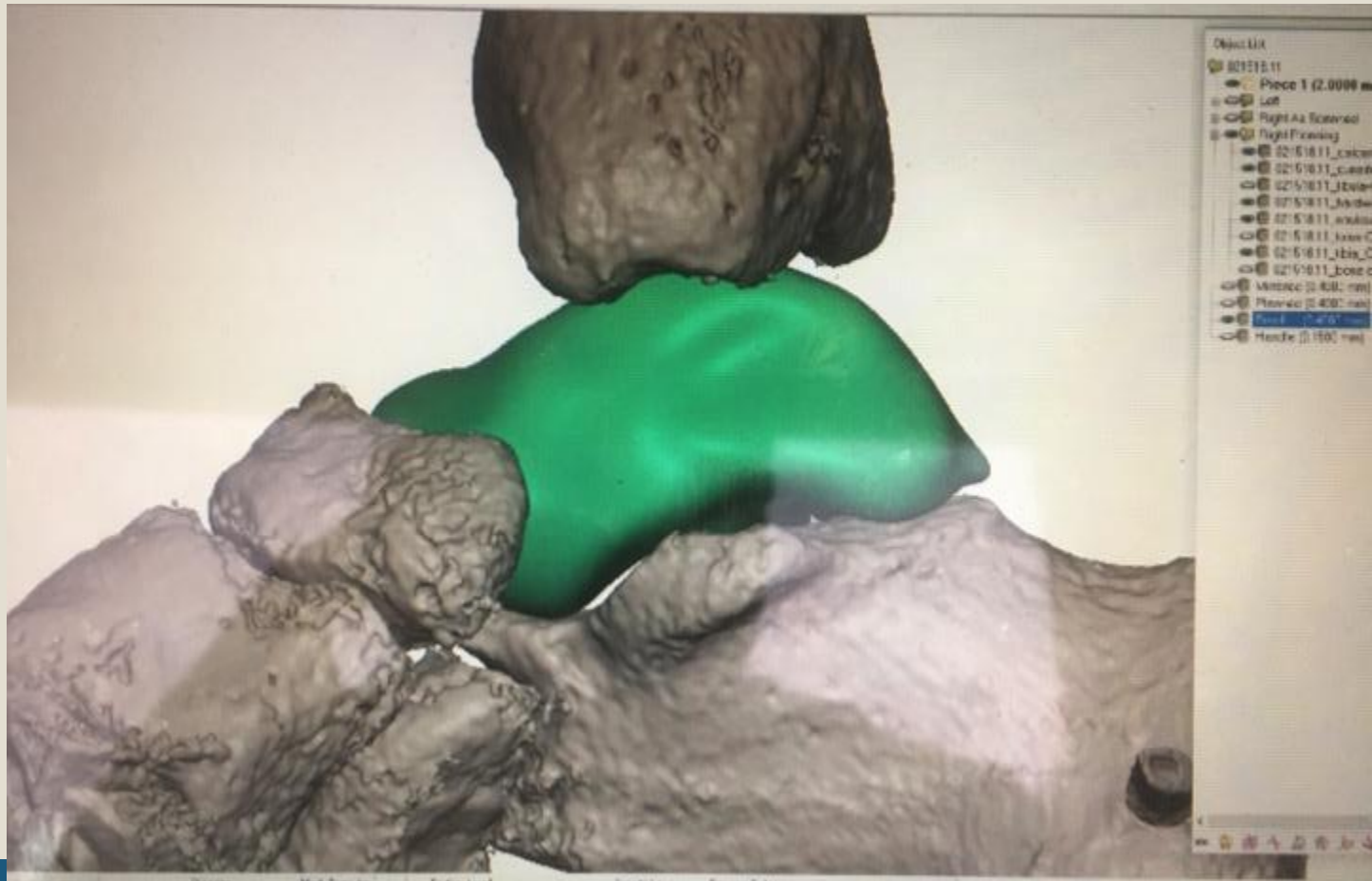
- Offered bulk allograft fusion
 - Concerned about function after pantalar fusion
- Presented to me 2 months later
- No signs of infection
 - Exam, labs and aspiration all negative
 - Pin holiday 3 weeks
 - Bilateral CT Scan

