

**Total Ankle Replacement**  
**Lauren McLaughlin-Kelly**

**Background:** When the Tibiotalar joint begins to wear away, ankle inflammation, pain, and joint swelling occur. To get rid of the inflammation and pain, which are usually caused by Arthritis/Osteoarthritis, an ankle replacement needs to be done. There are other options available but an ankle replacement is the best option for patients with severe Arthritis. Patients who have suffered from deformed/unstable ankles, bone infections, diabetes, obesity, severe osteoporosis, and other comorbidities, do not typically qualify for an ankle replacement. When the Tibiotalar joint is replaced it reaps many benefits, such as: regained ankle strength and stability, preserved range of motion, normal gait with less pain, and allows patients to return to a more active lifestyle. An ankle replacement is better than Arthrodesis (Ankle Fusion) because Arthrodesis limits the range of motion and can cause Arthritis to develop elsewhere.

**Current Status:** An ankle replacement is made up of three components. First, a titanium metal component that's attached to the Tibia, which replaces the socket of the ankle. Then a cobalt-chrome piece which is connected to the Talus, which replaces the top of the Talus. Finally, a polyethylene implant that is placed between the Tibia and Talus, which provides the bearing surface. Patients with a nickel allergy can receive an all titanium implant instead. The metal components are fixed into the bone with stems or pegs and have a special coating to persuade the bone to grow into them.

**Challenges:** Ankle replacement surgeries have risks such as: infection, damage to nearby nerves, bleeding, blood clot, the bones not joining together properly, misalignment of the bones, new Arthritis in neighboring joints, loosening of the artificial components due to osteolysis, and wearing out of the components. Infection is the leading cause of revision surgery, which often requires multiple surgeries to fix. Joint infections are difficult to treat because the bacteria adhere to the biomaterial and cannot be eliminated without removing the implant. The bacteria also have a high antibiotic resistance, which eventually leads to the formation of biofilm. Osteolysis is a condition where the bone is steadily destroyed, causing the bone to weaken over time and eventually causes the implant to loosen. Periprosthetic Osteolysis affects patients who've recently had a joint replacement, which can potentially lead to a follow-up surgery.

**Proposed Solutions:** The first proposed solution for infection is to use the metallic implant as an electrode to provide voltage controlled electrical stimulations. This helps to destroy infections without removing the implant, helps to prevent infections, and has the ability to enhance bone ingrowth of the implant, also known as osseointegration. Another proposed solution is to use

ultrasound therapy to kill the biofilm on the implant. This enhances the activity of the antibiotics, is minimally invasive, and the implant infected with biofilm can be directly targeted. The final proposed solution for infection is to use an implant that's coated in antibiotics. This prevents the formation of a biofilm and specifically targets the infected implant. Some proposed solutions for osteolysis are: have the patient take antiresorptive drugs to prevent osteolysis, coat the implant with antiresorptive drugs to directly prevent osteolysis, and coat the implant with hydroxyapatite, which can help regenerate bone and reduce implant rejection or failure. Overall it would be beneficial to use an implant that's coated in antibiotic and antiresorptive drugs, along with using ultrasound or the implant as an electrode. This prevents infection and loosening of the bones, specifically targets the implant site, and can potentially enhance the antibiotic drugs.

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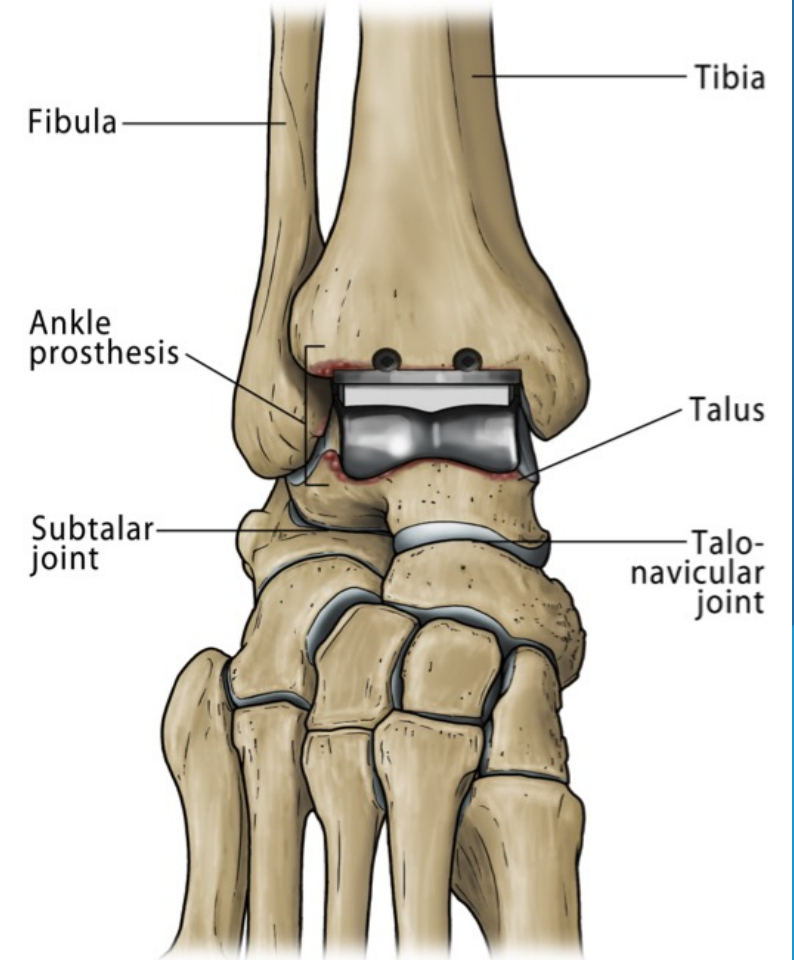
# Ankle Joint Replacement

