Stress Distribution within the Osteochondral Lesions of the Talus with Nonshoulder-type and Shoulder-type

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**Introduction**

- Microfracture is an effective treatment for Osteochondral lesions of the talus (OLT), particularly in cases with smaller lesions less than 15mm or 150 mm².
- Recent studies reported that microfracture underwent shoulder-type OLT who had significantly worse clinical outcomes than nonshoulder-type OLT.
- To the best of our knowledge, no previous reports have provided biomechanical data for how nonshoulder-type and shoulder-type OLT affect the clinical outcomes.
The purpose of this study was to clarify the stress distribution in articular cartilage of the talus with nonshoulder-type and shoulder-type OLT using finite element (FE) analysis.
Materials & Methods

- Case: the healthy volunteers
  - 33-year-old male (Case1).
  - 29-year-old female (Case2).
- Three-dimensional FE models of ankle joint
  - CT data using Mechanical Finder software (Version 7.0; Research Center of Computational Mechanics, Tokyo, Japan).
- Articular cartilage of the tibia and talus
  - 1.4 mm thickness.
Materials & Methods

- Nonshoulder-type (NS type) lesion and Shoulder-type (S type) lesion models
  - Cartilage defects: 5, 7, 9, 11, 13, 15 mm
- Loading condition at 686 N on the upper part of the tibia from the tibial axis for body-weight loading.
- The peak and average articular cartilage stress, and defect rim stress were compared between the two models and among the six different defect sizes.

a. NS type lesion model
b. S type lesion model
## Results

The peak and average articular cartilage and defect rim stress

<table>
<thead>
<tr>
<th>Lesion (mm)</th>
<th>Articular cartilage stress (average, MPa)</th>
<th>Defect rim stress (average, MPa)</th>
<th>Defect rim stress (peak, MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NS type</td>
<td>S type</td>
<td>NS type</td>
</tr>
<tr>
<td>5</td>
<td>0.18</td>
<td>0.21</td>
<td>0.18</td>
</tr>
<tr>
<td>7</td>
<td>0.20</td>
<td>0.28</td>
<td>0.19</td>
</tr>
<tr>
<td>9</td>
<td>0.21</td>
<td>0.28</td>
<td>0.20</td>
</tr>
<tr>
<td>11</td>
<td>0.24</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>13</td>
<td>0.26</td>
<td>0.24</td>
<td>0.26</td>
</tr>
<tr>
<td>15</td>
<td>0.28</td>
<td>0.28</td>
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</tbody>
</table>
The NS type and S type lesion models in Case 1, stress concentration was seen at the cartilage defect rim. The articular cartilage and defect rim stress increased with increasing defect size of the two models.
The NS type and S type lesion models in Case 2, stress concentration was seen at the cartilage defect rim. The articular cartilage and defect rim stress increased with increasing defect size of the two models.
Lesion size of OLT was the most powerful predictor of the clinical outcome. The containment of OLT has been considered of secondary importance because it was thought that contained and uncontained lesions of comparable lesion size behave similarly.

The shoulder-type OLT experience a worse clinical outcome than the nonshoulder-type OLT, even after adjustment for OLT size and regardless of location.

FE models of knee demonstrated that distribution of peak stress was concentrated on the defect rim for defects of 10 mm and greater. Although, peak rim stress did not significantly increase, as defects were enlarged from 10 mm to 20 mm.
Conclusions

- The present study evaluated the stress distribution in the articular cartilage of the talus with NS type and S type OLT using FE analysis.

- In the cartilage defect with the diameter of 13 mm and more, the S type lesion models exhibited higher peak defect rim stress than the NS type lesion models.


