

Concordance of Patellar Tendinopathy in Patients with Primary Knee Osteoarthritis: A Clinical and Ultrasonographic Study

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ABSTRACT

Purpose: Patellar tendinopathy occurs by patellar tendons [PT] repetitive microtrauma and overuse. Besides knee is the most commonly involved peripheral joint in osteoarthritis [OA]. The aim of study was to investigate the concordance of patellar tendinopathy in patients with primary knee OA.

Material and methods: Seventy eight [7 men and 71 women] patients with knee OA aged between 35-75 were included in the study. Demographic, clinical data, bilateral tenderness of the PT, visual analog scale [VAS] for pain assessment and ultrasonographic findings were recorded. The patients were divided into three groups according to grade of knee OA [grade 2, 3 and 4]. All patients' PT examined with ultrasonography [US] by the same investigator.

Results: The grade 2, 3, 4 OA groups were included 20, 42, 16 patients respectively. Significant correlations were detected between the proximal thicknesses of both knees (average) and age ($p=0.000$, $r=0.395$), weight ($p=0.001$, $r=0.382$), BMI ($p=0.021$, $r=0.261$) and VAS ($p=0.002$, $r=0.344$). There were statistically significant difference and positive correlation between measurements of PT thickness and grade of OA comparing with grade 2-3 OA ($p=0.001$). Furthermore there were statistically significant correlation between the tenderness of PT and proximal and distal PT thickness measurements in same knee ($r=0.244$, $p=0.031$; $r=0.416$, $p<0.001$, respectively). We did not detect any Power Doppler [PD] signal in 78 patients' PT.

Conclusion: The age, weight, BMI and severity of OA were independent risk factors of patellar tendinopathy. Also US is reliable imaging technique for detect patellar tendinopathy in patients with knee OA. Physical examination may not be omitted when evaluating patellar tendinopathy with US.

Keywords: Patellar tendinopathy; Knee osteoarthritis; Ultrasonography

INTRODUCTION

Osteoarthritis [OA] is a chronic noninflammatory degenerative disease characterized by progressive destruction of articular cartilage, osteophytes and subchondral sclerosis that occurs especially in weight-bearing joints. Progressive disability develops over time, exacerbated by joint pain and limited range of motion [1]. The knee is the most frequently involved peripheral joint in OA.

Patellar tendinopathy occurs from repetitive microtrauma and overuse of the patellar tendon [PT]. This condition also referred to as "jumper's knee", affects young active people involved in sports or recreational activities [2]. The diagnosis of PT injuries is often based on clinical findings such as tenderness on patellar insertion

and anterior knee pain; however, imaging of the PT with magnetic resonance imaging [MRI] or ultrasonography [US] is more advantageous [3]. US are a useful and straight forward method for the diagnostic investigation of patellar tendinopathy because of its low cost and feasibility. Furthermore, US can be used to verify the clinical diagnosis and assess the severity of tendinosis by examining parameters such as tendon thickness, internal structure and vascularization.

Although many studies on patellar tendinopathy related to sports injury have been reported, few have investigated the coexistence of patellar tendinopathy in primary knee OA. The aims of the present study were threefold: to test the reproducibility of palpation tenderness of the patellar tendon and visual analog scale [VAS] in patients with knee OA; to evaluate the effects of other OA risk

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Received: August 16, 2019; **Accepted:** August 26, 2019; **Published:** September 02, 2019

Citation: Tekeoglu I, Takci S, Harman H, Sag S (2019) Concordance of Patellar Tendinopathy in Patients with Primary Knee Osteoarthritis: A Clinical and Ultrasonographic Study. *Rheumatology (Sunnyvale)*. 9:252. DOI: 10.35248/2161-1149.19.9.252.

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factors in developing patellar tendinopathy using US imaging; and to assess the concordance of patellar tendinopathy and knee OA by comparing the severity of OA.

