Longitudinal T2 Mapping MRI Evaluation of Meniscal Changes After High Tibial Osteotomy: Greater Alterations in the Medial Meniscus

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INTRODUCTION: T2 mapping MRI quantitatively evaluates meniscal degeneration, as prolonged T2 values reflect increased water content (1). Conventional HTO evaluations focus on biomechanical changes, such as meniscal morphology. However, qualitative, biological changes are increasingly recognized as important for optimizing treatment strategies. This study aimed to quantitatively assess meniscal changes before and after OWHTO using T2 mapping MRI.

METHODS: A total of 52 knees in 39 patients (9 males and 30 females; mean age 57±7 years) who underwent HTO between 2016 and 2023 were included. This study was approved by the institutional review board. Radiographic assessments were performed preoperatively and at 1 year postoperatively, and MRI was performed preoperatively, at 1 year, and at 5 years postoperatively (14 knees at 5 years). For T2 mapping, regions of interest were set in the anterior, central, and posterior horns of both medial and lateral menisci, as well as the posterior root of the medial meniscus, and T2 values (ms) were measured. Medial meniscus extrusion (MME) was also evaluated on MRI.

RESULTS: Radiographic parameters significantly improved after HTO: femorotibial angle (FTA) from 180±4° to 173±3°, medial proximal tibial angle (MPTA) from 83±7° to 91±1°, and weight-bearing line ratio (WBLR) from 22±15% to 56±12% (all $p<0.05$). No significant differences were observed in aPPTA (81±3° →80±3°) or MME (3.3±2.2 mm→2.8±1.8 mm).
Preoperative medial meniscus T2 values were: anterior 21±4, central 25±5, posterior 23±4, posterior root 28±8; lateral meniscus: anterior 17±2, central 17±2, posterior 18±2. At 1 year, medial meniscus values were anterior 21±1, central 24±4, posterior 22±3, posterior root 26±7; lateral meniscus: anterior 17±2, central 16±2, posterior 18±2, with no significant changes in any region.(Figure1) T2 value changes were: medial anterior –0.2±3.9, central –1.2±4.4, posterior –0.9±4.0, posterior root –1.6±5.2; lateral anterior –0.2±3.0, central –0.6±3.0, posterior –0.3±3.7, showing relatively greater changes in the medial central and posterior root.
At 5 years, medial meniscus T2 values were anterior 20.1±3.8, central 22.9±5.1, posterior 24.6±7.7, posterior root 29±6.8; lateral meniscus: anterior 18.6±3.7, central 17.1±2.3, posterior 18.0±1.9. Changes from 1 to 5 years were again greater in the medial central (–5.7±11) and posterior root (–5.2±12) than in other regions.

DISCUSSION: Although HTO achieved significant lateralization of the weight-bearing axis, no statistically significant changes in meniscal T2 values were observed, suggesting a potential protective effect against degeneration. The medial central region and posterior root showed relatively greater changes, indicating susceptibility to the effects of HTO. Notably, the 5-year changes reached levels generally considered clinically meaningful for meniscal T2 values (2), extending the short-term observations of Choi et al. (3) and providing new mid-term evidence. Although MME did not differ significantly in mean values, a structural evaluation may require subgroup analyses that account for preoperative pathology.

SIGNIFICANCE/CLINICAL RELEVANCE: This study provides mid-term evidence that OWHTO may protect against medial meniscal degeneration, as reflected by clinically meaningful changes in meniscal T2 values over 5 years. These findings support the importance of considering biological, qualitative meniscal changes in addition to mechanical realignment when planning HTO, potentially improving long-term joint preservation.

REFERENCES: (1) European Radiology (2019) 29:5664‑72. (2) Knee Surg Sports Traumatol Arthrosc. 2024 Dec;32(12):3141-3150. (3) Orthop J Sports Med. 2021;9:23259671211047904

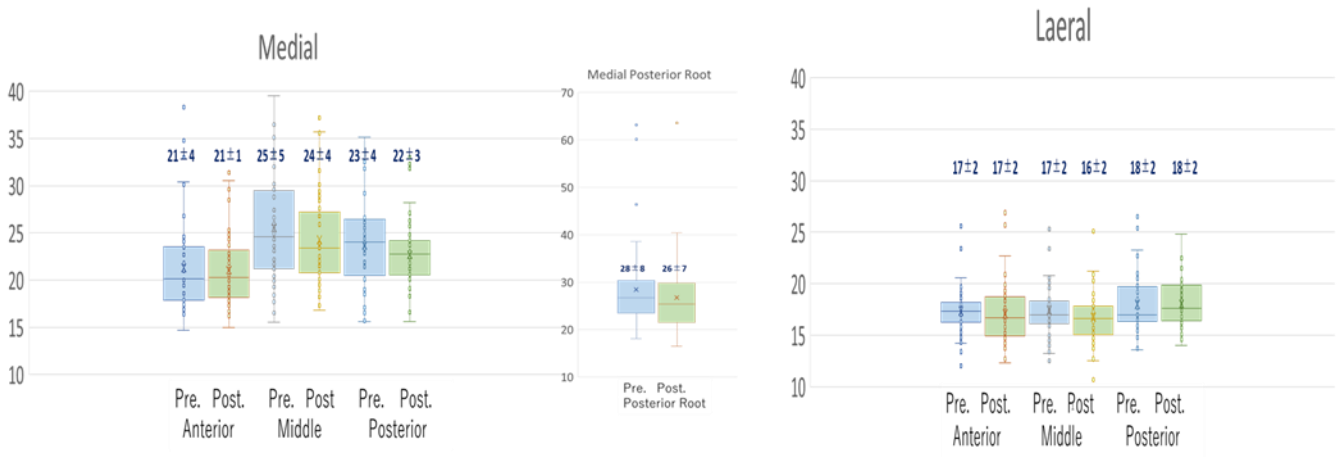

Figure 1Figure 1. T2 values of the medial and lateral meniscus at 1-year follow-up after OWHTO.