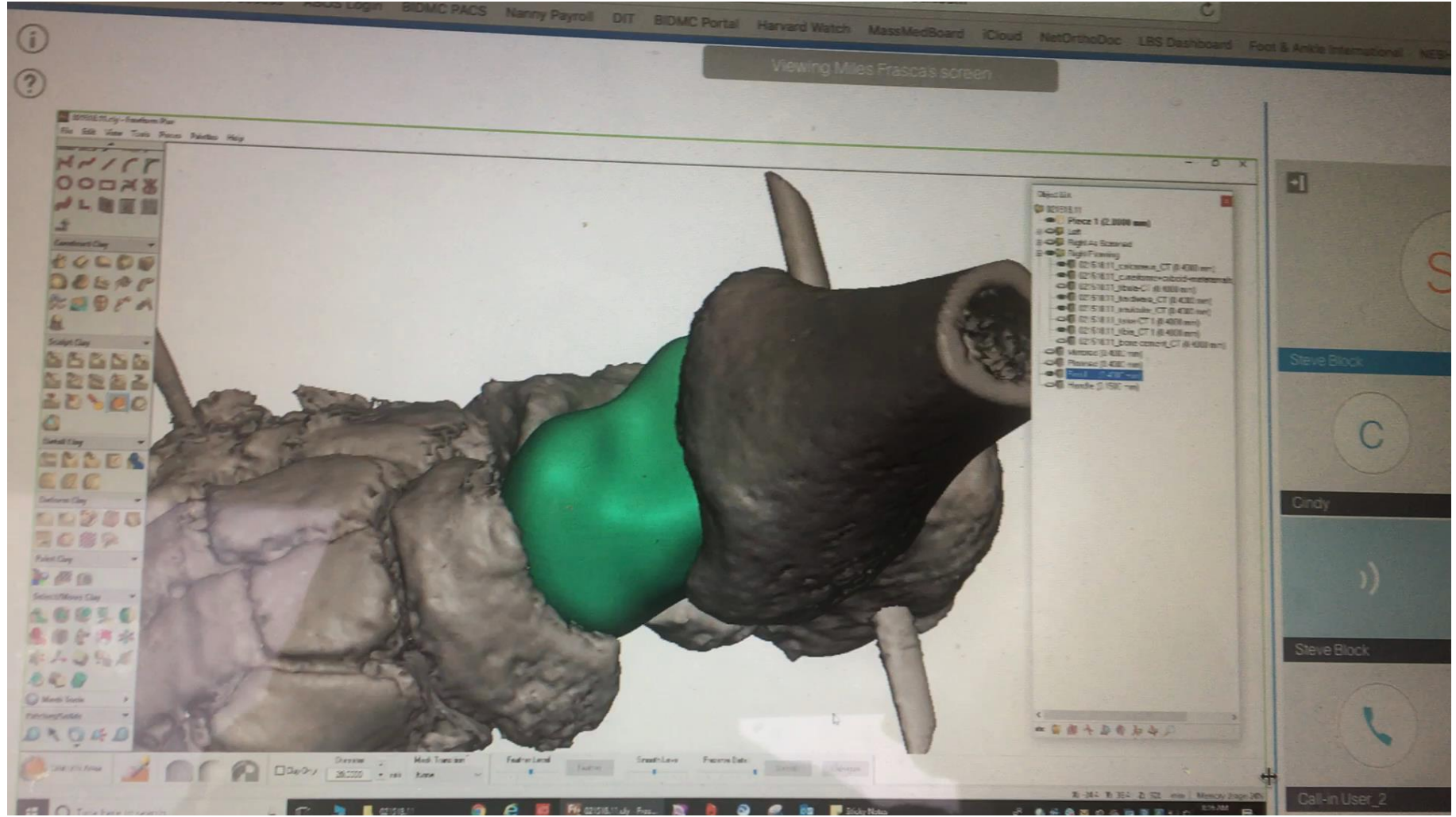


Case 1: Talar Extrusion



- Plan for 3D printed metal talus







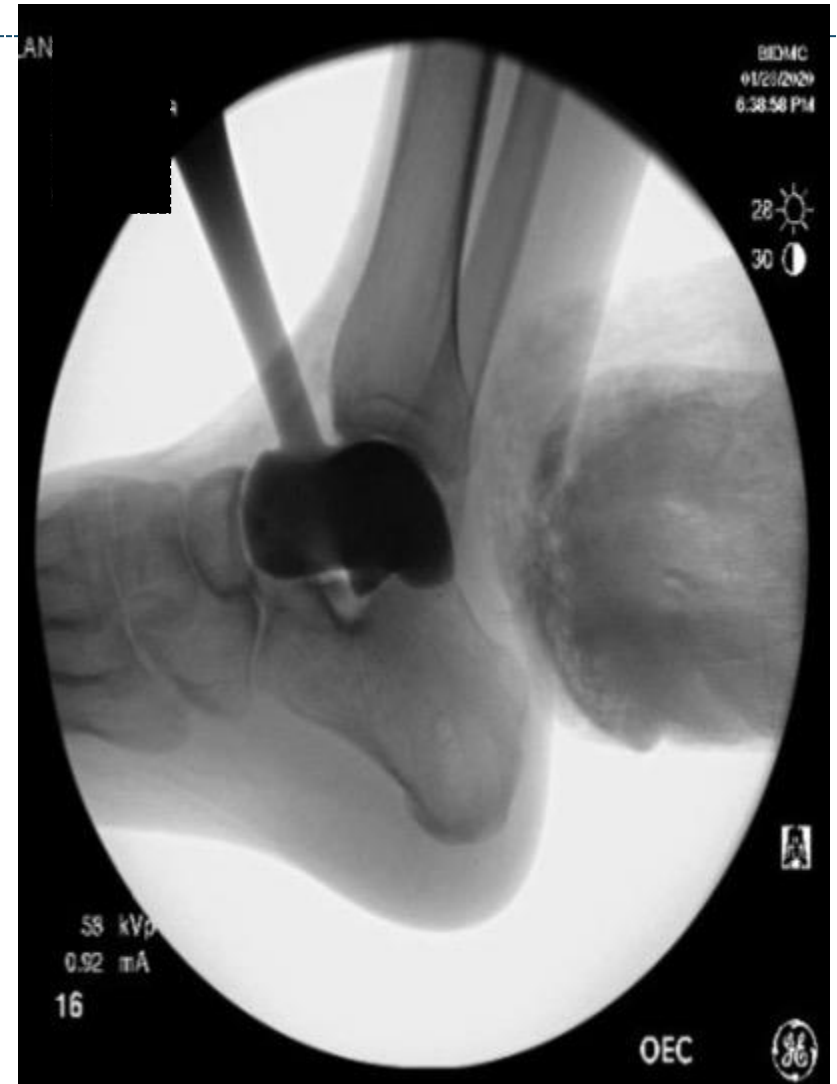
Intra-Op



Intra-Op



Intra-Op



Post-Op: 2 years



Post-op



- Returned to work as security guard
- Able to walk comfortably
- Can run short distances
- 1/10 pain at end of day
- ~30 degrees total ankle ROM






3D Printed Talus



- 27 Patients with AVN
- Mean f/u 22.2 months
 - VAS 7 -> 3.9
 - Ankle ROM maintained
 - FAOS scores improved on all measures
 - One amputation



3D Printed Total Talus Replacement for Avascular Necrosis of the Talus

Rishin J. Kadakia, MD¹ , Craig C. Akoh, MD¹ , Jie Chen, MD¹,
Akhil Sharma, BS¹ , and Selene G. Parekh, MD, MBA¹

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Mid term outcomes?



- 3-8 year outcomes
- Custom ceramic total talus case series from Japan
- 55 ankles
 - JSSF Ankle-Hindfoot score improved from 42 to 89
 - No revisions
 - No amputations



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An Alumina Ceramic Total Talar Prosthesis for Osteonecrosis of the Talus

Akira Taniguchi, MD, PhD, Yoshinori Takakura, MD, PhD, Yasuhito Tanaka, MD, PhD, Hiroaki Kurokawa, MD, Kiyonori Tomiwa, MD, Takenori Matsuda, MD, Tsukasa Kumai, MD, PhD, and Kazuya Sugimoto, MD, PhD

Investigation performed at the Department of Orthopaedic Surgery, Nara Medical University, Nara, Japan

Long term outcomes



- 10-36 year follow up from Thailand
- 28/33 prostheses still in place
- Median AOFAS HF scores
 - 78 (mean, 75; range, 66 to 83)



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The Talar Body Prosthesis: Results at Ten to Thirty-six Years of Follow-up

Thos Hamroongroj, MD, and Thossart Harnroongroj, MD

Investigation performed at the Department of Orthopaedic Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand

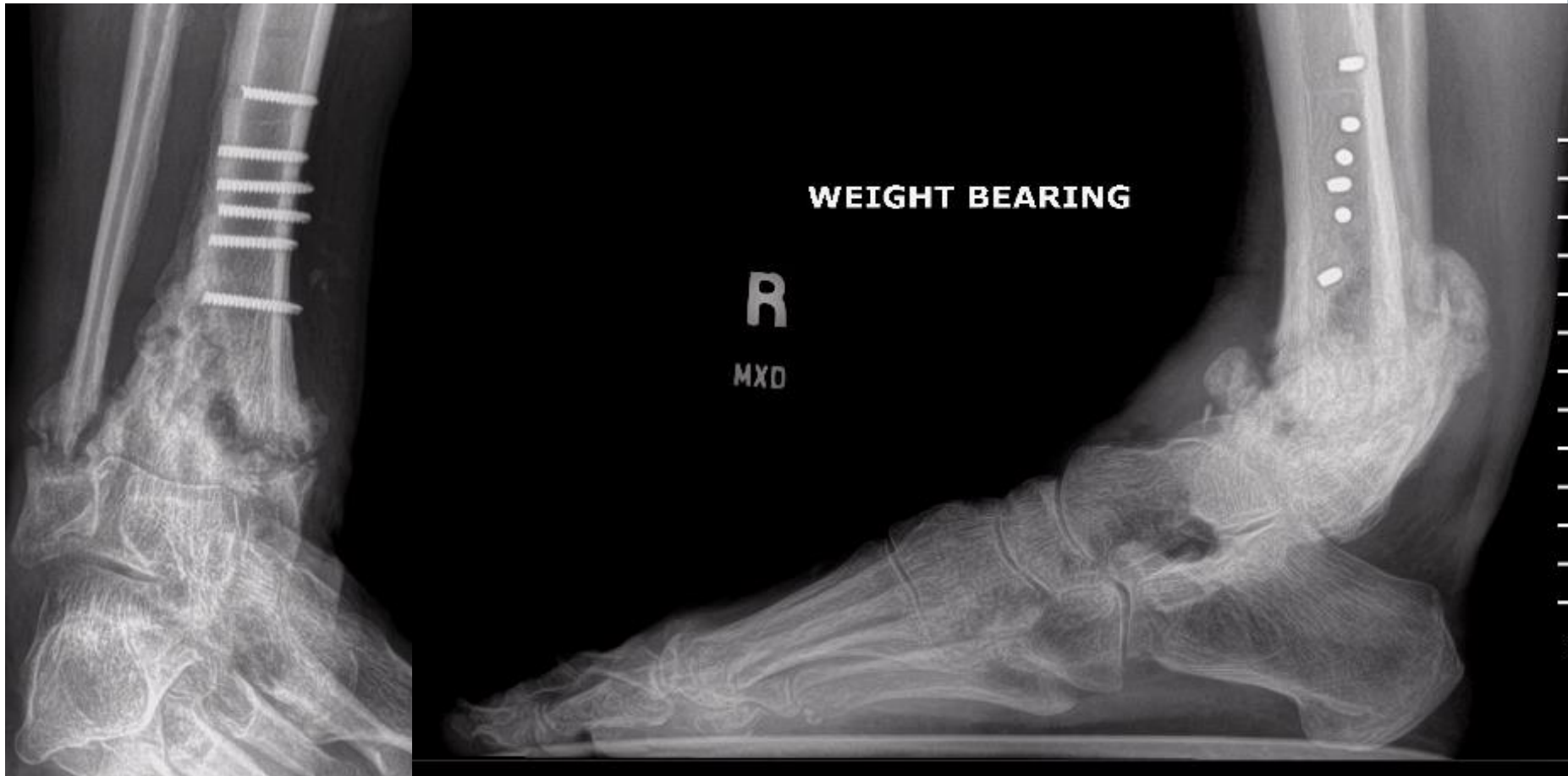
Case 2: Distal Tibial Nonunion



- 58 yo Female RN
- HTN, well controlled diabetes (A1c 5.4)
- Pilon fracture
 - Initial ex-fix and staged ORIF
- Nonunion and hardware failure
- Removal of hardware
- Progressive deformity and pain