MATERIALS AND METHODS

Subjects and clinical data

This study included 78 patients [7 males and 71 females] aged 35-75 years with knee OA who were referred to outpatient clinic of the faculty of medicine. OA is classified using the criteria developed by the American College of Rheumatology [4], and is routinely characterized in the knee joint using radiographic diagnosis according to the five-point grading system developed by Kellgren and Lawrence [5]. To avoid conditions that could interfere with the PT, we excluded patients with inflammatory rheumatic diseases, infectious disease of the joints, hemarthrosis, a history of trauma to the knee, those who had undergone patellar tendon or knee surgery, and patients aged >75 because of the possibility of tendon atrophy.

The following demographic and clinical data were recorded at baseline: sex, age, bilateral tenderness of the PT (presence/absence), height, weight, Body Mass Index [BMI] and Visual Analog Scale [VAS] for pain assessment. Furthermore, all patients were examined by antero-posterior and lateral knee graphics to evaluate the grade of knee OA. Patients were divided into three groups according to grade of OA. Patients with grade 1 OA were excluded because they were younger and had mild OA. To assess tenderness and pain, the inferior pole of the patella was tilted anteriorly in both the right and left knees.

US ASSESSMENT

Subjects were imaged in the supine position with the knee extended; care was taken to ensure that the quadriceps was relaxed. The examination comprised gray-scale and power Doppler [PD] sonography of the right and left PTs of the patients. The PTs were scanned with the transducer oriented parallel to the long and transvers axis of the tendons. In scans, a normal PT showed a 4-5-mm-thick band consisting of parallel hypo- and hyper-echoic

regions in regular waveform. PT measurements were made 6 mm distal to the patellar (Figure 1) and 6 mm proximal to the tibial tuberosity insertions (Figure 2) on the longitudinal and transversal plane. PT thickness was calculated the mean of two measurement.

A Logiq P5 US machine [General electric, Wauwatosa, United States] with a 5-13-MHz linear transducer was used. All US examinations and determination were performed by a trained ultrasonographer with 2 years of experience [US1], after which the examinations were repeated by another trained ultrasonographer with 6 months of experience [US2]. US1 findings were used in the statistical analysis. The study protocol was approved by the Ethics Committee of our institution and informed consent was obtained from all patients.

STATISTICAL ANALYSIS

Descriptive statistical analyses were performed and presented as means [IQR] \pm standard deviation for continuous variables. All qualitative data were expressed as frequencies and percentages. Statistical tests of differences in continuous variables between groups were performed using the ANOVA test. Correlations were investigated by Pearson correlation analysis and multivariate linear regression models, when appropriate. Unweighted kappa statistics were used to calculate interobserver agreements for measurement of PT thickness. p values <0.05 were considered to indicate significance. All statistical analyses were performed using SPSS for Windows version 20.0.

RESULTS

This study included 71 females and 7 males aged 35-75 years who had knee OA. The grade 2, 3 and 4 OA groups included 20, 42 and 16 patients, respectively. Significant differences were observed between grade 2 and 3 and between grade 2, 3 and 4 OA in all variables, with the exception of height (height, respectively, $p=0.234$, $p=0.308$). The demographic and clinical characteristics of the groups are summarized in Table 1 with the mean [IQR] \pm standard deviation values and the P values of the intragroup correlations.

