Distribution of Subchondral Bone Strength in the Talus and Tibial Plafond: A Biomechanical Study

Slif D. Ulrich, MD
Brent G. Parks, MS
Michael A.Tsai, BS
Stuart D. Miller, MD

Department of Orthopaedic Surgery
Medstar Union Memorial Hospital
Baltimore, MD
Disclosure

- Distribution of Subchondral Bone Strength in the Talus and Tibial Plafond: A Biomechanical Study

 Slif D. Ulrich

My disclosure is in the Final AOFAS Mobile App. I have no potential conflicts with this presentation.
Introduction

- The subchondral bone is damaged and causes Osteochondral lesions.
- Frequency of the location, etiology, and morphology still remain controversial.
- Promising results have been achieved in the past two decades to treat defects.
- Problem of defects extending into the underlying subchondral bone has not received much attention.
- Anterolateral and posteromedial vs. central medial central lateral defects.
Hypothesis

- Talus and plafond subchondral bone strength varies significantly based on location on the talus and plafond.
- Aim to compare subchondral bone strength in different zones of the Ankle surfaces.
Methods

- Twelve cadaver specimens of the talus and plafond were used to determine the puncture strength of the subchondral bone.
  - Age: 48 ± 6
  - 11 M ; 1F
  - BMD, gm/cm² : 1.42
Methods

Puncture tests were performed in nine assigned zones on the talus/plafond articular surface in based on a grid of sections.

Zone 1: anterior medial

Zone 9: posterior lateral
Methods

- Compressive load was applied through a standard microfracture awl at 2 mm/min, and load/deflection data were collected continuously at 30Hz
- MTS Bioframe
Puncture strength was defined as the first drop in load viewed on the load-deflection curves.
Statistics

- One-way ANOVA
- Post hoc comparisons were made using Scheffe test.
- The relative talus and tibial bone strength were compared to each individual location in the nine-zone grid system. Statistically significant differences p-value less 0.05. (Sigma Stat)
- Linear regression BMD vs Puncture Strength
Results Talus

- Diameter: anterior-posterior, 30.3±4.1 mm, and medial-lateral, 26.2±2.5 mm.

- Zone 1, the extreme anterior-medial zone, > Zones 7 and 9, the extreme posterior medial and lateral zones (215±91 N versus 104±43 N and 102±35 N, respectively; P=<.001).

- No other significant differences were observed
The average diameter: anterior-posterior, $25.7 \pm 4.09$ mm, and medial-lateral, $23.73 \pm 2.01$ mm.

Zone 3, Zone 7, the extreme anterior-lateral zone, posterior medial zone > strength than Zones 8, the extreme posterior medial zone ($202 \pm 72$ N; $206 \pm 81$ versus $112 \pm 64$, respectively; $P<.001$)

No other significant differences were observed
Results Tibia
Results

mild Correlation R: 0.54
Discussion

- First one to describe topographical differences in subchondral bone strength in the ankle
- Might explain widely quoted posterior medial and anterior lateral defects
- Results are similar to topographical differences in mechanical properties of cartilage
  posterior aspects softest talus, tibia > talus
  Athannasiou et al 1995
- Limitation: 11/12 were male cadavers
Conclusion

- These results suggest that the bone is weaker in the posterior region of the talar dome and palfond than in the anterior region.

- These findings may partly explain the clinical observation of frequent osteochondral lesions.

- The data may also suggest that variations in bone strength occur in normal ankle joint mechanics.

- Arthroscopic microfracture probes and total ankle arthroplasty systems should take into account this variation in talar dome bone strength.
References