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T2* mapping of subtalar cartilage: Precision and association between anatomical variants and cartilage composition

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AVG: data acquisition, analysis and interpretation of the data, drafting the article and revising it for important intellectual content, final approval of the version to be submitted; SDM, KLB, ALB, EEW: interpretation of the data, drafting the article and revising it for important intellectual content, final approval of the version to be submitted.

Running Headline: T2* mapping of the subtalar joint and anatomical variants

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ABSTRACT

Hindfoot arthritis is an important contributor to foot pain and physical disability. Whilst the subtalar joint (STJ) is most frequently affected, anatomical variants such as facet configuration were suggested to further STJ cartilage deterioration. T2* mapping enables detection of ultra-structural cartilage change, particularly in thin cartilage layers, but its feasibility in the STJ has not yet been evaluated. The purpose of this study was to evaluate segmentation consistency and inter-scan short-term precision error of T2* mapping of talocalcaneal cartilage and to investigate the relationship between facet configuration and STJ T2* values. Using 3Tesla morphological magnetic resonance imaging, STJ configuration was categorized according to the degree of fusion between anterior, medial or posterior facets. Subsequently, 2 repeats of multi-echo gradient recalled echo sequences were performed to

obtain T2* maps with repositioning. Segmentation consistency of T2* values attained an ICC of 0.90 (95%CI 0.69-0.99). Precision errors comprised a coefficient of variation (CV) ranging 0.01-0.05, corresponding to a Root Mean Square CV of 0.03-0.04. A 2-joint configuration type (i.e., fused anterior-medial facets) was significantly associated with a decrease in posterior facet T2* values (β=-0.6, *p*=0.046). STJ T2* mapping is a reliable method requiring at least a 4% difference within people to enable detection of significant change. Anatomical variants in STJ configuration were associated with T2* values with the more stable 3-joint types exhibiting more favourable cartilage outcomes. Longer-term larger-scaled studies focussing on arthritis pathology are needed to further support the use of T2* mapping in hindfoot disease monitoring.

Key words: subtalar joint, MRI, T2*, reliability, anatomy

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INTRODUCTION

Hindfoot arthritis is an important source of foot pain and physical disability with the subtalar joint (STJ) also known as talocalcaneal joint, most frequently affected.[1] STJ pathology may originate from trauma, congenital deformity, chronic tibial posterior tendon dysfunction, inflammatory arthritis, obesity, repetitive overload and/or instability.[1] If left untreated, cartilage deterioration will evolve along with progressive joint deformity and instability, ultimately affecting foot function as well as lower limb alignment.[1-4] Alignment and function of the STJ have also been identified as determinants of surgical outcomes following ankle arthrodesis and total knee replacement.[4,5] Since joint alignment and function is adversely

affected by cartilage disease, the need for early detection of disease in this joint is thus warranted.

Interestingly, anatomical variants in the STJ are particularly frequent but generally overlooked as potential intrinsic risk factors of accelerated cartilage degeneration.[6,7] Specifically, the anterior articular facets may be missing or fused with the medial facets, giving rise to three main configurations: a three-joint configuration, a fused configuration with a relatively large anterior-medial joint, and a joint configuration without an anterior joint.[6,7] Suggested to determine joint stability and relative articular contact areas in the STJ, facet joint configuration may thus have an impact on long-term joint health.[6]

Innovative biochemical magnetic resonance imaging (MRI) techniques are being developed aiming to detect ultra-structural cartilage changes prior to macroscopic lesions. T2*, an emerging parameter in this field, has already been applied in the talocrural joint, knee and hip and may be of interest in the evaluation of thin cartilage layers.[8-11]This mapping technique does not require contrast administration, has good intra- and inter-rater reliability and has shown to be sensitive to change indicated by acceptable precision errors.[10,12-14] Although laminar variations comparable to standard T2 can be appraised,[14] the multi-echo gradient echo sequences commonly used to quantify T2* are characterized by short echo times to image T2* species which normally display as dark or black structures when using standard of care imaging protocols.[9, 10, 12, 14, 15] Similar to standard T2, T2* appears able to discriminate cartilage composition based on interactions between water molecules and the collagen fibril network. Unlike standard T2 mapping, however, decreases in cartilage T2* values were associated with worse cartilage degeneration as corroborated by histological validation in hip and knee cartilage specimen [8,11,12, 16] Despite its sensitivity to scanner imperfections and/or magnetic susceptibility[9,10,14], these features altogether would render T2* mapping a suitable

candidate to accurately evaluate early cartilage deterioration in thin curved cartilage plates.[15] Yet, no study has investigated its feasibility in the STJ.

