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Research article

Superolateral Hoffa's fat pad oedema: Relationship with cartilage T2* value and patellofemoral maltracking

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ABSTRACT

Purpose: To determine (1) the association between superolateral Hoffa's fat pad (SHFP) oedema and early cartilage degeneration using T2* mapping and (2) whether patellofemoral maltracking is related to cartilage T2* values or SHFP oedema.

Materials and methods: In this retrospective study, 68 patients (71 knees) with anterior knee pain who had undergone 3-Tesla magnetic resonance imaging (MRI) were enrolled. Cartilage T2* values in medial and lateral patellofemoral compartment as well as patellofemoral maltracking parameters (trochlear angle, sulcus angle, patellar tilt angle, tibial tuberosity-to-trochlear groove [TT-TG] distance, and patellar-tendon to patellar-length [PT-PL] ratio) were compared between case group (24 knees with SHFP oedema) and control group (47 knees without the oedema). The associations between the patellofemoral maltracking and the cartilage T2* values as well as the SHFP oedema were investigated using logistic and linear regression analyses.

Results: The case group showed significantly higher cartilage T2* value in the lateral patellar facet, wider sulcus angle, greater TT-TG distance, and higher PT-PL ratio than the control group. Both SHFP oedema and higher cartilage T2* value in the lateral patellar facet were significantly associated with wider sulcus angle, greater TT-TG distance, and higher PT-PL ratio.

Conclusion: SHFP oedema appears to be associated with inherent cartilage degeneration in the lateral patellar facet. Patellofemoral maltracking might be a risk factor for SHFP oedema and early cartilage damage in the lateral patellar facet.

1. Introduction

Superolateral Hoffa's fat pad (SHFP) oedema is characterized by anterior knee pain and tenderness in the lower pole of the patella and is exacerbated by hyperextension [1]. It is caused by friction between the patellar tendon and the lateral femoral condyle. The MOST study reported that the prevalence was 13.4% [2]. Chung et al. [3] reported that SHFP oedema, which could be visualised using magnetic resonance imaging (MRI), was an important imaging biomarker of patellofemoral maltracking or malalignment. This observation may help the clinician decide which cases are more likely to be successfully treated with early monitoring or intervention.

Anatomical changes associated with patellofemoral maltracking or malalignment could lead to chondromalacia or secondary osteoarthritis in the lateral patellofemoral joint due to abnormal contact area and contact pressure [4,5]. Several previous studies have assessed the association between SHFP oedema and chondral lesions of the patellofemoral compartment, and these studies used semiquantitative scoring or volume measurement on standard sequences to evaluate the patellofemoral cartilage [6,7]. However, the standard MRI has limitation with low sensitivity in the evaluation of early articular cartilage degeneration [8]. If early cartilage damage can be anticipated before the

Abbreviations: dGEMRIC, delayed gadolinium-enhanced MRI of cartilage; ICC, intraclass correlation coefficient; ME-GRE, multi echo gradient recalled echo; MRI, magnetic resonance imaging; OR, odds ratios; PD, proton density; PT-PL, patellar tendon/patellar length; ROI, region of interest; SHFP, superolateral Hoffa's fat pad; TSE, turbo spin-echo; TT-TG, tibial tuberosity-to-trochlear groove

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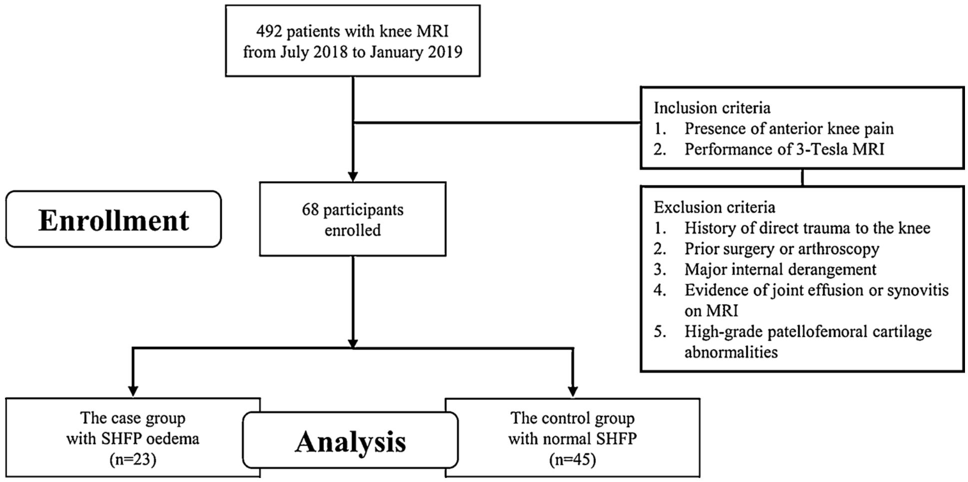


Fig. 1. Flow diagram of the studied population. ***MRI***, magnetic resonance imaging; ***SHPF***, superolateral Hoffa's fat pad.

morphologic change occurs, the source of anterior knee pain can be thought as a cartilage problem, as well as soft tissue problem, and the earlier management can be offered to preserve the cartilage and joint integrity.