We matched the ultrasonographic findings among the groups,

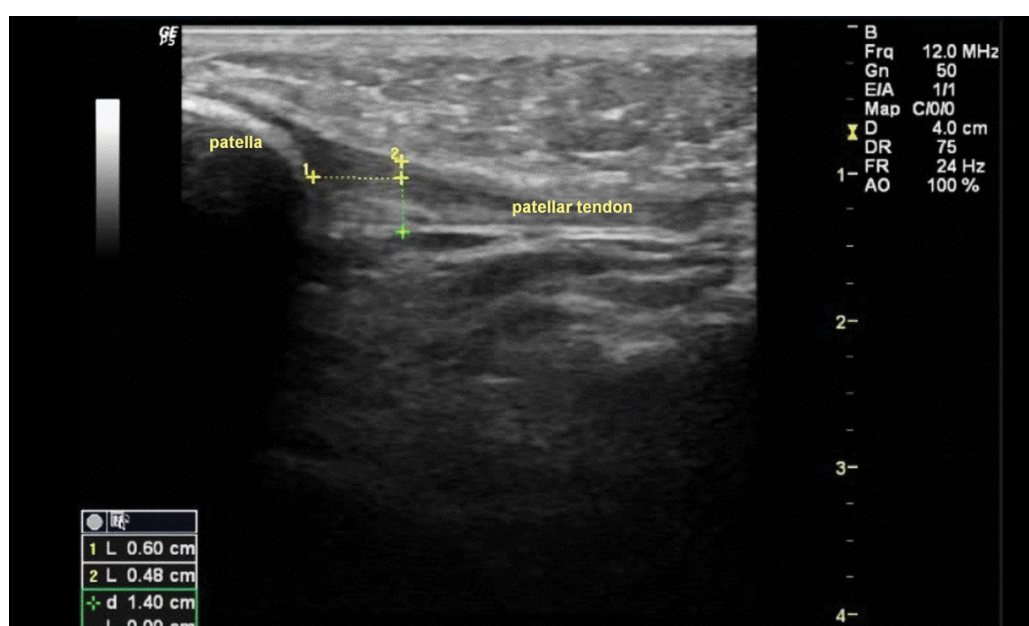


Figure 1: The measurement of patellar tendon from proximal end.

and detected no PD signal in the PT in 78 patients. A significant correlation was observed between PT tenderness and proximal and distal PT thickness measurements in same knee ($r=0.244$, $p=0.031$; $r=0.416$, $p<0.001$, respectively). Significant differences in and positive correlations of, PT thickness and the grade of OA was found between the grades 2-3 and 4 OA groups. In contrast, we found no significant difference in ultrasonographic findings between grades 3 and 4 OA patients (Table 2). Figure 3 shows the correlation between PT thickness [average] and grade of OA.

Significant correlations were detected between the proximal thicknesses of both knees [average] and age ($p=0.000$, $r=0.395$), weight ($p=0.001$, $r=0.382$), BMI ($p=0.021$, $r=0.261$) and VAS ($p=0.002$, $r=0.344$). Likewise, significant correlations were found

between the distal thickness in both knees [average] and age ($p=0.000$, $r=0.593$), weight ($p=0.001$, $r=0.325$), BMI ($p=0.021$, $r=0.318$) and VAS ($p=0.002$, $r=0.650$).

To establish the best model to predict PT thickness, multivariable linear regression analysis was performed with the variables that were significantly correlated by univariate analysis with PT thickness. Thus, the dependent variable was the PT thickness and the independent variables were age, weight and grade of OA, respectively. The stepwise procedure selected age, weight and grade of OA as the best predictors. In this model, the R^2c for age was 0.156 ($F=14.08$ $p=0.000$), the grade of OA was 0.143 ($F=12.67$, $p=0.001$) and weight was 0.146 ($F=13.04$, $p=0.001$).