This is the first study to report on the use of cartilage T2* mapping in the STJ including its relationship with anatomical variants such as joint configuration. First, we aimed to evaluate the feasibility of STJ T2* mapping by determining segmentation consistency as well as short-term inter-scan precision errors. Second, we investigated the relationship between anatomical joint configuration and cartilage ultra-structure as quantified by T2* mapping. We hypothesized that T2* mapping is a reliable method to evaluate the ultra-structure of thin curved STJ cartilage. Whilst suggested to offer improved joint stability combined with greater relative articular surfaces and thus greater potential to decrease contact stresses,[6] a three-joint configuration was expected to relate to more beneficial (i.e., higher) cartilage T2* values when compared to fused or 2-joint configuration types.

MATERIALS AND METHODS

Study design

This was a cross-sectional study with an observational analytic design and was therefore assigned a Level of Evidence IIIe.

Participants

Twelve healthy able-bodied participants (six men, six women; mean (Standard Deviation, SD) age: 29.1 (5.0) years; body mass index (BMI) kg/m^2): 22.1(1.8)) voluntarily took part in this study. All participants were recruited from the local community or university campus.

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Inclusion criteria were: age 20-40 years, BMI 20-30 kg/m^2, injury free at the time of study, sports participation maximum three times/week, no changes in regular life style the week prior to the study MRI procedure. Exclusion criteria were: history of surgical or arthroscopic ankle procedures, traumatic ankle ligament injuries or chronic ankle instability, cartilage injury or degenerative pathology to the ankle joint, a history of fractures at the lower leg or foot as well as contraindications to MRI. On recruitment, eligibility criteria were verified using a standard questionnaire. Although this was not the case in any of the participants, MRI scans of the study visit were used to verify the presence of unknown cartilage lesions in particular. To reduce interference from excessive joint loading on cartilage outcomes, all participants were instructed not to practice sports the day before testing or on the testing day and to avoid running, lifting heavy weights and taking stairs 4 hours preceding the MRI procedures.[17-19] The right lower limb was the dominant limb in all participants and was defined as the limb the participant would choose to kick a ball.[18-20] The study was approved by the Institutional Human Ethics Committee and all participants provided written informed consent.

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Experimental procedures

To reduce interference from residual deformation and its effect on cartilage hydration preceding the experiment,[21] the MRI protocol started with 1 hour of physical rest during which the participants were positioned supine. After 1 hour of standardized physical rest,[18, 19] 3D DESS WE scans were performed. Data were subsequently acquired to generate two repeated T2* maps with repositioning, enabling the determination of the short-term inter-scan precision error. To control for diurnal variation in cartilage thickness, and thus, hydration, all volunteers attended the MRI department at the same time of day (i.e., after office hours).[22]

Participant characteristics

Prior to the MRI procedures, descriptive data of age, gender and physical activity level were collected by questionnaire. Physical activity level in particular was determined utilizing the Baecke questionnaire which has been evaluated for reliability and validity in Flemish adults.[23-25] This 16-item questionnaire assesses physical activity level by quantifying 'work' (8 questions), 'sports' (4 questions) and 'leisure' (4 questions) activities using a five-point Likert scale (1 = never and 5 = always). By counting up the scores of the three distinct dimensions each subject's total physical activity score was calculated. Using a stadiometer and standard digital scales respectively, height and weight were measured with participants standing barefoot and wearing loose, comfortable clothing, after which the body mass index (BMI) was calculated.

Magnetic resonance imaging

High resolution images of the right hindfoot were obtained with a dedicated phased array high resolution 8-channel Foot-Ankle coil (Invivo, Gainesville, FL, USA) on a 3T Trio Tim magnet (Siemens Medical Solutions, Erlangen, Germany). Participants were imaged in supine position with the foot in 90° of dorsal flexion relative to the lower leg. This foot position ensured an approximate perpendicular orientation of the posterior STJ relative to the main magnetic field in an attempt to minimize interference from magic angle effects.[26]

To evaluate STJ facet configuration, a sagittal 3D double echo steady state sequence was applied with fat suppression by means of water excitation (sag3D DESS WE).[7] The following parameters were implemented: partition thickness 0.4mm, echo time 5.5 ms, repetition time 15.6 ms, flip angle 28°, field of view 105 mm and matrix 384 pixels, in-plane resolution 0.27x0.27, acquisition time 07'19". The 3D DESS WE sequence was preferred because of its capability to provide time-efficient high-resolution and near-isotropic acquisitions with