Advanced MRI parametric mapping techniques have been developed to evaluate articular cartilage, including T1rho, sodium MRI, delayed gadolinium-enhanced MRI of cartilage (dGEMRIC), and T2 mapping [9]. Most of them remain under investigation, and T2 mapping is the most developed in daily practice [8,10]. Quantification of cartilage transverse relaxation time (T2 mapping) has shown the potential to reflect early cartilage degeneration by detecting matrix degradation [11]. For instance, Subhawong et al. [12] investigated the association between SHFP oedema and early cartilage degeneration using T2 mapping. In addition to T2 mapping, T2* mapping potentially offers several advantages. T2* mapping is performed with a gradient-echo pulse sequences that does not require a 180° refocusing pulse and it gives shorter acquisition time with possibility of high signal-to-noise ratio compared to the T2 mapping. T2* mapping was recently used for evaluating the articular cartilage [11,13–15].

Therefore, the present study aimed to determine, using cartilage T2* mapping, whether SHFP oedema is associated with early cartilage degeneration in the patellofemoral compartment. We also evaluated whether SHFP oedema and early cartilage degeneration were correlated with patellofemoral morphological measurements, which are related to underlying patellofemoral maltracking or malalignment.

2. Materials and methods

2.1. Study population

This retrospective study was approved by the institutional review board, and the requirement for informed consent was waived. Between July 2018 and January 2019, 492 patients underwent MRI of the knee at a single institution. The inclusion criteria were: (1) presence of anterior knee pain, (2) positive physical examination of patellofemoral symptoms, such as the patellar grind test, patellar compression test, patellar brush test, and mediopatellar plica test, and (3) performance of 3-Tesla MRI. Clinical data for the presence of anterior knee pain was based on the referring physician's notes with history and physical examination of knee joint. The exclusion criteria were: (1) history of direct trauma to the knee, (2) prior surgery or arthroscopy, (3) major internal derangement (such as an anterior or posterior cruciate ligament tear), and (4) evidence of joint effusion or synovitis on MRI. Patients with (5) high-grade patellofemoral cartilage abnormalities were also excluded because cartilage T2* values cannot be measured when there is too little cartilage. Of the remaining 68 patients that constituted the study population, 27 were men and 41 were women (mean age: 47 ± 13 years; range: 18–77 years). Our objective was to compare two groups, one with oedema in the SHFP (the case group) and another without SHFP oedema (the control group), with regard to early cartilage degeneration and patellofemoral morphological measurements on MRI scans (Fig. 1). Demographic findings, including sex, age, and body mass index (BMI, kg/m^2), were obtained from the medical records.

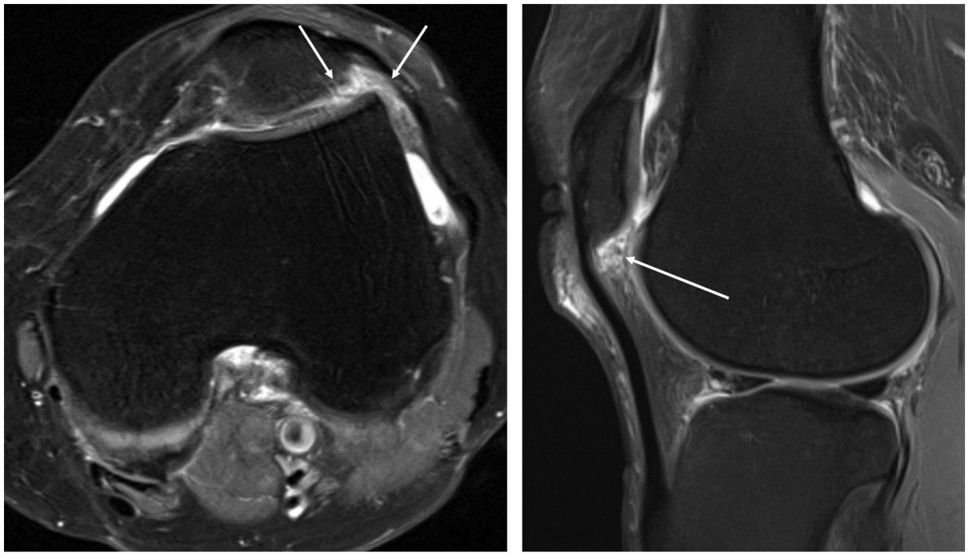
2.2. MRI acquisition

MRI was performed using a 3-Tesla MR system (Skyra; Siemens Healthineers). The protocol of knee MRI consisted of (1) proton density (PD)-weighted turbo spin-echo (TSE) sequences with fat saturation (TR/TE, 4000-4100/27-35) in the axial, sagittal, and coronal planes, and (2) a multi-echo, gradient-recalled echo (ME-GRE) sequence that used six echoes to allow sagittal T2* mapping. Sagittal T2* maps were constructed using a TR of 1100 ms and TE values of 4.4 ms, 11.9 ms, 19.4 ms, 27.0 ms, and 34.5 ms. The geometric acquisition parameters of all sagittal images were identical (field-of-view: 140 x 140 mm; matrix: 352 × 352; section-thickness: 3 mm).

2.3. Image analysis

All MRI scans of the knee were reviewed by two radiologists (BLINDED and BLINDED, with 3 and 9 years of experience in musculoskeletal radiology, respectively) independently. The presence of focal oedematous change of the SHFP was evaluated (Fig. 2). Abnormal signal intensity in the superolateral portion that extended for more than 10% of the length of the patellar tendon was recorded as positive [2]. Patients were then divided into two groups: a case group with SHFP oedema and a control group without.