Lauren McLaughlin-Kelly



# What is an ankle joint replacement?

- ▶ Tibiotalar Joint consists of the Tibia and the Talus
- ▶ When cartilage on the bone surface wears away it causes inflammation, pain, and joint swelling
- ▶ The damaged parts of the joint are removed and replaced with metal joints, with a piece of plastic between the metal joints
- ▶ The metal parts are fixed into the bone via pegs or stems, and have a special coating to urge the bone to grow into them



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# Why do people need an ankle joint replacement?

- ▶ To get rid of the inflammation and pain
  - ▶ typically caused by Osteoarthritis, Rheumatoid Arthritis, or Arthritis
- ▶ Arthritis is when the articular cartilage is being damaged
- ▶ Orthotics, physical therapy, and corticosteroid injections are often recommended for a patient with mild or moderate arthritis
  - ▶ OA is a progressive and degenerative disorder
  - ▶ RA is a disorder where the body's immune system accidentally attacks the healthy tissue
  - ▶ OA Post Traumatic Arthritis is the dominant type of ankle arthritis
- ▶ Arthroscopic debridement is an option for people with arthritis that isn't severe yet
- ▶ Ankle fusion is another option for people with severe arthritis





# Who isn't able to have ankle replacement surgery?

If you are/have:

- ▶ Severely deformed or unstable ankles
- ▶ Bone infections
- ▶ Circulatory issues
- ▶ Diabetes
- ▶ Obesity
- ▶ Severe osteoporosis
- ▶ Severe avascular necrosis



# Benefits of an ankle replacement

- ▶ Regain ankle strength and stability
- ▶ Preserves range of motion
- ▶ Allows patient to walk normally with less pain
- ▶ Patient can return to a more active lifestyle
- ▶ Better option than Ankle Fusion (Arthrodesis) because that fuses the ankle bones together
  - ▶ limiting range of motion



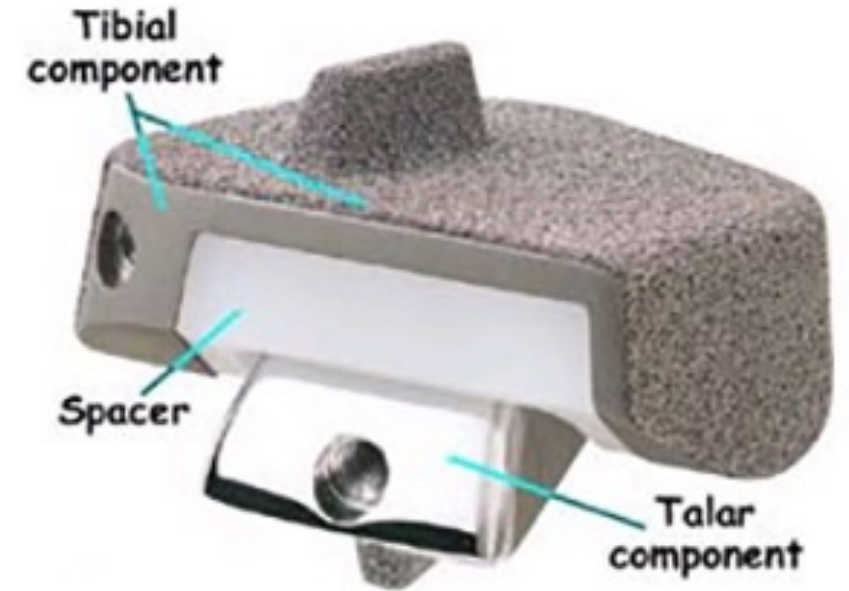
<https://seaviewortho.com/emerging-technology-in-the-foot-and-ankle-total-ankle-arthroplasty/>