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higher signal-to-noise ratio and thinner slices which, in turn, reduce interference from partial volume averaging.[7,27,28]

To assess STJ cartilage composition, quantitative T2* mapping (T2* MapIt, Siemens Erlangen, Germany) was performed using a multi-echo gradient recalled echo sequence implementing the following parameters: partition thickness of 3 mm, echo times of 4.18, 11.32, 18.46, 25.60 and 32.47 ms, repetition time of 422 ms, field of view of 159 mm, matrix of 384 (interpolated 768), in-plane resolution 0.41x0.41 (interpolated 0.21x0.21), and acquisition time of 2'42". Sagittal T2* maps were collected covering the talar dome extending from the talar shoulders.

Image analysis

All images were transferred to a stand-alone desktop computer for analysis. All image analyses were performed by a trained reader with 7 years of experience in musculoskeletal MR image processing at time of analysis.

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Assessment of STJ configuration

STJ configuration was classified into six types by one investigator (AVG) as described previously[7]; Type A1 was defined as a configuration with three (i.e., anterior, medial and posterior) distinct facets. If a connection was apparent between the anterior and medial facets with separate posterior facets, cases were classified as A2, B1 or B2 depending on the extent of cartilaginous connection between facets (Fig 1). Specifically, STJs showing a confluence between facets, however with a small inclination, were classified type A2 whereas the presence of a narrowed cartilaginous fusion was described as a Type B1. If one continuous

cartilaginous surface hampered distinguishing anterior from medial facets, cases were assigned a type B2. If the anterior facet was missing on the calcaneus and no connection between the medial and posterior facet was present, cases were reported as type B3. Type C was recorded when a fusion of all three facets was present.[7] In our hands, intra-rater reliability of classification into configuration types attained a kappa value of 0.7. Although substantial agreement could be achieved, a limited degree of uncertainty was revealed for classifications within A-types and within B-types. Since A- and B-types were grouped for statistical analysis, this degree of uncertainty did not influence the present results.

<<Figure 1 to be inserted about here>>

T2* quantification

T2* values were quantified for the talocalcaneal cartilage in the posterior STJ solely as only this facet was distinctly visible in all participants. Additionally, the majority of forces applied to the shank are transmitted to the distal foot through the posterior chamber of the STJ[29], further justifying our approach.

T2* values were calculated as transverse relaxation times (in ms) implementing a pixel-wise, mono-exponential, non-negative least squares fit analysis derived from sagittal in-line reconstructed maps (MapIt, Siemens Medical Solutions, Erlangen, Germany).[30-32] Whilst image segmentation was performed on the interpolated reconstructed images (i.e., colour-coded T2* map, MapIt) (Fig 2A), previously published recommendations advise the inclusion of at least 6 pixel rows per cartilage layer to optimize accuracy of laminar analyses.[33] Since MRI-objectified cartilage thickness in the talocalcaneal joints ranges from 0.55 to 1.00mm[34] and the in-plane resolution of the interpolated T2* maps equaled

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0.2*0.2mm, talocalcaneal full thickness cartilage layers were combined and segmented manually using passive polygon contours (Fig 2A). Prior to segmentation, thresholding was performed applying center and window values of 30 ms each (Java-based version of the public domain NIH Image software; Research Services Branch, National Institutes of Health). Care was taken to avoid inclusion of boundary pixels at the cartilage/synovium and cartilage/bone interfaces as partial-volume averaging or magical angle effects may enhance variability in T2* calculations.[35] Nevertheless, given the slice thickness of 3 mm, some amount of partial-volume averaging must be assumed in the reported T2* values. Being centered on the talar dome, T2* maps extended from the lateral to medial talar shoulder with the STJ comprising 8 slices. T2* values were averaged for each slice to obtain a mean STJ T2* value for all slices. Similar to relaxation times, areas of regions of interest (ROI, in mm^2) were determined to support analysis of segmentation consistency. The first echo of the gradient echo series served as a visual guidance to assist in defining ROIs during image processing.[20,30]

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Statistical analysis

The Shapiro Wilk test revealed a Gaussian distribution for all continuous variables ($p > 0.05$). Hence, descriptive statistics for continuous variables are reported as means and SD. Categorical data are presented as absolute counts and proportions relative to the total sample whenever appropriate. All statistical analyses were performed using the SPSS statistical

package for Windows (version 22, IBM Statistics, Armonk, New York, USA). Level of significance was set at $\alpha<0.05$.