Case 2: Distal Tibial Nonunion



Initial Work Up



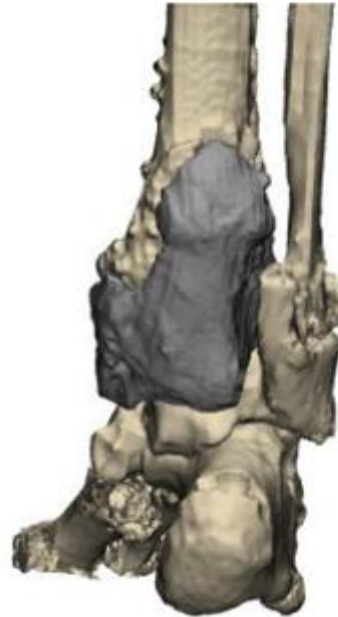
- Labs/ESR/CRP all normal
- Open biopsy
 - Likely AVN of distal tibia
 - Cultures all no growth
- Offered amputation by two surgeons
- Bone transport to fusion?
 - Poorly tolerated frame



Case 2: Distal Tibial Replacement/TTC

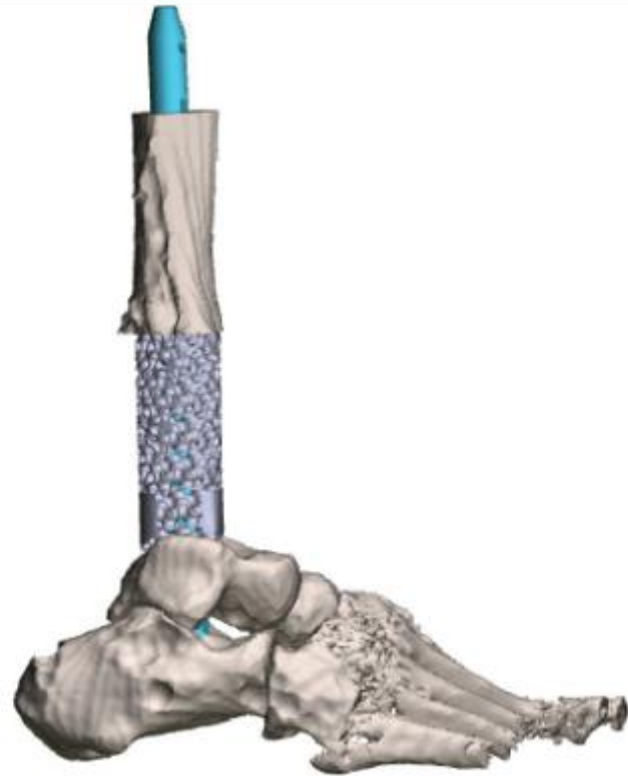


Preoperative Anatomy