For the region of interest (ROI) analysis of the T2* map, MRI data was transferred to imaging software (Syngo.via; Siemens Healthineers) and the coloured T2* maps were reconstructed. In combination with the morphologic images provided by the PD-weighted TSE sequences, ROIs were manually drawn in the representative sagittal images of the T2* map, through the medial and lateral patellofemoral joints. The ROI covered the full thickness of cartilage in the lateral/medial patellar facets and in the lateral/medial trochlear facets. Subsequently, the mean values of the T2* relaxation times for each ROI were calculated. The segmented areas of cartilage were then overlaid on an image with a TE of 27.0 ms from the multi-echo T2* acquisition; this provided the best cartilage-to-bone and cartilage-to-joint fluid contrast. The



A B

Fig. 2. A 49-year old woman with anterior knee pain. (A) Axial and (B) sagittal proton density-weighted fat-saturated MR images showing focal ill-defined oedema-like signal intensity in the superolateral Hoffa's fat pad (dotted circles).

segmented areas of cartilage were then colour-coded in the image with a TE of 27.0 ms. Normal cartilage was displayed as a smooth and homogeneous blue colour on the articular surface [16]. The time required for T2* analysis was less than 10 min for each patient. The mean cartilage T2* value for healthy volunteers was found to be 28.2 ± 1.7 ms on the medial tibial cartilage and 27.5 ± 1.6 ms on the lateral tibial cartilage, taken as a normal reference T2* value [17]. Examples of cartilage T2* maps with ROI measurement in the four different zones are shown in Fig. 3.

With regards to the patellofemoral maltracking parameters, the following criteria were measured on axial and sagittal PD-weighted images according to previously described methods: trochlear angle [2,18], sulcus angle [2,18–20], patellar tilt angle [18–21], tibial tuberosity-to-trochlear groove (TT-TG) distance [18–21], and patellar tendon/patellar length (PT-PL) ratio (based on the Insall–Salvati ratio) [1,18–21] (Fig. 4).

2.4. Statistical analysis

The Student's *t*-test was performed to compare age, cartilage T2* values, and patellofemoral maltracking parameters, while the chi-square test was used to compare the two groups in terms of sex. Logistic regression analysis was used to assess the association between SHFP oedema and relevant maltracking parameters. The maltracking parameters were first tested in univariate logistic regression analysis, and then multivariate logistic regression analysis was performed to assess the association between SHFP oedema and relevant maltracking parameters, adjusted for age, sex, and BMI. Multiple linear regression and Pearson correlation were performed to assess the association between cartilage T2* values and relevant maltracking parameters. Assessment of relative importance of regressors in the multiple linear regression analysis was performed by R package [22]. Interrater agreement for the presence or absence of SHFP oedema was tested by the Cohen kappa test. Interrater agreement for the cartilage T2* values and patellofemoral maltracking parameters was measured with the intraclass correlation coefficient (ICC). A *P*-value of < 0.05 was considered statistically significant. All data were tested for normality using the Kolmogorov-Smirnov test. According to the Kolmogorov-Smirnov test, the data was normally distributed. Statistical analyses were performed using the SPSS software package, version 20.0.

3. Results

The case group contained a total of 23 patients (mean age: 52 ± 12 years; 6 men, 17 women; mean BMI: 25.1 ± 3.2) with 24 knee MRI examinations demonstrating SHFP oedema, while the control group comprised 45 patients (mean age: 45 ± 12 years; 21 men, 24 women; mean BMI: 24.9 ± 3.3) with 47 knee MRI examinations without SHFP oedema. There were no differences in age, sex, or BMI between the two groups (P = 0.051, 0.101, and 0.843, respectively).

The case group demonstrated significantly higher cartilage T2* values in the lateral patellar facet than the control group ($P = 0.004$), as well as significantly wider sulcus angle ($P < 0.001$), longer TT-TG distance ($P < 0.006$), and higher PT-PL ratio ($P < 0.001$) (Table 1).

Univariate logistic regression analysis showed an association between SHFP oedema and the following maltracking parameters: sulcus angle, TT-TG distance, and PT-PL ratio. Of all demographic and maltracking parameters, wider sulcus angle (odds ratios [OR] = 1.325, P = 0.006), longer TT-TG distance (OR = 2.228, $P = 0.019$), and higher PT-PL ratio (OR = 1.092, $P = 0.036$) were significantly associated with SHFP oedema (Table 2).

Among the maltracking parameters, the following were positively correlated with T2* value in lateral patellar cartilage: sulcus angle ($r = 0.264$, $P = 0.026$), TT-TG distance ($r = 0.259$, $P = 0.029$), and PT-PL ratio ($r = 0.185$, $P = 0.123$) (Fig. 5). Multiple linear regression analysis demonstrated that the following parameters were significantly independently associated with higher cartilage T2* value in the lateral patellar facet: sulcus angle (β = 0.0832, relative importance = 41%), TT-TG distance (β = 0.3225, relative importance = 43.6%), and PT-PL ratio (β = 0.0203, relative importance = 15.4%) (Table 3).

Interrater agreement was excellent (kappa = 1.0) for the presence or absence of SHFP oedema, and the ICCs for cartilage T2* values, trochlear angle, sulcus angle, patellar tilt angle, TT-TG distance, and PT-PL ratio were from 0.848 to 0.915. Representative images for the case and control groups are shown in Figs. 6 and 7.