Reliability and precision of STJ T2* mapping

As MRI-objectified quantitative cartilage assessments were previously advised to be performed by a single reader,[36] intra-rater reliability as a measure of segmentation consistency was determined using Intra-Class Correlation Coefficient (ICC) 3,2 with 95% Confidence Interval (CI) for a two-way mixed effects model and absolute agreement using T2* maps from all participants. Interpretation of the ICC at the group level was based on previously published recommendations where values higher than 0.75 indicate sufficient reliability and values higher than 0.90 correspond to optimal reliability.[37,38] Confidence intervals (CIs) were also inspected to ensure that lower limits of the interval met the minimum acceptable level, which was set at 0.70.[38] From all participants, one of the two T2* maps was randomly selected and posterior STJ facets were segmented twice in a blinded manner with repetitions at least 2 weeks apart.

The short-term inter-scan precision error as a means to assess measurement error was expressed as the Coefficient of Variation (CV; CV=(SD/mean) and Root Mean Square CV (RMS CV; RMS CV=$\sqrt{((CV_1^2+\ldots+CV_n^2)/n)}$) to allow for comparison with previous studies in the field.[30,32,35,39] Errors were calculated from the two repeated baseline T2* measurements.

Relationship between T2* values and anatomical variants

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To ensure acceptable cell counts for analysis, configuration type categories were grouped by recoding the respective variable into 2 new categories; that is a 3-joint configuration type (i.e., A1,A2) and a 2-joint configuration type (i.e., B1, B2).[6,7] Subsequently, a multiple hierarchical regression model was generated to investigate the relationship between the explanatory variable (i.e., joint configuration type) and the dependent variable (i.e., mean T2* value posterior STJ). Since female participants tended to have lower T2* values than males (r = -0.6, p =0.06), this hierarchical regression model controlled for gender entered as the first of two blocks. Other potential confounders such as BMI (r = 0.3, p = 0.36), age (r = 0.0, p = 0.88) or physical activity score as assessed with the Baecke questionnaire[23] (r = 0.0, p = 0.98) did not correlate with T2* outcomes in this sample and, thus, were not included as to avoid over-fitting of the model.

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RESULTS

Segmentation consistency and inter-scan precision error

Internal segmentation consistency of posterior STJ T2* relaxation times attained an ICC of 0.90 (95%CI 0.69-0.99). Intra-class correlation coefficients pertaining to consistency in segmented ROI areas reached ICC values of 0.95 (95%CI 0.83-0.99).

Short-term inter-scan precision errors for the posterior STJ T2* values comprised a CV ranging from 0.01 to 0.05 which corresponded to a RMS CV of 0.04. Accordingly, precision errors of ROI areas attained a CV range of 0.01 to 0.05 equalling a RMS CV of 0.03.

T2* and configuration type

The mean (SD) posterior STJ T2* value was 20.4 (1.8) ms (in males: 21.4 (1.5) ms and in females: 19.5 (1.6) ms). Of the 12 participants, 3 displayed an A1-type facet configuration (25%), 4 showed an A2-type (33%), 2 a B1-type (17%) and 3 a B2-type configuration (25%). As such, 7 participants displayed a 3-joint configuration type (58%) whereas 5 individuals presented with a 2-joint type (42%).

Figure 3 displays the distribution of mean (SD) STJ T2* values across the distinct facet types. Hierarchical regression modelling revealed that configuration type significantly predicted T2* values in the posterior STJ (β=-0.6, *P*=0.046). Specifically, after adjustment for gender, the presence of a 2-joint configuration type as compared to a 3-joint configuration type was associated with a 2.1ms decrease in T2* relaxation times (Table 1). The final model explained 43% of the variance in T2* values of which 34% was attributed to the variance in joint facet configuration. Table 2 presents mean (SD) posterior STJ T2* values stratified by joint facet configuration and also includes gender distributions across configuration types.

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DISCUSSION

The goal of this study was to investigate the feasibility of cartilage T2* mapping in the STJ. Subsequently, relationships between cartilage biochemical composition and STJ configuration types were explored. With the STJ being a key contributor to shock absorption during the early stance phase of walking gait,[29] joint configuration has been suggested as an intrinsic risk factor for early cartilage deterioration onset.

