Center for Future Convergence Medical Device Development

Development of 3D-printed Patient-Specific Total Ankle Prosthesis with Biomembrane-mimic Polymer Coating for Wear Resistance and Prevention of Osteolysis(Funded by Ministry of Health and Welfare)

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Major research goals

The goal of this project is to develop total ankle prosthesis that are personalized 3D-printing technology and coated with polymers imitating biomembranes to prevent periprosthetic osteolysis.

Major development topics

1. Artificial Ankle Joint Development.
2. 3D-printed Patient-Specific Total Ankle Prosthesis.
3. Biomembrane-mimic Polymer Coating for Wear Resistance and Prevention of Osteolysis.

Major expected achievements

Background

1. Total joint arthroplasty is a valid alternative treatment option for end-stage arthritis, as it results in pain relief, improved joint mobility, and better function.
2. Unlike the hip or knee joints, the ankle joints are small and have a unique joint shape, and the highest load per unit area. These features make total ankle arthroplasty difficult to perform than other joints.
3. As the elderly population grows, demand for artificial joint is increasing.
4. There are no 3-components mobile-bearing total ankle prosthesis made by Asia manufacture.
5. Nowadays three ankle prosthesis is available in Korea, all is imported from USA and Europe.

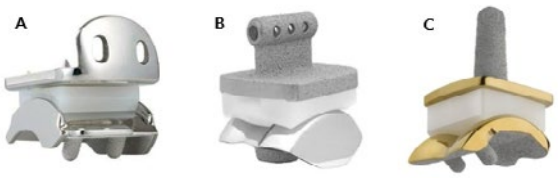


Figure 1. Available total ankle prosthesis in Korea [A: Hintegra; France, B: Salto; France, C: Zenith; UK and Germany]

Methods

1. Developing prosthesis for patient-customized total ankle arthroplasty using 3D-printing technology.

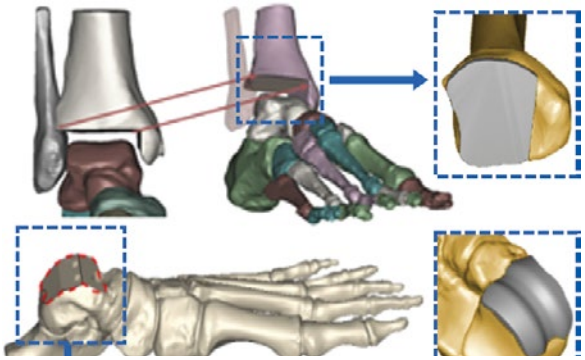


Figure 2. 3D-printed Patient-specific Prosthesis

2. Developing prosthesis for total ankle arthroplasty using biomembrane-mimicking polymer coating technology to prevent osteolysis, the most important factor in reoperation or revision.

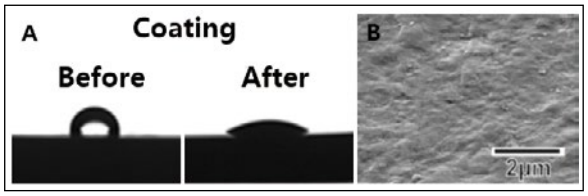


Figure 3.(A) Coating contact angle and(B) surface analysis

Expected achievements

1. The first 3D-printed mobile-bearing total ankle prosthesis of Asia.
2. Localization of artificial ankle joint.
3. Exports to overseas markets through establishing strategic alliances and marketing strategies with related associations based on its leading clinical position in Asia-Pacific such as China and South East Asia countries.

Representative figures of major achievements

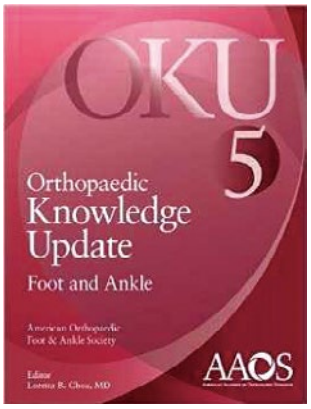
- About 100 papers are published in SCI journals, and many are published in top 10% journals in orthopedic surgery.(The American Journal of Sprots Medicine, The Journal of Bone and Joint Surgery(AM), The Bone and Joint Journal, etc.)
- Two research papers(Heterotopic ossification after total ankle arthroplasty and Distraction osteogenesis for brachymetatarsia) are minutely quoted in "Campbell's Operative Orthopaedics"(12th Edition, Elsevier, 2013)

TABLE 10-4 Classification of Heterotopic Ossification After Total Ankle Arthroplasty

CLASS	CRITERIA
0	No heterotopic ossification
I	Islands of bone within the soft tissue about the ankle
II	Bone spurs from the tibia or talus, reducing the posterior joint space by < 50%
III	Bone spurs from the tibia or talus, reducing the posterior joint space by ≥ 50%
IV	Bridging bone continuous between the tibia and the talus

From Lee KB, Cho YJ, Park JK, et al: Heterotopic ossification after primary total ankle arthroplasty, *J Bone Joint Surg* 93A:751, 2011.

- Chief editor of "Osteonecrosis of the Talus" Chapter for Orthopedic Knowledge Update 5th edition by American Orthopedic Foot and Ankle Society.



Major relevant publications

1. Primadi A, Kim BS, Lee KB : Tarsal tunnel syndrome after total ankle replacement--a report of 3 cases. Acta Orthop. 2016;87(2):205-6.
2. Lee KB, Kim MS, Park KS, Cho KJ, Primadhi A : Effect of anterior translation of the talus on outcomes of three-component total ankle

arthroplasty. BMC Musculoskelet Disord. 2013 Sep 5;14:260.
3. Lee KB, Cho YJ, Park JK, Song EK, Yoon TR, Seon JK : Heterotopic Ossification After Primary Total Ankle Arthroplasty. J Bone Joint Surg Am. 2011 Apr 20;93(8):751-8.
4. Bai LB, Lee KB, Song EK, Yoon TR, Seon JK : Total Ankle Arthroplasty Outcome Comparison for Post-Traumatic and Primary Osteoarthritis. Foot Ankle Int. 2010 Dec;31(12):1048-56.
5. Lee KB, Park YH, Song EK, Yoon TR, Jung KI : Static and Dynamic Postural Balance After Successful Mobile-Bearing Total Ankle Arthroplasty. Arch Phys Med Rehabil. 2010 Apr;91(4):519-22.
6. Lee KB, Cho SG, Seon JK : Cementless total ankle arthroplasty in diabetic neuropathic arthropathy. Diabet Med. 2008 Nov;25(11):1358-60.
7. Lee KB, Cho SG, Hur CI, Yoon TR : Perioperative complications of HINTEGRA total ankle replacement: Our initial 50 cases. Foot Ankle Int. 2008 Oct;29(10):978-84.

Research networks

1. Corentec(Medical instruments)
2. Department of Mechanical Engineering, Sejong University
3. Department of Materials Science and Engineering, Korea University
4. Osong Medical Innovation Foundation
5. Department of Pharmacology, Chonnam National University Medical School.
6. BMD organization - Bone Metabolism and Disease organization is established for clinical and basic research on bone disease treatment. This organization is consist of Anatomy, Dental, Pharmacy, Rheumatology, and Orthopedics.