# Ankle joint replacement components

Made up of 3 parts:

- ▶ Titanium Metal component: attached to Tibia
- ▶ Cobalt-Chrome piece is connected to the Talus
- ▶ Polyethylene implant is placed between the Tibia and Talus
- ▶ For patients with an allergy to Nickel, an all Titanium implant is another option
- ▶ The tibial component is the metal component of the joint that replaces the socket of the ankle
- ▶ The talus component replaces the top of the talus
- ▶ The tibial component is made up of two parts; a metal component attached to the bone and a plastic cup that provides the bearing surface

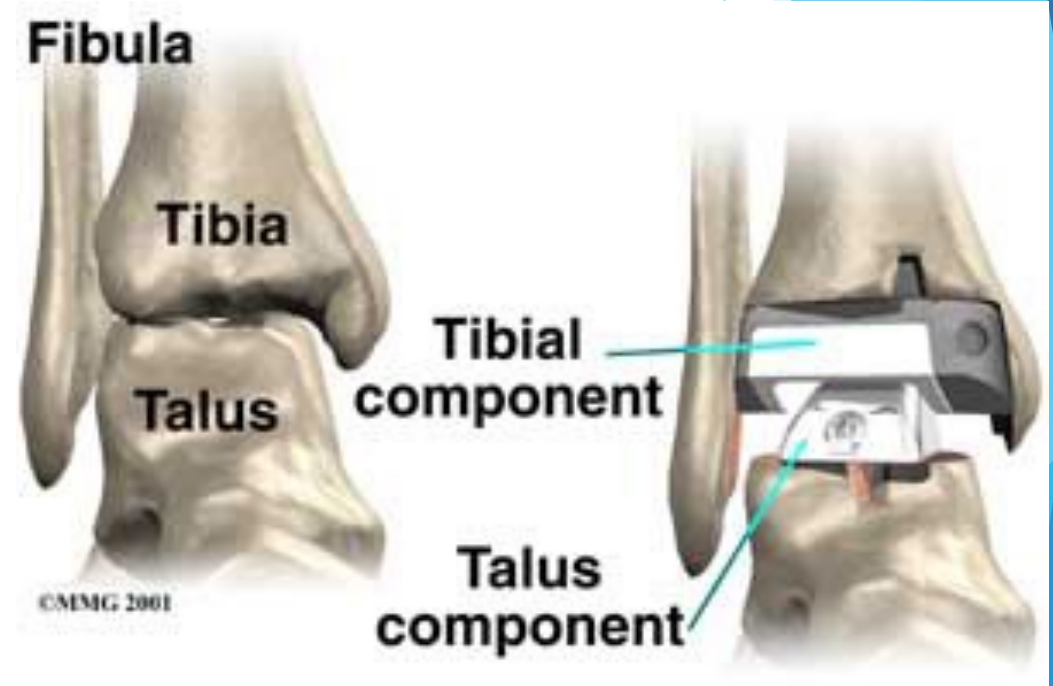


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# Risks of ankle replacement surgery

- ▶ Infection
- ▶ Damage to nearby nerves
- ▶ Bleeding
- ▶ Blood clot
- ▶ The bones not joining together properly
- ▶ Misalignment of the bones
- ▶ New arthritis in neighboring joints
- ▶ Loosening of the artificial components
- ▶ Wearing out of the components



<https://www.orthonorcal.com/blog/ankle-replacement-surgery-components-21493.html>



# Why are joint infections difficult to treat?

- ▶ Bacterial adhesion to biomaterial
- ▶ Cannot be eliminated without removing the implant
- ▶ High resistance to antibiotics
- ▶ Formation of biofilm