4. Discussion

Our findings highlight an apparent association between SHFP oedema and higher cartilage T2* value in the lateral patellar facet. Patients with a wider sulcus angle (indicating a shallow trochlea),

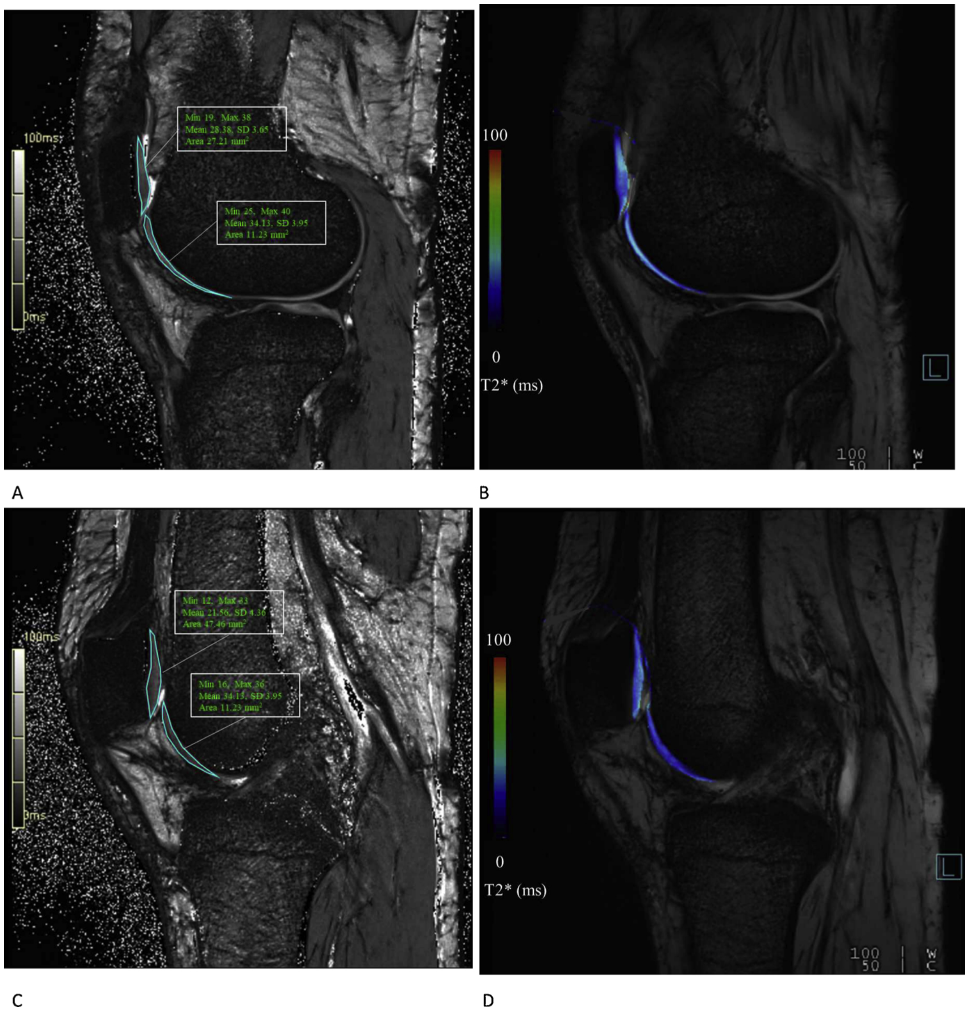


Fig. 3. Sagittal T2* maps of the lateral patellar/trochlear facets and medial patellar/trochlear facets obtained from a 52-year old woman with anterior knee pain. (A) ROIs were manually drawn in the representative sagittal T2* map of the lateral patellar/trochlear facets and (B) the segmented areas of cartilage were overlaid in the image with a TE of 27.0 ms from the multi-echo T2* acquisition, to provide a corresponding colour-coded image of the cartilage. (C) Sagittal T2* map and (D) corresponding colour-coded image of cartilage in the medial patellar/trochlear facets. ***ROI***, region of interest; ***TE***, echo time.

longer TT-TG distance (indicating a more lateral patellar position), and a higher PT-PL ratio (indicating patella alta) had significantly higher cartilage T2* value in the lateral patellar facet (indicating more severe cartilage degeneration), as well as SHFP oedema. Thus, patellofemoral maltracking might be a marker for SHFP oedema and concurrent inherent cartilage degeneration, as well as a predictor of future cartilage loss [6,7].

As MRI imaging has developed, quantitative MRI techniques have been used to detect early cartilage degeneration. On account of its development, functional MRI techniques can find the chondromalacic lesion which is hard to detect in standard MRI alone [8]. Chondromalacic lesion can be found by increased signal intensity within articular cartilage on T2-weighted fast spin-echo images, but this is not easy and using T2 or T2* mapping makes it easier [23,24]. T2 mapping has emerged as a functional imaging tool for cartilage; it reflects early alterations in collagen organization and tissue anisotropy. These cartilage degeneration-related changes lead to increased water mobility and thus increased T2 value on MRI [25]. However, T2 mapping is limited in a clinical setting because its acquisition times exceed 10 min to ensure accurate characterization of the T2 map [14]. For this reason, T2* mapping has been suggested as an alternative to T2 mapping; it has shown reliable results in cartilage imaging because it has a shorter scan time and higher spatial resolution [15,26]. Despite these advantages, T2* mapping has not been used to assess cartilage degeneration in patients with SHFP oedema and patellofemoral maltracking. Therefore, in the present study, we used T2* mapping to find the association between SHFP oedema and early cartilage change.

Several studies have identified an association between SHFP oedema and patellofemoral cartilage damage [6,7,12]. For instance, Jarraya et al. [6] performed a large-scale epidemiological study using semiquantitative scoring of cartilage lesions; they reported that SHFP oedema was associated with cartilage damage of the patellofemoral joint. Subhawong et al. [12] performed cartilage T2 mapping and reported that patients with SHFP oedema had a higher cartilage T2 value in the patellofemoral joint. Haj-Mirzaian et al. [7] investigated the association between SHFP oedema and patellar cartilage volume loss using quantitative volumetric MRI analysis, demonstrating that SHFP oedema was associated with simultaneous lateral patellar chondromalacia. They suggested that SHFP oedema is a predictor of lateral patellar osteoarthritis [7]. As anticipated, we found that the cartilage T2* value of the lateral patellar facet was higher in the case group with SHFP oedema than in the control group.