Excellent segmentation consistency could be attained for both T2* relaxation times and corresponding areas of segmented ROIs. High point estimates were supported by acceptable 95% CI lower bounds which confirmed that good agreement could be obtained with limited interference from between-person variability. Intra-rater reliability for T2* in the STJ is comparable to point estimates reported for knee cartilage and with the use other techniques such as standard T2 (i.e., ICCs ranging 0.8-0.9).[10,30,40] Additionally, precision errors after repositioning equalled on average 3-4% (i.e., ~0.8ms in this sample). Thus, in view of the assessment of T2* changes over time, within-person differences are required to reach at least 4% to increase the likelihood of detecting change with 95% confidence. One may argue that short-term inter-scan precision errors are merely based on repositioning which may not be relevant in clinical settings. Although inter-session comparisons may be influenced by factors such as patient and slice positioning, or magnetic field shimming,[35,39] our precision errors are in agreement with or smaller than T2 or T2* precision errors reported previously in either talocrural or knee joints including assessments based on inter-session repetitions (i.e., CVs ranging 2.0-4.7, RMS CVs ranging 0.01-0.08).[30,32,35,39]

This is the first report on T2* mapping in the STJ, yet present T2* values fit well within ranges reported previously in the healthy hindfoot, that is talo-crural joints, showing T2* relaxation times of 16.6 to 23.3ms.[9,41] Despite the lack of a gold standard or complementary biochemical mapping technique to validate T2* measurements in the STJ, growing evidence suggests that a decrease in T2* value is associated with more progressed cartilage

degeneration as observed in histologic analyses of knee and hip specimens.[8,11,12,16,42] Interestingly, we found a relationship between STJ configuration and cartilage composition. Specifically, those participants exhibiting a fused or 2-joint configuration type tended to have lower T2* values in the posterior STJ when compared to the participants displaying a 3-joint configuration type. Three-joint types have a more transverse orientation of the anterior facet. Along with the potential presence of a capsular fold in the talocalcaneonavicular joint, 3-joint configurations may experience restricted range of motion in inversion/eversion movement as well as improved joint stability.[6,29] Additionally, 3-joint types were suggested to exhibit larger total articular cartilage surfaces relative to the bone which all together may lead to more optimized intra-articular stress distribution upon joint loading.[6] Conversely, fused types may provide the foot with less stability and smaller relative total articulation surfaces. Similar to unfavourable talocrural cartilage T2 or T2* values as seen in functionally unstable ankle joints or asymptomatic cavovarus feet,[9,43] these anatomical alterations may put the cartilage at risk for accelerated deterioration.

One may argue that the anatomical variants under study are present from birth and, from a developmental point of view, should allow for cartilage adaptation over time. Hence, long-term prospective studies are warranted to further gauge the clinical relevance of joint configuration as an independent risk factor or moderator in accelerated STJ cartilage breakdown. Nevertheless, the current results support the use of T2* mapping as a promising technique with potential for fast assessment of STJ cartilage quality. This technique may create a new avenue to monitor (hind)foot joint health and/or to identify individuals at increased risk for accelerated STJ cartilage disease. Ultimately, this marker may hold potential to assist in selecting appropriate candidates for conservative or surgical joint alignment procedures and/or to evaluate or devise effective disease modifying interventions in the STJ. Importantly, however, as T2* measurements may change considerably due to

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cartilage defects within ROIs, assessment of method feasibility needs to be repeated in larger-scaled (older) populations with actual hindfoot cartilage disease in order to support STJ T2* mapping as a clinically viable methodology.

Despite the well-controlled experimental set-up, some limitations require consideration. First, between-reader reliability would have provided a more comprehensive view on method feasibility. Nevertheless, our feasibility constructs are in close agreement with T2 or T2* mapping in the talocrural or knee joint, which have proved to reveal acceptable inter-reader reliability estimates.[10,30,32,35,40] We also opted to evaluate method feasibility for full thickness layers only and did not subdivide the posterior STJ into additional sub-compartments as is commonly performed in similar study set-ups of hip or knee cartilage imaging. Whilst a sub-compartmental approach would have allowed us to examine location-specific cartilage changes, these analyses would require additional reduction of ROI areas and thus would likely have further compromised the level of precision and reproducibility of the technique. Additionally, unlike hip or knee joints which allow greater degrees of angular movement, the STJ is a plane synovial joint which is small and only permits sliding motions with very limited angular movement. Taken together with the relatively high congruence of the hindfoot especially under loading[18], we suggest that variability in location-specific changes is less in the STJ when compared to hip or knee joints. Thus, a sub-compartmental approach may be less relevant, especially considering the technical challenges when analysing increasingly small ROIs. Second, although we were able to establish significant associations, our sample size is relatively small and presents with a limited array of joint configuration variants (i.e., no B3 or C-types present in this sample).[7]Although the more extremely fused joint types may be more prevalent in other ethnic populations (i.e., Indian or Egyptian populations) due to more deep squatting in daily life [7,44], we were thus unable to explore the effects of the more extremely fused joint types. Finally, we were also the first to report on the