The extents of interobserver agreement were 88%, 91% for the

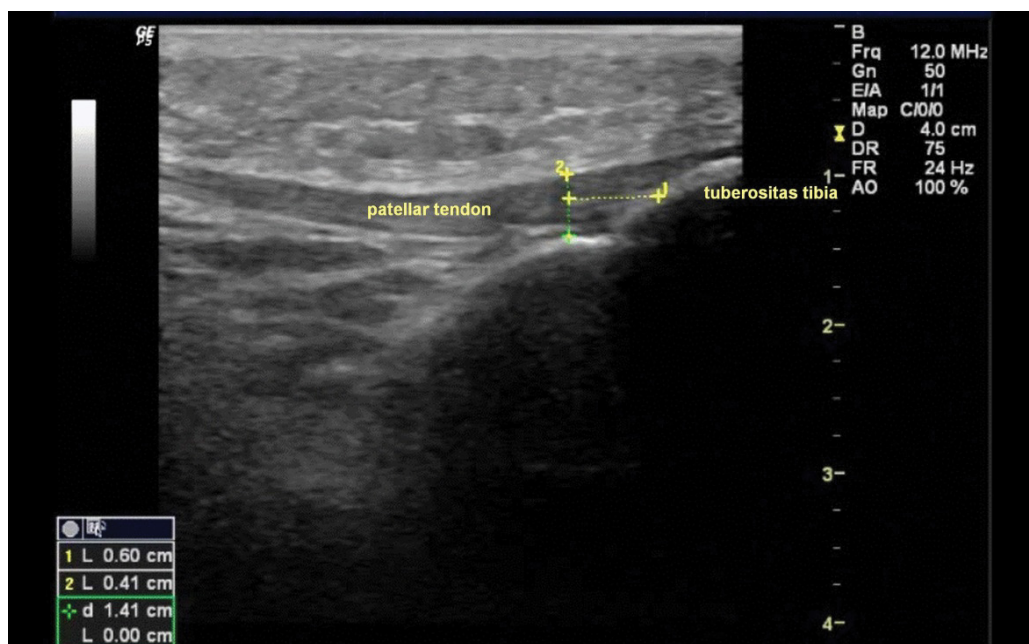


Figure 2: The measurement of patellar tendon from distal end.

Table 1: The demographic and clinical characteristics of 78 patients with knee OA and intragroup correlations.

Different characteristics	Grade 2 OA	Grade 3 OA	Grade 4 OA	Grade 2,3 p values	Grade 3,4 p values	Grade 2, 3, 4 p values
Age, mean [IQR] ± SD years	45.45 ± 5.01 [45.4]	56.62 ± 7.67 [57]	62.75 ± 7.27 [62.25]	0	0.01	0
Height, mean [IQR] ± SD, cm	163.45 ± 7.38 [163.5]	160.76 ± 7.20 [160.12]	162.69 ± 4.99 [161.37]	0.201	0.234	0.308
Weight, mean [IQR] ± SD, kg	71.9 ± 13.99 [70.37]	82.45 ± 14.4 [81.12]	85.25 ± 11.99 [85.62]	0.005	0.577	0.006
BMI, mean [IQR] ± SD, kg/cm ²	26.86 ± 4.5 [26.52]	31.91 ± 5.29 [32.21]	34.14 ± 7.56 [32.96]	0.001	0.38	0
Tenderness of PT(right), % patients	0	54.8 (n:23)	68.8 (n:11)	0	0.218	0
Tenderness of PT (left), % patients	5 (n:1)	64.3 (n:27)	68.8 (n:11)	0	0.338	0
VAS	1.15 ± 1.08 [1]	6.77 ± 2.10 [6.5]	7.63 ± 2.15 [7.62]	0	0.751	0

BMI: Body Mass Index; OA: Osteoarthritis; PT: Patellar Tendon; VAS: Visual Analog Scale

Table 2: The ultrasonographic findings of the patients with knee OA and intragroup correlations.