SHFP oedema has gained attention recently, with several studies postulating that it results from patellofemoral maltracking [2,6,19,21,27]. For example, Campagna et al. [27] and Widjajahakim et al. [2] demonstrated that a more lateral patellar displacement (longer

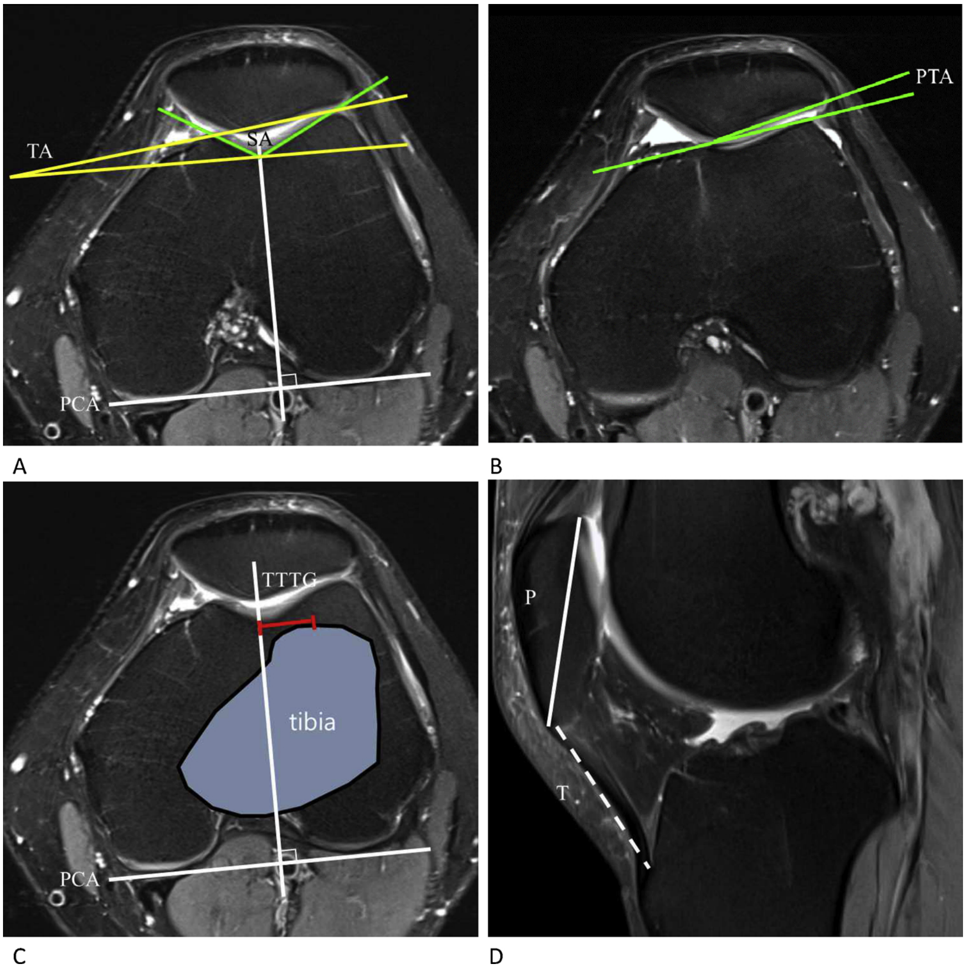


Fig. 4. MR images to measure patellofemoral maltracking parameters. (A) The section with the posterior-most condyle is selected. The trochlear and sulcus angle areas are then drawn based on both the posterior condylar axis and the lines between the bony cortex of the femoral trochlea. (B) The section with the greatest patellar width is selected. The patellar tilt angle is then drawn based on both the line tangential to the anterior condyles and the line parallel to the bony lateral patellar facet. (C) Tibial tuberosity-to-trochlear groove distance is measured as the distance from the mid-trochlear groove to the midpoint of tibial tuberosity, parallel to the posterior condylar axis. (D) The section with the greatest diagonal patellar length selected (P, solid line), and the distance of the patellar tendon from the inferior patellar pole to the tibial tuberosity (T, dashed line) is then measured. Insall–Salvati ratio was calculated as T/P. ***P***, patella; ***PCA***, posterior condylar axis; ***PTA***, ***SA***, sulcus angle; ***TA***, trochlear angle; patellar tilt angle; ***TTTG***, tibial tuberosity-to-trochlear groove distance; ***T***, patellar tendon.

Table 1
Comparison of cartilage T2* values and patellofemoral maltracking parameters between case group and control group. ***TT-TG,*** tibial tuberosity-to-trochlear groove distance; ***PT-PL,*** patellar tendon to patellar length ratio.

	Case (n = 24)	Control (n = 47)	*P* value
Patellofemoral T2* cartilages			
lateral patellar facet, (ms)	29.8 ± 3.7	27.2 ± 3.3	0.004*
medial patellar facet, (ms)	21.6 ± 4.1	21.9 ± 3.4	0.764
lateral trochlear facet, (ms)	36.2 ± 5.1	36.1 ± 4.7	0.944
medial trochlear facet, (ms)	27.9 ± 3.2	26.5 ± 3.3	0.102
Patellofemoral maltracking			
trochlear angle, (°)	6.5 ± 2.7	6.1 ± 2.4	0.541
sulcus angle, (°)	147.6 ± 7.3	138.6 ± 6.9	< 0.001*
patellar tilt angle, (°)	7.4 ± 3.7	7.1 ± 4.4	0.821
TT-TG distance, (mm)	11.5 ± 2.6	9.9 ± 1.8	0.006*
PT-PL ratio	1.1 ± 0.1	0.9 ± 0.1	< 0.001*

* Indicates statistically significant difference.