## Current solutions to fix infections

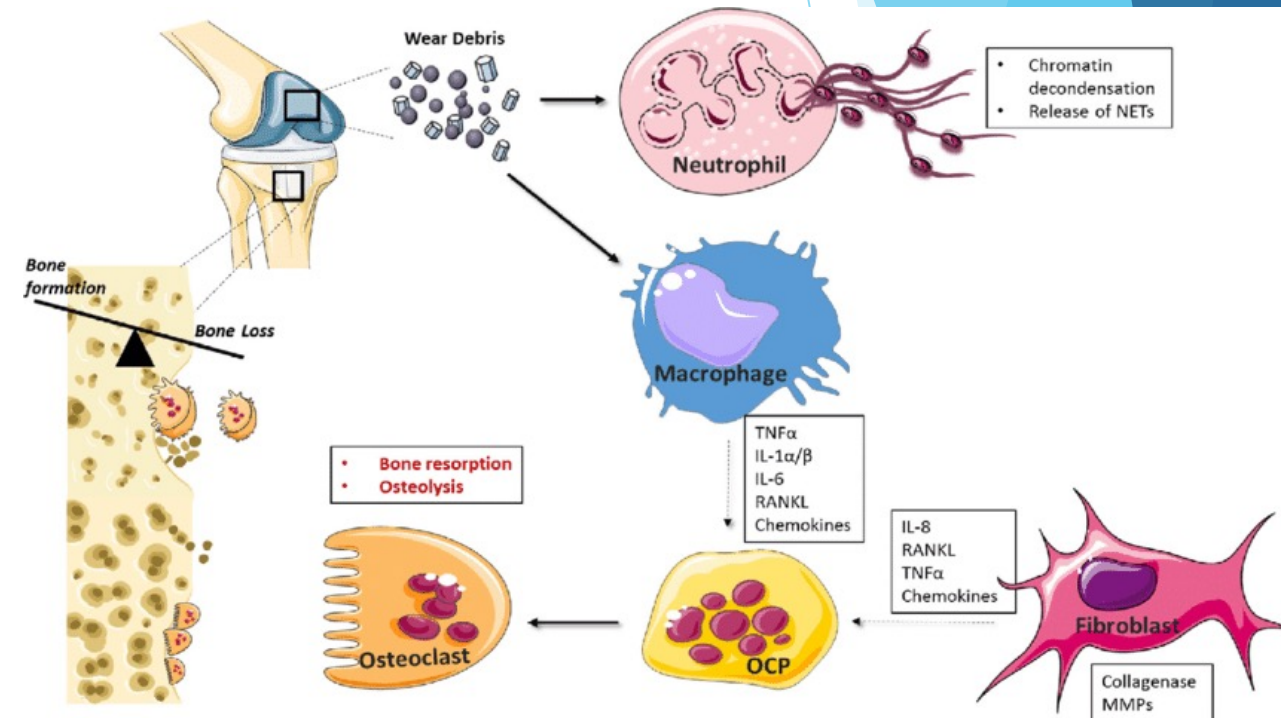
Current treatment options:

- ▶ Washout (I&D), leave implants in place
- ▶ Remove implants, I&D, put new ones
- ▶ Remove implants, I&D, antibiotic cement spacer



# What is osteolysis and how does it impact an implant?

- ▶ A condition where the bone is progressively destroyed, causing the bone to weaken
- ▶ The weakened bone causes the implant to loosen over time, causing instability
- ▶ 3 most common types of Osteolysis:
  - ▶ Distal clavicular osteolysis: also known as “weight lifters shoulder”
  - ▶ Periprosthetic osteolysis: affects some patients who've had a joint replacement surgery
  - ▶ Acro-osteolysis: a rare condition in which the distal phalanges begin to erode and degenerate



[https://www.researchgate.net/figure/Cellular-mediators-of-periprosthetic-osteolysis-Wear-debris-particles-generated-from\\_fig1\\_325407236](https://www.researchgate.net/figure/Cellular-mediators-of-periprosthetic-osteolysis-Wear-debris-particles-generated-from_fig1_325407236)



# What is osteolysis and how does it impact an implant?

- ▶ Periprosthetic osteolysis affects patients who've had joint replacements
- ▶ Polyethylene & other materials can break down and the accumulation of debris can result in bone degeneration
- ▶ A vital sign of periprosthetic osteolysis is an aseptic loosening of the implant
- ▶ Symptoms don't typically occur until after there's been extensive bone loss
- ▶ Symptoms include: pain, weakness, and stiffness
- ▶ Imaging may be done to rule out an infection
- ▶ If the bone loss is extensive, a follow-up surgery may be required



# Proposed solutions for infection

- ▶ Use ultrasound therapy to kill biofilm on the implant
  - ▶ Enhances the activity of antibiotics
  - ▶ Minimally invasive
  - ▶ The biofilm infected implant can be directly targeted
- ▶ Use the metallic implant as an electrode to provide voltage controlled electrical stimulation
  - ▶ Helps eradicate infections
  - ▶ Helps prevent infections
  - ▶ Helps with osseointegration
- ▶ Use an implant that is coated in antibiotics
  - ▶ Prevents the formation of a biofilm
  - ▶ Specifically targets the infected implant





# Proposed solutions for osteolysis

- ▶ Have patient take antiresorptive drugs to prevent osteolysis
- ▶ Coat the implant with antiresorptive drugs to directly prevent osteolysis
  - ▶ Examples of antiresorptive drugs: bisphosphonates (alendronate, ibandronate, risedronate, zoledronic acid), denosumab, calcitonin, estrogen/estrogen-progestin, an estrogen agonist/antagonist (raloxifene), and a tissue specific estrogen complex (estrogen/bazedoxifene)
- ▶ Cemented implants
- ▶ Coat the implant with hydroxyapatite
  - ▶ Can help regenerate bone
  - ▶ Can help reduce implant rejection or failure