Proposed Nominal Implant



Intra-Op



Intra-Op



Intra-Op



Intra-Op



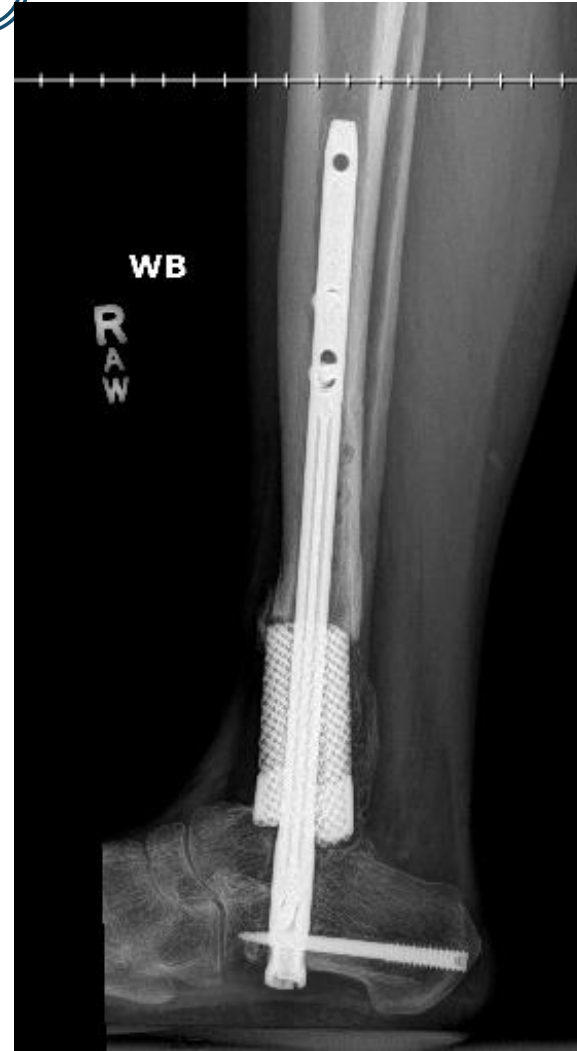
Intra-Op



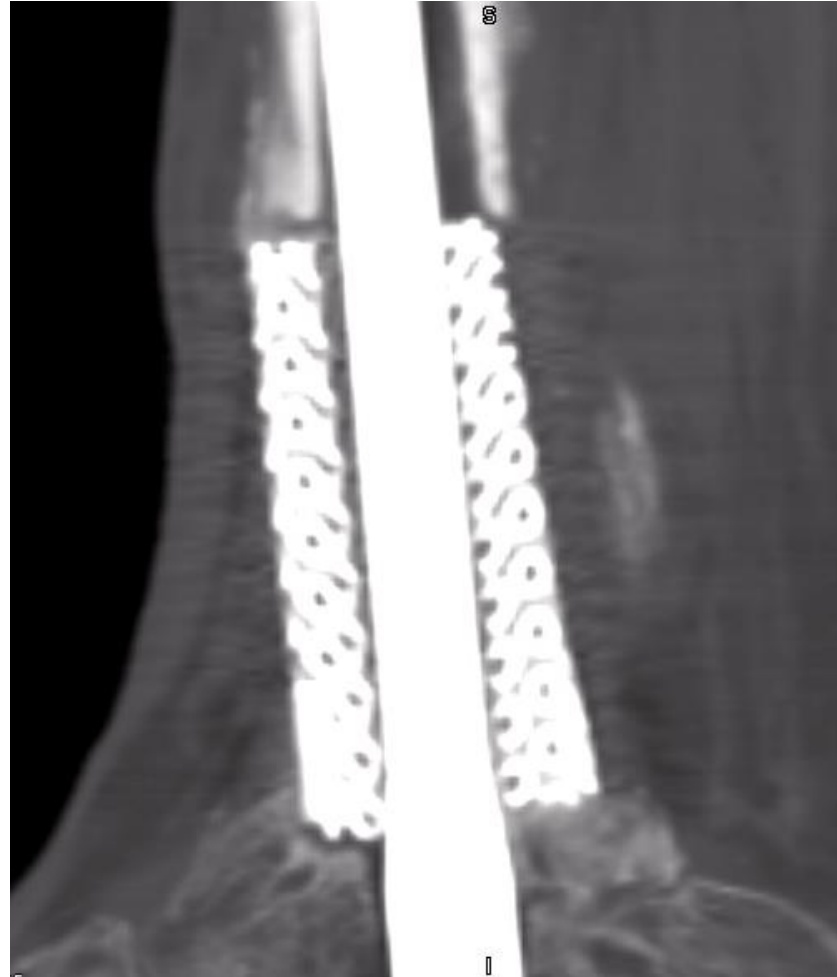
Post-Op



Post-Op: 1 Year



Post-Op CT Scan



Post-Op



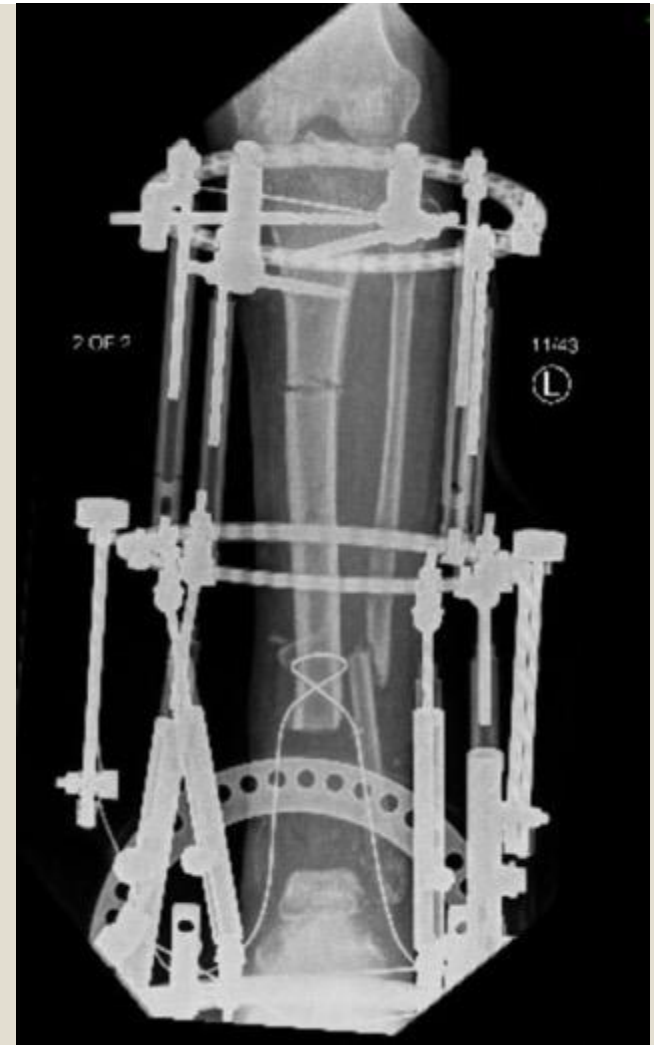
- Returned to work as RN
- Rocker bottom shoes
- Walking pain free for first time in 2 years