Details	Grade 2 OA	Grade 3 OA	Grade 4 OA	Grade 2,3 p values	Grade 3,4 p values	Grade 2, 3, 4 p values
Proximal thickness(mm)(right) (mean [IQR] ± SD)	37.3 ± 8.44 [36.1]	48.6 ± 10.2 [47.3]	49.8 ± 14.1 [48.6]	0	0.828	0
Proximal thickness(mm)(left) (mean [IQR] ± SD)	37.2 ± 8.1 [37]	46.5 ± 12.7 [45]	48 ± 9.6 [47.3]	0.002	0.394	0.001
Distal thickness (mm)(right) (mean [IQR] ± SD)	35.3 ± 5.1 [34.8]	45.8 ± 8.4 [46.1]	47 ± 8 [46.6]	0	0.542	0
Distal thickness (mm)(left) (mean [IQR] ± SD)	34.9 ± 4.8 [35.3]	46 ± 8.1 [45.7]	46.6 ± 5 [46.2]	0	0.577	0
Power Doppler signal	~	~	~	~	~	~

OA: Osteoarthritis

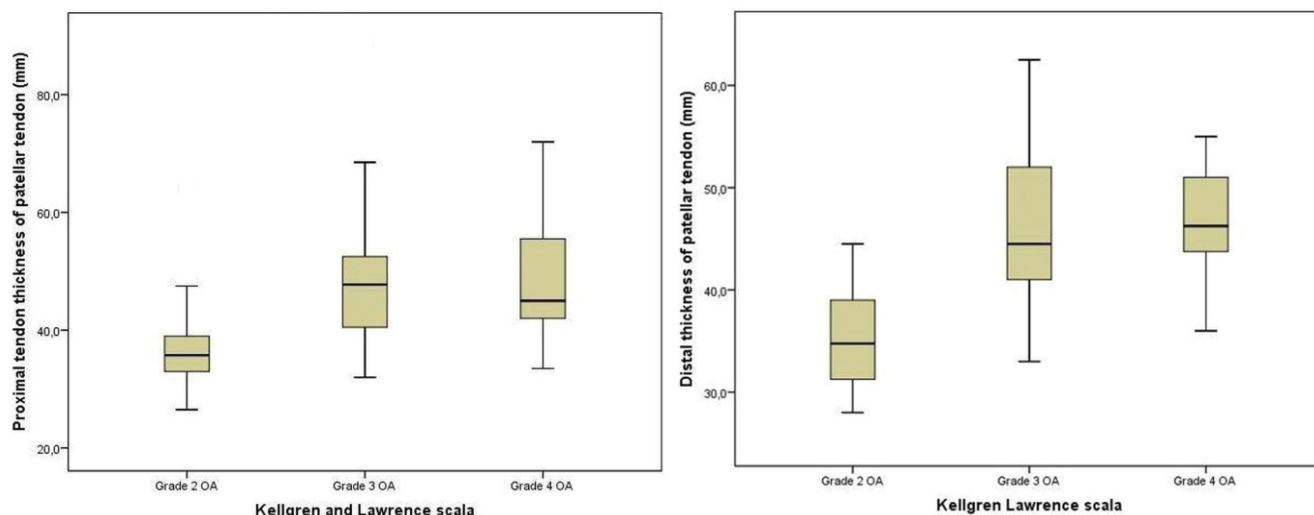


Figure 3: Mean and standard deviations of proximal and distal tendon thickness of patellar tendon in various grades of knee osteoarthritis.

proximal PT thickness and distal PT thickness with [respective] κ values of 0.74, 0.76.

DISCUSSION

The knee joint is commonly affected by OA. The prevalence of knee OA is increasing due to increased prevalence of obesity and age [6-9]. Among obese adults, the lifetime risk of developing OA increases threefold [10-12]. Felson et al. [13] showed that obesity is a recognized risk factor for developing knee OA. Furthermore, weight and BMI are related to knee OA by affecting its severity. Additionally, Goulston et al. [14] showed that increased BMI is an independent risk factor for self-reported knee pain, independent from radiographic evidence of disease severity. Therefore, the relationship between OA and BMI might be due to the patients' initial obesity, which results in increased OA severity. While the disability might improve over time, the patients' mobilization and endurance may deteriorate. This condition causes the imbalance of calorie intake and output, and the patients tend to gain weight. In addition to obesity, age is considered another important factor affecting and inducing OA. In this study, we observed a strong correlation between grade of OA and age.

