The Effect of a Synthetic Bone Wedge on the Strain Response of the Lateral Cortex and Fixation Plate Following a High Tibial Osteotomy

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<td>I have no financial conflicts to disclose.</td>
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• Medial opening wedge high tibial osteotomy (MOWHTO) has been developed to address uni-compartmental knee osteoarthritis (OA) caused by varus mal-alignment $^{[1,2,3]}$

• Approximately 16% - 35% of patients experience a lateral cortex fracture with associated delayed- or non-union, loss of stability, or recurrent varus deformity $^{[4,5,6]}$

• Newer fixation techniques, such as locking plates, provide greater stability and likely reduce potential risks associated with MOWHTO and complications may be further mitigated by the insertion of bone grafts or synthetic bone wedges

• There is limited biomechanical data to support this improved stability gained by synthetic inserts in the presence of a locking plate fixation construct
Purpose and Hypothesis

To determine the effectiveness of a synthetic bone insert on improving MOWHTO integrity in response to post-surgical cyclical loading.

It was hypothesized that the addition of a synthetic insert would increase the number of cycles to failure by providing support to the MOWHTO and the lateral cortical hinge with increased surface area for load distribution.
Methods

Specimen Preparation

- Twelve fresh frozen cadaveric knees
  Mean (SD) age = 73.5 [9.9] years

- A MOWHTO was performed on all specimens by a fellowship trained orthopedic surgeon

- Specimens randomized to either:
  i) **No-wedge**
  ii) **Wedge** (beta tri-calcium phosphate wedge; NEOTIS, SBM Orthopaedics, France)

- Stabilized with a compression fixation plate Otis-C-Plus, SBM Orthopaedics, France
Loading Protocol

- Strain gauges applied to lateral cortex and fixation plate

- Staircase cyclical loading protocol applied to specimens within an Instron® materials testing system:
  - Sinusoidal waveform between 200N and 800N for 5000 cycles
  - Maximum force increases by 200N every 100 cycles
  - Loading continued until failure or completion of 2400N
Data Analysis

- Comparison of minimum and maximum strains, at failure, from the fixation plate and lateral cortex between conditions (independent samples t-test)

- Cycles to failure compared between conditions (independent samples t-test)

- A Kaplan-Meir survivalability analysis was conducted to interpret the survivability of the two conditions (log-rank test [7])

- Fracture patterns graded according to Takeuchi et al (2012)[6] and compared between conditions (Kruskall-Wallis test)
**Results**

### Strains

**Lateral Cortex**
- Minimum Strain: Plate+Wedge vs. Plate, $P<0.05$
- Maximum Strain: Plate+Wedge vs. Plate, $P<0.05$

**Fixation Plate**
- Minimum Strain: Plate+Wedge vs. Plate, $P<0.05$
- Maximum Strain: Plate+Wedge vs. Plate

- Minimum and maximum strains increased significantly at the lateral cortex between wedge conditions.
- On the fixation plate, the minimum strains transitioned significantly from a compressive to tensile strain.
- No significant difference between the maximum strains on the plate.
Results

Cycles to Failure

- No significant difference in the cycles to failure between conditions
- Kaplan-Maier curve showed a distinction between conditions but these were not statistically significant
Fracture Patterns

- There was a significant difference (p=0.015) in the type and severity of fractures that occurred between the two conditions.

  - Eighty-three percent of the wedge and plate specimens experienced a type-I fracture that extended only into the lateral cortical hinge with the remaining specimens having a type-II fracture (vertical fracture toward the diaphysis).

  - Conversely, 83% of the plate only specimens failed with a fracture into the tibial plateau (type-III) with the remaining 17% experiencing a type-I fracture.
Discussion and Conclusions

- The lack of a statistical difference in the mean cycles to failure, and between the Kaplan-Meir curves, is consistent with the assertion that synthetic materials are not intended for immediate load-bearing.

- The addition of a synthetic insert to a MOWHTO may protect the fixation plate and cortex by limiting the tensile strains they experience and may produce less severe and complex fractures when failures occur.

- At the very least, the use of a synthetic insert does not harm the integrity of the acute post-surgical MOWHTO environment.