reproducibility of the MRI classification system of STJ anatomical variants as previously described[7] and thus could not compare our performance to the existing literature. Whilst acceptable to good reproducibility could be attained in experienced hands, difficulty and error was revealed when distinguishing variants within A- and B-types. As this concurs with rater experiences reported previously[7], our data confirms that C-types may not be present in European populations whereas fusions between anterior and middle facets account for the majority of configuration types present in similar populations.[7] Hence, the convergent validity of the methodology when executed by experienced readers is further supported.

CONCLUSION

Our results show that, in healthy young adults, T2* mapping is a reliable method to monitor cartilage ultra-structure in thin cartilage layers such as the STJ. To enable significant longitudinal change, at least 4% in within-subject difference should be attained. Our sample confirmed that anatomical variants co-define cartilage quality in the STJ with 3-joint configuration types accounting for more beneficial cartilage outcomes. Long-term follow-up studies with larger samples in arthritis populations are warranted to endorse feasibility and applicability of STJ T2* mapping in clinical settings.

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FIGURE LEGENDS

Figure 1. Subtalar joint configuration types as present in this sample. A: A1-type with distinct anterior, medial and posterior facets; B: A2-type with confluence of medial and anterior facets, which remain clearly distinct through the presence of a small inclination between facets; C: B1-type with fusion of medial and anterior facets with narrowing at the site of the fusion; D: B2-type with complete fusion of medial and anterior facets.(7) a = anterior facet; m = medial facet; p = posterior facet.

Figure 2. Example of a polygon contour segmentation of the talocalcaneal cartilage in the posterior subtalar joint. A: segmentation on a colour coded in-line reconstructed T2* map (MapIt, Siemens, Erlangen, Germany); B: first echo of the multi-echo gradient echo sequence used as a visual reference during segmentation.

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Figure 3. Mean (SD) T2* values of the posterior subtalar joint across the 4 distinct facet configuration types as present in the current sample. Note that A1 and A2 types and B1 and B2 types have been merged into respectively 3-joint and 2-joint configuration types for analysis.

TABLES

Table 1. Hierarchical regression model of the relationship between subtalar joint configuration type and posterior subtalar joint cartilage T2* values.