Critical Bone Defect Salvage



- Disclosure: I am NOT a frame guy
- Cable transport to fusion?
- Masquelet?



Benefits



- Single procedure
- Better structural qualities than bulk allograft
- Better healing?
 - 100% nonunion for bulk allograft TTC fusions in diabetics
 - ✦ Jeng CL FAI 2013 and Berlet G FAI 2014



Outcomes



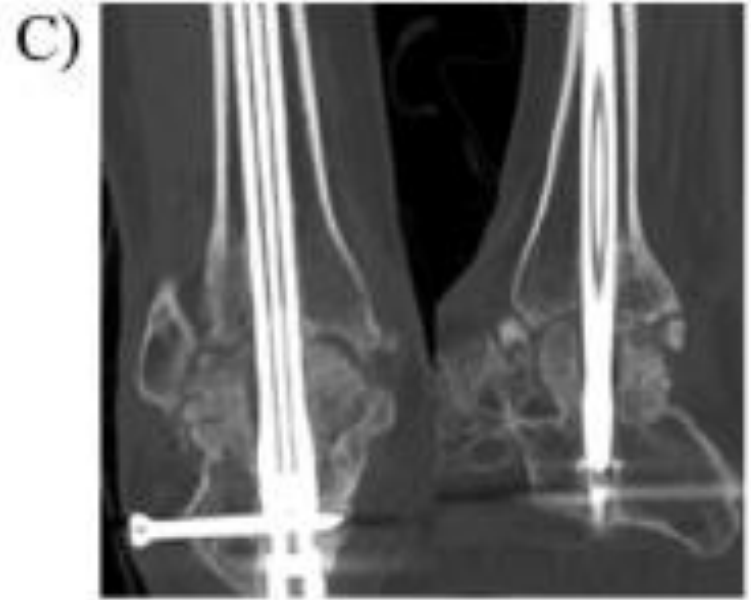
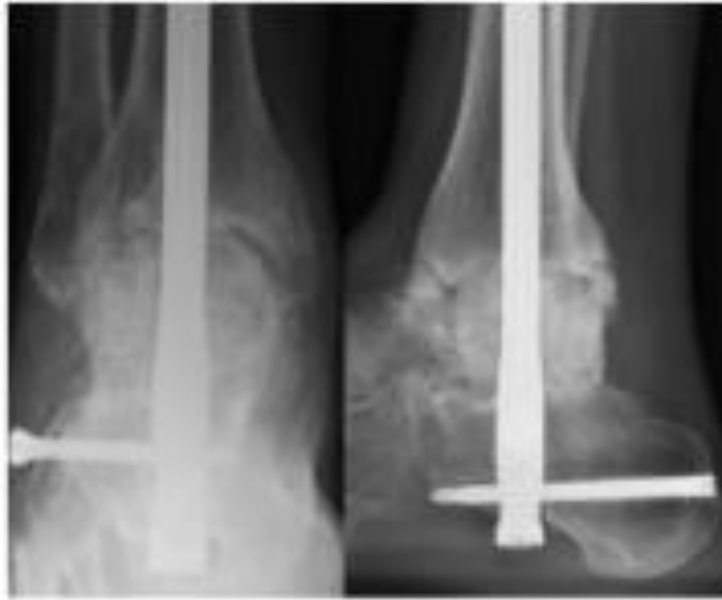
- 85% fusion rate with titanium printed metal cages
- Dekker et al FAI 2018
 - 13/15 patients with fusion on CT
 - 2/15 amputation



