Articular Cartilage Changes of the Proximal Tibiofibular Joint in MRI T1-rho Mapping Following an Open-Wedge Osteotomy of the Proximal Tibia with Hemicallotasis for Medial Knee Osteoarthritis

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Medial opening wedge osteotomy of the proximal tibia with hemicallotasis (HCO)\textsuperscript{1, 2}
Correction angle (CA) = postop. HKA – preop. HKA

Postop. %Mechanical Axis (%MA) =
a point approximately 65 to 70% of the distance from the medial edge of the proximal tibial plateau (∝ Hip-Knee-Ankle angle: HKA angle 6~8°)

HKA angle
- ; varus
+ ; valgus
The purpose of this study are

1) to examine the effects of HCO on the articular cartilage of proximal tibio-fibular joint (PTFj) based on the analysis using a quantitative T1ρ magnetic resonance imaging (MRI), and

2) to clarify the relationship between the CA and the articular cartilage change of PTFj.
## Patient profiles and Methods

<table>
<thead>
<tr>
<th>Patients (knees)</th>
<th>13 (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>medial OA</td>
</tr>
<tr>
<td>Gender</td>
<td>5 male (5 knees)</td>
</tr>
<tr>
<td></td>
<td>8 females (8 knees)</td>
</tr>
<tr>
<td>Age at surgery</td>
<td>avg. 64 y.o. (53 - 72 y.o.)</td>
</tr>
</tbody>
</table>

All patients underwent
- HCO without fibulectomy
- X-ray and MRI evaluations pre-operatively and at one year after surgery
Radiographic evaluation

Weight-bearing full-length hip-to-ankle scanogram using a image-intensifier and digital flat panel detector

Parameters

1) FTA (°)

2) %Mechanical Axis (%MA)  
   = $\frac{\beta}{\alpha} \times 100$ (%)  

3) Height of the fibular head 
   = $\frac{B}{A} \times 100$ (%)  

4) Height of the distal fibular end 
   = $\frac{B'}{A'} \times 100$ (%)
MR imaging protocol:

- **Scanner**: a 3-Tesla (Achieva 3T, Philips)
- **Sequence**: 3D WATS (3D T1w. fast field echo with water-selective excitation), T1ρ

**Quantification of the T1ρ relaxation time**

- Construction of T1ρ mappings using PRIDE software (Philips)
- Setting of ROI on the full thickness cartilage in PTFJ
- Measurement using Image J software (NIH)

<table>
<thead>
<tr>
<th>Sequence</th>
<th>3D WATS</th>
<th>T1rho</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetition time (ms)</td>
<td>10</td>
<td>4.7</td>
</tr>
<tr>
<td>Echo time (ms)</td>
<td>4.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Field of view (mm)</td>
<td>140 × 140</td>
<td>140 × 140</td>
</tr>
<tr>
<td>Matrix</td>
<td>400 × 400</td>
<td>320 × 320</td>
</tr>
<tr>
<td>Thickness</td>
<td>4mm</td>
<td>4mm</td>
</tr>
<tr>
<td>Flip angle (°)</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>TSL (ms)</td>
<td>1, 10, 20, 30, 40</td>
<td></td>
</tr>
</tbody>
</table>
Changes in the FTA and %MA

Correction Angle: avg. $16^\circ$ ($9^\circ \sim 22^\circ$)
Relationship between $\Delta B/A$ and CA in PTFj

Height of the fibular head

- Height of the distal fibular end had no change postoperatively.
Change in $T_1\rho$ relaxation times in PTFj

**T1\rho value**

- Pre-op.: 38.8 ms
- Post-op.: 40.0 ms

$p = 0.02$

**ΔT1\rho value**

$r = 0.78$

$p < 0.01$
HCO has several attractive advantages compared to conventional procedures, including the simplicity of the surgical procedure without fibulectomy, easier acquisition of accurate correction, and the great correction angle$^{1,2,7,8}$. On the other hand, we reported that T1-rho relaxation time of PTFj cartilage showed a constant value ranged from 35 ms to 40ms$^3$, and its value was not affected by aging or cartilage degeneration in the femorotibial joint in knee osteoarthritis$^5$. In addition, we also reported that T1-rho values more than 40 ms could indicate the degenerative change of articular cartilage$^6$. There are some limitations of the MRI analysis only up to one year after surgery and no histological examination by biopsy.

In conclusion, this study clarified that, within the CA more than 15$^\circ$ in HCO, the degenerative change of articular cartilage in the PTFj occurred due to the upward translocation of the fibular fead$^{10-12}$ postoperatively as evidenced by MRI T1-rho mapping. This result suggests that the fibular osteotomy may be needed with the valgus correction more than 15$^\circ$ in HCO.
References