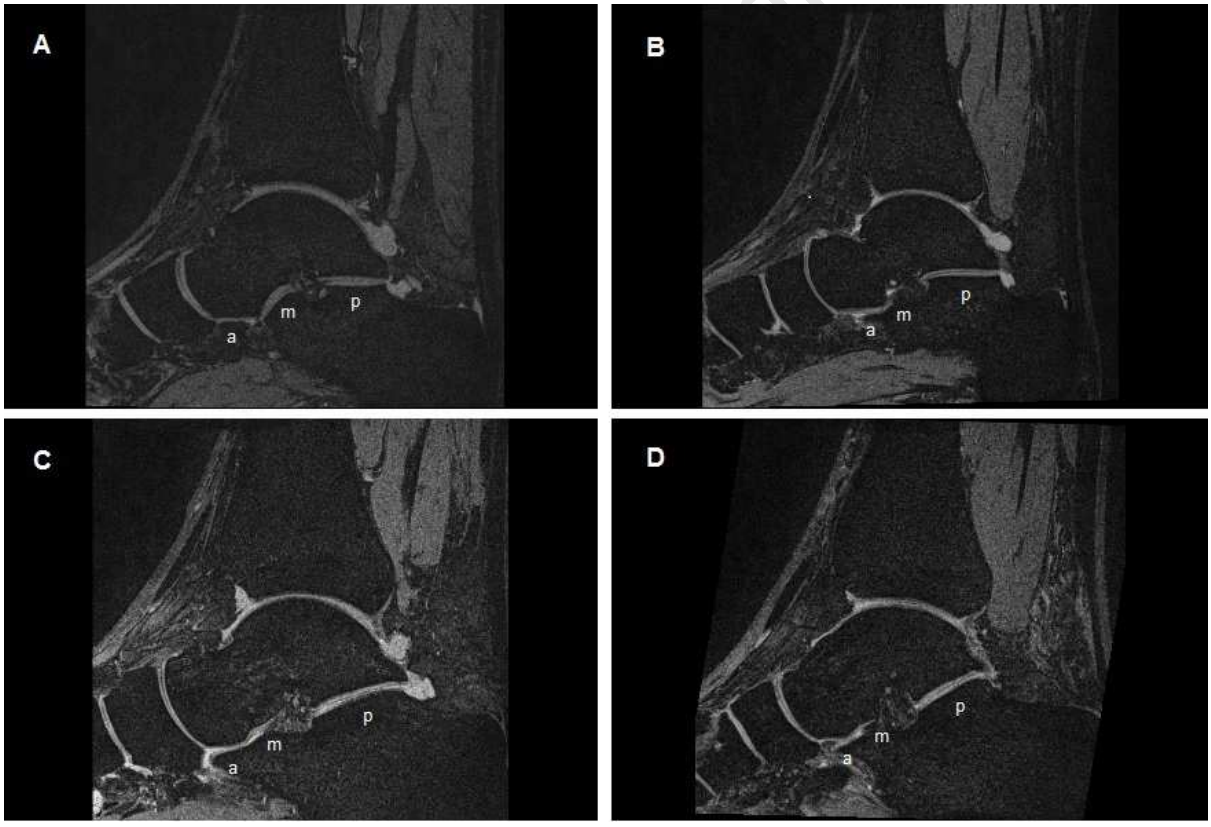
Model	**B (95% CI)**	**SE**	**β**	***t***	***P*-value**
Block 1					
(Constant)	20.9 (19.3,22.6)	0.7		28.1	
Gender	-1.0 (-3.4,1.3)	1.1	-0.3	-1.0	.359
Block 2					
(Constant)	23.7 (20.7,26.8)	1.4		17.5	
Gender	-0.7 (-2.7,1.3)	0.9	-0.2	-0.7	.475
2-joint Configuration Type[#]	-2.1 (-4.1,-0.1)	0.9	-0.6	-2.3	.046*

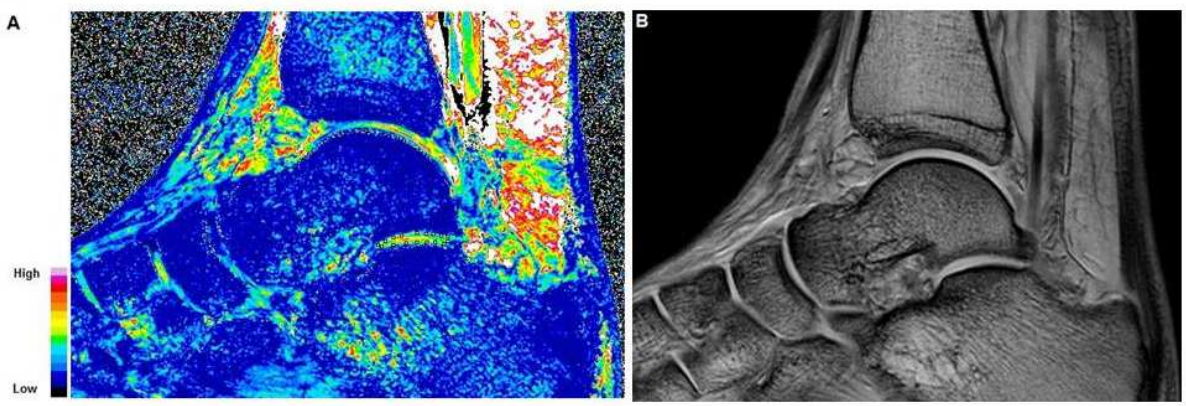
[#]Reference category: '3-joint Configuration Type'; B=Unstandardized Coefficient: Presence of a 2-joint configuration type as compared to a 3-joint configuration type corresponds with B ms decrease in T2* outcomes; 95% CI = 95% Confidence Interval (Lower Bound, Upper Bound); SE = Standard Error; β = standardized regression coefficient; *t* = *t* statistic; *$p <$ 0.05.