TT-TG distance) and a higher-riding patella were significantly associated with SHFP oedema, suggesting that these conditions cause an impingement between the lateral femoral condyle and the posterior aspect of the patellar ligament. Matcuk et al. [19] and Widjajahakim et al. [2] found that wider sulcus angle, indicating flatness of the trochlear groove, might be a risk factor for SHFP impingement. Our findings are consistent with these previous studies. In a used multivariate logistic regression analysis, we found that higher PT-PL ratio, longer TT-TG distance, and wider sulcus angle are risk factors for SHFP oedema on MRI.

Patellar tracking along the trochlear groove is stabilised during the knee's range of motion by a congruent morphology of bony articulation, as well as by soft tissues surrounding the patella [28–30]. It follows that patellofemoral maltracking may cause impingement on soft tissue such as the SHFP, leading to cartilage damage in the patellofemoral joint. Thuiller et al. [31] found that patients with patellofemoral maltracking showed higher cartilage $T_{1\rho}$ values in their lateral patellar facets, reflecting early cartilage degeneration. Our results were consistent with previous studies in this regard. We found that higher-riding patella, longer TT-TG distance, and wider sulcus angle were significantly associated with SHFP oedema and with higher T2* cartilage value in the lateral patellar facet. Several possible mechanisms may explain our results. For example, high-riding patella—also known as patella alta—causes delayed engagement between the patella and trochlear groove during knee flexion; this reduces the articular contact area and leads to abnormal increases in maximal patellofemoral contact pressure [2,7,18]. Alternatively, a wide sulcus angle between the trochlea and patella alta confers less bony constraint on the mediolateral stability of the patella during low flexion. This may increase the chances of SHFP impingement and patellofemoral maltracking [2,18]. Finally, an increased TT-TG distance generates lateral movement of the patella, leading to lateral displacement [18,21]. Such abnormal patellar alignment probably decreases the contact area, resulting in increased patellofemoral joint stress, particularly in the lateral area [2,18,27]. Consistent with these mechanisms, our results showed that the case group had a significantly higher cartilage T2* value of the lateral patellar facet. However, our results showed no difference in lateral trochlear groove between the two groups. Interestingly, the T2* values in the lateral trochlear groove were higher than the normal value in both

Table 2
Association between patellofemoral maltracking parameters and SHFP oedema. ***CI***, confidence interval; ***TT-TG***, tibial tuberosity-to-trochlear groove distance; ***PT-PL***, patellar tendon to patellar length ratio; ***N/A***, not applicable (was not included in multivariate analysis).

	Univariate			Multivariate		
	Odds ratio	95% CI	*P* value	Odds ratio	95% CI	*P* value
Age	1.040	0.996-1.085	0.074	N/A	N/A	N/A
Sex	0.510	0.178-1.459	0.209	N/A	N/A	N/A
Body mass index	1.020	0.866-1.201	0.815	N/A	N/A	N/A
Patellofemoral maltracking						
trochlear angle, (°)	1.063	0.876-1.292	0.535	N/A	N/A	N/A
sulcus angle, (°)	1.185	1.087-1.291	< 0.001*	1.325	1.086-1.616	0.006*
patellar tilt angle, (°)	1.014	0.901-1.141	0.818	N/A	N/A	N/A
TT-TG distance, (mm)	1.421	1.082-1.866	0.012*	2.228	1.141-4.352	0.019*
PT-PL ratio (x10^2)	1.089	1.089-1.146	0.001*	1.092	1.006-1.186	0.036*

* Indicates statistically significant difference.