Patellar tendinopathy is a common and often difficult to treat overuse injury which is characterized by activity-related anterior knee and focal palpation tenderness of the PT. The clinical diagnosis is based mainly on clinical examination, in which the assessment is a non-standardized manual palpation [14]. The diagnosis is confirmed with imaging, commonly US and MRI. Pain, tenderness and imaging changes of the PT are commonly found at the junction of the inferior pole of the patella and the tendon insertion [15].

Although the clinical findings are obvious in patients with complete disruption of the tendon, the symptoms and physical examination may be equivocal and nonspecific in those with tendinopathies. Evaluation of tendon abnormalities was limited before the use of sonographic examination, and the clinician often lacked objective evidence regarding the severity of the tendon lesion or the exact location of the abnormality [16]. US characteristically reveal swelling of the tendon and loss of fascicular continuity and this finding corresponds histologically to collagen degeneration with increased ground substance and vascularity [17]. The imaging appearance of asymptomatic tendinopathy is indistinguishable from symptomatic

tendinopathy [18].

The PT has a conic shape proximally with a wider and thinner shape, and tapers distally to a narrower and thicker end with a slight posterior bulge [19,20]. The caliber of insertion is larger proximally; this conical shape is often more prominent in physically active individuals, whereas the tendon is more ribbon-like in sedentary individuals [16]. Toprak et al. [21] showed that the distal and proximal portions of the PT had similar thicknesses in all of the participants. Conversely, in the current study, we found the proximal thickness of the PT was greater than the distal thickness.

Duri et al. [22] found that palpation of the PT is the only reasonable indicator in the comprehensive biomechanical and clinical examination. In the current study, we found concomitance between PT tenderness and increased PT thickness in both knees of patients with OA. Furthermore, we found a significant correlation between PT tenderness and severity of OA, especially in patients with grade 3 OA compared to patients with grade 2 OA. In contrast to these findings, PT tenderness did not differ between patients with grade 3 and grade 4 OA.

We measured VAS to measure the pain intensity. As expected, the VAS was correlated with the grade of OA and also with the proximal and distal PT thickness.

The etiology of patellar tendinopathy seems to be multifactorial, including weight, BMI, waist-to-hip ratio, leg length difference, arch height of the foot, quadriceps flexibility, hamstring flexibility, quadriceps strength and vertical jump performance [23].

The main strengths and originality of the study include the identification of factors that affect PT thickness such as age, height, weight, BMI and severity of knee OA. Few studies have examined the patellar tendinopathy risk factors in patients with OA, and most of those studies included younger active patients and athletes. Lian et al. [24] observed no association between PT with age and height. In contrast, Toprak et al. [21] found a positive correlation between age and PT thickness. In addition, Crossley et al. [25] showed an association between PT and weight. Our study is the first to show that the patients' age, weight and BMI are correlated with increased PT thickness. We found no correlation between PT thickness and height. Interestingly, other studies have reported a positive correlation between height and the Achilles tendon thickness [26].

COMMENTARY

severity of OA. Indeed, PT thickness is larger in patients with grades 3 and 4 knee OA than in those with grade 2 OA. This study suggests that the risk factors for PT thickening might include age, weight and severity of OA.

The study had some limitations, principally that we cannot explain all of our observations. An explanation is that, although inter-observer reliability was good-to-excellent, patients were evaluated by different clinicians at different times, and intra-reader reliabilities for PT thickness could not be calculated.

CONCLUSION

This study demonstrated that US provides a new imaging technique for patellar tendinopathy in patients with knee OA. When evaluating patellar tendinopathy by US, a physical examination is also required. The patients' age, weight, BMI and severity of OA were found to be independent risk factors for PT thickness.

ACKNOWLEDGEMENTS AND CONFLICT OF INTEREST

The authors declared that there was no conflict of interest.

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