

Quantitative assessment of anterior talofibular ligament quality in chronic lateral ankle instability using magnetic resonance imaging T2* value

Yoshihiro Akatsuka¹, Atsushi Teramoto¹, Yasutaka Murahashi¹, Katsunori Takahashi¹, Rui Imamura¹, Hiroyuki Takashima², Kota Watanabe¹, Toshihiko Yamashita¹

¹Sapporo Medical University, Sapporo, JPN, ²Hokkaido University, Sapporo, JPN
Email of presenting author: akatsuka.y@sapmed.ac.jp

Disclosures: Yoshihiro Akatsuka (N), Atsushi Teramoto (N), Yasutaka Murahashi (N), Katsunori Takahashi (N), Rui Imamura (N), Hiroyuki Takashima (N), Kota Watanabe (N), Toshihiko Yamashita (N)

INTRODUCTION: The residual anterior talofibular ligament (ATFL) quality is important in chronic lateral ankle instability (CLAI) repair surgery.¹ However, few studies have investigated a method of a preoperative quantitative ATFL quality assessment. The purpose of this study was to determine T2* normal reference values for ATFL and to investigate the feasibility of the quantitative ATFL quality evaluation in CLAI using T2* values.

METHODS: The institutional review board of our hospital approved this study (reference number: 322-250). Informed consent was obtained from all individual participants. This study enrolled 15 patients with CLAI and 30 healthy volunteers. They all underwent 3.0-T MRI consisting of three-dimensional T2-weighted images along with high-resolution T2* map images. The entire ATFL T2* values from the T2* map were measured. The prediction equation (variables: age, height, and weight) in a multiple linear regression model was used to calculate the T2* normal reference value in the healthy group. T2* ratio was defined as the ratio of the actual T2* value of the patient's ATFL to the normal reference value for each patient. A Telos device was used to measure the talar tilt angle (TTA) and anterior drawer distance (ADD) from the stress radiograph in the CLAI group. Anterior translation (AT) was measured by a manual test using a capacitance-type strain sensor. All patients with CLAI underwent arthroscopic ATFL repair after an MRI examination. The ATFL tension (taut, mild laxity, and laxity) and quality (excellent, moderate, and poor) were evaluated from arthroscopic findings.

RESULTS SECTION: T2* values of ATFL in the healthy and CLAI groups were 10.82 ± 1.84 ms and 14.05 ± 4.60 ms, respectively, and were significantly higher in the CLAI group ($P = 0.0284$). Multiple regression analysis revealed that the T2* normal reference value was significantly predicted by age, height, and weight ($R^2 = 0.65$, $P < 0.0001$) (Figure 2). The prediction equation of the T2* normal reference value is shown as follows: $T2^* \text{ value (ms)} = 14.9 + 0.14 \times \text{age (years)} - 4.7 \times \text{height (m)} - 0.03 \times \text{weight (kg)}$. A significant positive correlation was found between the T2* ratio and TTA ($r = 0.66$, $P = 0.007$) (Table 1). Arthroscopic findings included ATFL tension (taut: 0, mild laxity: 10 cases, laxity: 5 cases) and quality (excellent: 3 cases, moderate: 8 cases, poor: 4 cases). A trend toward higher T2* values as the intraoperative findings progressed from mild laxity to laxity, from excellent to poor, or from moderate to poor. No significant differences were found between T2* values and intraoperative arthroscopic findings.

DISCUSSION: This study demonstrated the feasibility of the quantitative ATFL quality evaluation in CLAI using T2* values. The main finding in this study was that the T2* ratio revealed a significant positive correlation with the TTA of the stress radiograph in patients with CLAI. A higher T2* value indicates a combination of less densely packed collagen fibrils, periligamentous scar tissue,² and a histological lower score.³ Using the T2* value provides a quantitative assessment of ATFL quality.

SIGNIFICANCE/CLINICAL RELEVANCE: This work demonstrates the feasibility of applying T2* mapping for quantitative assessment of ATFL quality. T2* value may be a useful indicator in selecting a surgical strategy.

REFERENCES: 1. Michels F, et al. *Knee Surg Sports Traumatol Arthrosc*: 2018; 2. Biercevicz AM, et al. *J Orthop Res* 2014; 3. Biercevicz AM, et al. *J Orthop Res* 2015

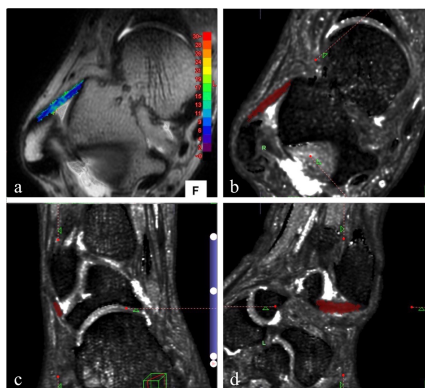


Figure 1. (a) Fusion oblique axial image of 3D T2-weighted image and T2* map image (color map); (b, c, d) T2* map reconstructed images: oblique axial image, oblique coronal image, and oblique sagittal image. Red regions show the anterior talofibular ligament

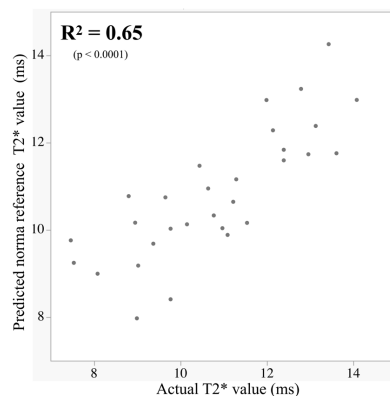


Figure 2. Predicted normal reference T2* value versus actual T2* value using a multiple regression model as a function of the linear combination of age, height, and weight.

Table 1. Instability measurements and correlation coefficient with T2* value or T2* ratio

	Mean \pm SD	Correlation coefficient (95% CI) with T2* value	P value	Correlation coefficient (95% CI) with T2* ratio	P value
TTA, $^{\circ}$	13.1 ± 4.6	0.5 (-0.016-0.81)	.057	0.66 (0.23-0.88)	.007
ADD, mm	7.7 ± 1.9	0.57 (0.057-0.84)	.033	0.4 (-0.16-0.77)	.152
AT, mm	8.9 ± 3.0	0.09 (-0.44-0.58)	.747	-0.03 (-0.53-0.49)	.919

Abbreviation: SD, standard deviation; TTA, talar tilt angle; ADD, anterior drawer distance; AT, anterior translation