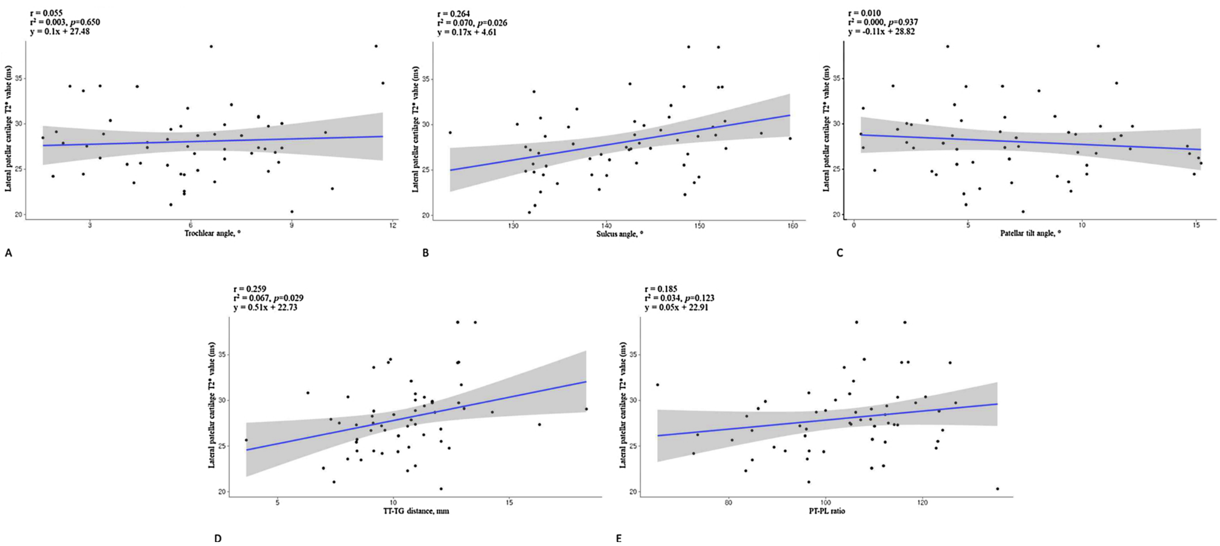


Fig. 5. The relationship between patellofemoral maltracking parameters and cartilage T2* value in the lateral patellar facet. (A) Trochlear angle, (B) sulcus angle, (C) patellar tilt angle, (D) tibial tuberosity-to-trochlear groove distance, and (E) patellar tendon/patellar length ratio. ***PT-PL***; patellar tendon/patellar length; ***r***, Pearson's correlate; ***r2***, goodness-of-fit of linear regression; ***TT-TG***, tibial tuberosity-to-trochlear groove.

Table 3
The relative importance analysis (multiple linear regression) to select predictor variables among maltracking parameters for higher cartilage T2* values in lateral patellar facet. ***TT-TG***, tibial tuberosity-to-trochlear groove distance; ***PT-PL***, patellar tendon to patellar length ratio; ***N/A***, not applicable (was not included in multivariate analysis).

	Estimate	Standard Error	*t* value	Relative importance
trochlear angle, (°)	N/A	N/A	N/A	N/A
sulcus angle, (°)	0.0832	0.0554	1.50	41%
patellar tilt angle, (°)	N/A	N/A	N/A	N/A
TT-TG distance, (mm)	0.3225	0.1919	1.68	43.6%
PT-PL ratio (x10^2)	0.0203	0.0309	0.66	15.4%

groups, which might be confounding factors for the results seen in the lateral trochlear groove. Symptoms (anterior knee pain) and the magic-angle effect may constitute confounding factors when measuring trochlear groove cartilage [14,32]. More in-depth studies are needed to determine the effect of SHFP oedema on cartilage degeneration in the lateral trochlear groove.

There were several limitations in the present study. Firstly, the study was conducted retrospectively in a single institution, with a limited study population. Future studies involving larger populations are warranted. Secondly, we did not perform any arthroscopic assessment of chondromalacia. In future, *in vitro* or animal studies will be required to clarify the T2* mapping of cartilage ultrastructure. Thirdly, we used patients without SHFP oedema as a control group. However, these patients were not true controls, as their knee MRI examinations were also performed due to anterior knee pain. Future cohort studies may need to compare cartilage T2* values between patients with SHFP oedema and asymptomatic controls. Fourth, the low number of study participants could have caused selection bias. We included only 14% (68 of 492 patients) of the initially enrolled patients because the T2* map of cartilage could be acquired from a 3.0-T MRI scanner at our institution. However, there were no difference in selecting patients for either a 1.5- or 3.0-Tesla MRI. Thus, we cautiously consider that our sample size might represent the population of SHFP oedema patients, despite its low sample size. Large and high-quality studies are warranted in the future to determine the prevalence and factors associated with SHFP oedema.

Our findings demonstrated that patients with SHFP oedema showed significantly higher cartilage T2* value in the lateral patellar facet than patients without SHFP oedema. In patients with of patellofemoral maltracking, wider sulcus angle, longer TT-TG distance, and higher PT-PL ratio were risk factors for SHFP oedema and for higher cartilage T2* value in the lateral patellar facet. Thus, SHFP oedema may be a marker of inherent cartilage degeneration and patellofemoral maltracking may lead to SHFP oedema and concurrent cartilage degeneration in the lateral patellar facet.