Outcomes



- **Steele et al JFAS 2020:**
 - 92% vs 62% fusion rates
 - Titanium cage vs allograft femoral head

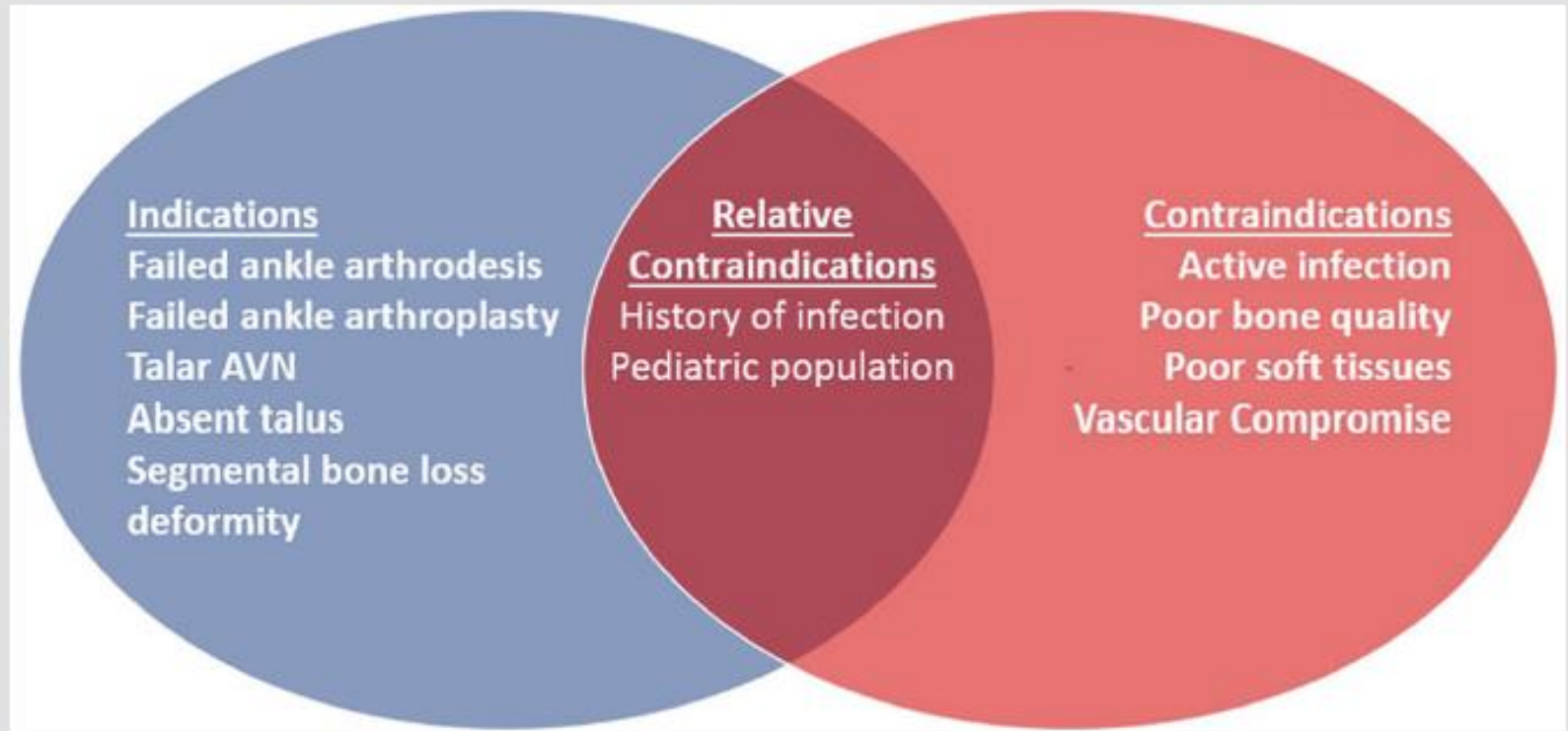


Who is a Candidate?



Figure 2.

Indications/contraindications for custom 3D-printed implants. AVN, avascular necrosis.



Final Thoughts



- Limited by your imagination
- Multiple companies
 - Restor3d
 - Additive Orthopaedics
 - 4-web
- Salvage procedures
- Best out of a lot of bad options?



Thank you