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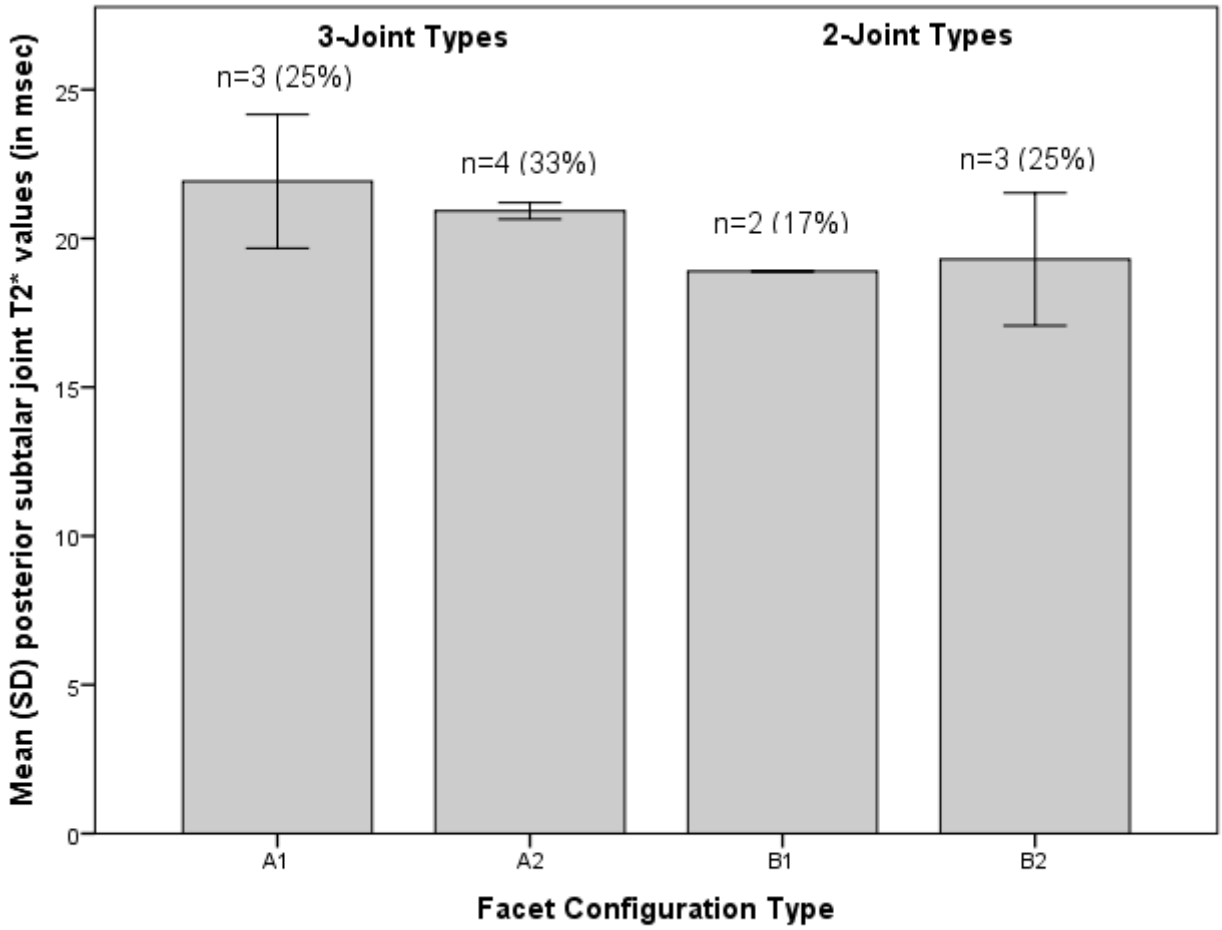
Table 2. Posterior subtalar joint T2* values and gender distribution stratified by facet joint configuration (i.e., 2-joint and 3-joint configuration). Data are presented as mean (SD) unless stated otherwise.

	2-joint configuration	3-joint configuration
Gender, females (n,%)	2 (17%)	4 (33%)
T2* values (in ms)	19.1 (1.6)	21.4 (1.4)





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3-Joint Types
2-Joint Types
n=3 (25%)
n=4 (33%)
n=2 (17%)
n=3 (25%)
Mean (SD) posterior subtalar joint T2* values (in msec)
25
20
15
10
5
0
A1
A2
B1
B2
Facet Configuration Type

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