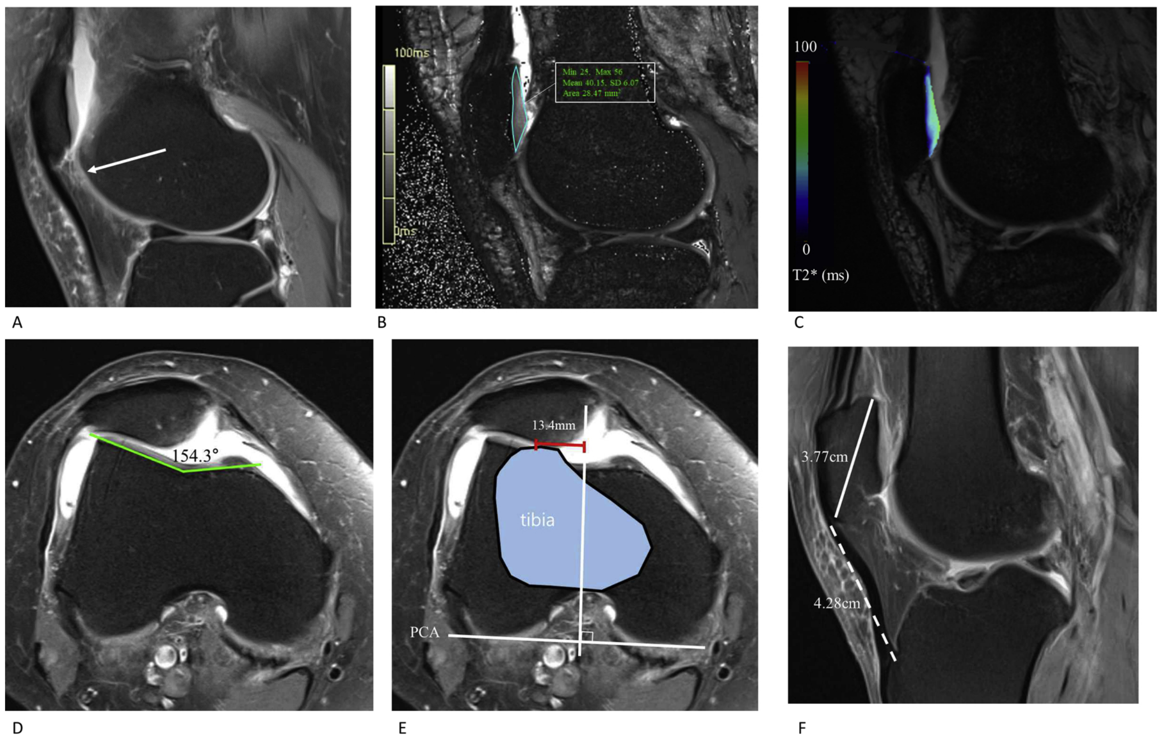


Fig. 6. A 57-year-old woman with SHFP oedema. (A) Sagittal proton-density weighted fat-saturated image showing focal, ill-defined, oedema-like signal intensity in the SHPF (dotted circle). (B) Sagittal T2* map and (C) corresponding colour-coded image of cartilage in the lateral patellar facet showing elevated T2* value (40.15 ms). (D) Relatively wide sulcus angle between the bony cortex of the femoral trochlea (154.3°). (E) Relatively long tibial tuberosity-to-trochlear groove distance (13.4 mm). (F) The greatest diagonal length of the patella is 3.77 cm and the length of patellar tendon is 4.28 cm, with a relatively high Insall–Salvati ratio of 1.135. ***PCA***, posterior condylar axis; ***SHFP***, superolateral Hoffa's fat pad.

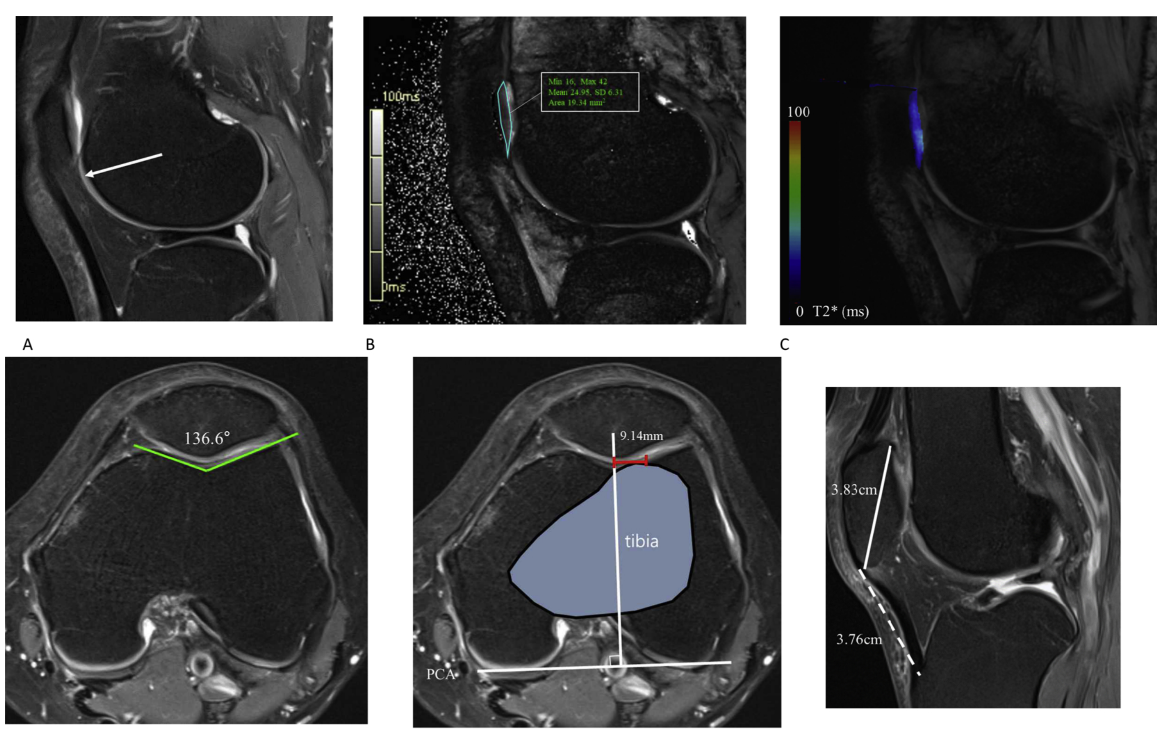


Fig. 7. A 55-year-old woman without SHFP oedema. (A) Sagittal proton density-weighted, fat-saturated image shows normal signal intensity in the SHFP (arrow). (B) Sagittal T2* map and (C) corresponding colour-coded image of cartilage in the lateral patellar facet showing low T2* value (24.95 ms). (D) Sulcus angle between the bony cortex of the femoral trochlea within the normal range (136.6°). (E) Tibial tuberosity-to-trochlear groove distance within normal range (9.14 mm). (F) The greatest diagonal length of the patella is 3.83 cm and the length of the patellar tendon is 3.76 cm, with a normal Insall–Salvati ratio of 0.981. ***PCA***, posterior condylar axis; ***SHFP***, superolateral Hoffa's fat pad.

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