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Full Length Research Paper

The evaluatıon of knee MRI fındıngs ın terms of patellar chondromalacia

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The purpose of this study was to define the incidental frequency of patellar chondromalacia in patients who had not been previously diagnosed with this pathological entity, and also to identify the pathological conditions of the knee which may bear the potential to give way to the development of patellar chondromalacia. 280 patients, of whom 117 were males and 163 females, undertook MRI examinations of their knees at the Numune Teaching and Research Hospital, Adana, Turkey. MRI examinations were performed by the utilization of a 0.2 T low-field open scanner. The incidence of chondromalacia in the study group was found to be 1.8 %. In addition to this finding, certain pathological entities were found to bear etiological potentials for the development of chondromalacia. It is concluded that even though the interpreter factor is important in the evaluation of MRI examinations of the knee in terms of chondromalacia, the images obtained from the 0.2 T open scanner were good enough to demonstrate the morphologic changes of both patellar chondromalacia and other entities which may lead to this condition.

Keywords: Magnetic Resonance Imaging (MRI), Patellar chondromalacia, knee

INTRODUCTION

The knee joint is the biggest and most complicated joint of the body in terms of anatomic structure and function. The joint is composed of the lateral and medial condyles of the femur and tibia, together with the patella, the ligaments, menisci, bursae, and the interconnecting joint capsule. A disorder concerning any one or more of these components may lead to the complaint of pain in the knee and cause serious morbidity (Romano et al, 2012).

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The first step in the evaluation of the knee joint is a detailed investigation based on the complaint of the patient, followed by a thorough physical examination. For a scrutinized evaluation, radiologic examinations and even invasive modalities may be utilized. Radiologic options include conventional radiograms, computed tomography (CT), ultrasonography (US), and magnetic resonance imaging (MRI). Arthroscopy, on the other hand, is an invasive modality which can be utilized both for diagnostic and therapeutic purposes. But all of these modalities have certain constraints (Üstün, 2003).

Anterior knee pain represents the complaint of pain originating from the anterior compartment of the knee

Table 1. The demographic data of patients

	Number (%)	Mean age ± standard deviation
Male	117 (41.8)	32.2 ± 12.7
Female	163 (58.2)	36.8 ± 12.6
Sum	280 (100.0)	34.9 ± 12.8

Table 2. The outpatients departments referring the patients

	Number	Percentage
Physical Therapy and Rehabilitation	16	5,7
Interventional Radiology	2	0,7
Oncology	2	0,7
Orthopedics and Traumatology	250	89,3
Rheumatology	8	2,9
Sports Medicine	2	0,7
Sum	280	100,0

joint. This complaint usually arises from the patellofemoral joint and surrounding supportive tissues. Anterior knee pain is usually due to a disorder in the extensor mechanism of the knee joint. This pain is aggrevated by stress-creating physical activity on the patellofemoral joint which is not used in a properly fashion. As a result, the imbalance in the extensor mechanism of the knee leads to a softening in the articular cartilage, and this diminishment in the cartilage mass gives rise to the creation of an excess amount of pressure on the lateral patellar facet. The pain grows steadily due to the changes in the articular cartilage, inflammation, subchondral bone irritation, and synovitis, as well as the increased neural sensitivity due to the stress at the lateral retinaculum (Fulkerson et al, 2000). Patellar chondromalacia is a debilitating disorder in that it leads to weakening and by time, loss of, the cartilage tissue of the patella. Patellar chondromalacia is an important social issue which leads to work loss due to the morbidity it creates.

By conducting this study, we aimed to investigate and define the incidental frequency of patellar chondromalacia in patients who had not been previously diagnosed with this pathological entity, and also to identify the pathological conditions of the knee which may bear the potential to give rise to the development of patellar chondromalacia. A 0.2 T open MRI system was utilized for this purpose, and standard MRI protocols were administered.

MATERIALS AND METHODS

Knee MRI examinations of 280 patients of whom 117 were males and 163 females were performed at the Radiology Department of the Numune Teaching and Research Hospital, Adana, Turkey. The majority of the patients were referred from the Orthopedics Department. The ages of the patients ranged between 12 and 71 years. Only those patients with no previous diagnosis or suspicion of patellar chondromalacia were included in the study. The study was approved by the investigational ethics review board of the hospital and conducted in accordance to the principles in the Declaration of Helsinki. Informed consent was obtained from every patient prior to the MR examination. MRI examinations were performed in a 0.2 T, low-field open scanner. Axial T2-weighted gradient echo (GRE) sequence, together with axial T2-weighted spin echo (SE) and sagittal GRE and sagittal T1-weighted SE sequences, were utilized in order to examine and evaluate the patellar cartilage. Concerning the joint cartilage, the following were assessed as findings in favor of patellar chondromalacia: focal signal loss at patellar cartilage, marginal irregularity of cartilage, cartilage defect extending to subchondral bone, fissure at articular cartilage, and ulceration. All statistical analyses were performed with the SPSS 15.0 statistical software. The Chi-Square test was utilized for the comparison of categoric variants. Statistical significance was appointed as $p < 0.01$. Increase or decrease in the risk in accordance with the increase in variants found to be of importance according to the analyses, was defined with the Odds Ratio.

RESULTS

The age range of the 280 patients was 12 – 76 years, and the mean age was 34.9 ± 12.8 years. The male / female ratio was 7 / 10 (Table 1).

Only those patients who had not been previously diagnosed with or suspected of having patellar chondromalacia were included in the study. Most of the patients were referred from the Orthopedics Department

Table 3. Frequencies and percentages of clinical diagnoses

Clinical diagnosis	Frequency	Percentage
Arthritis	4	1,4
Knee pain	76	27,1
Joint pain	44	15,7
Fibromyalgia	1	0,4
Gonarthrosis	16	5,7
Hemarthrosis	1	0,4
Juvenile rheumatoid arthritis	2	0,7
Meniscal tear	118	42,1
Myalgia	6	2,2
Osteoarthrosis	1	0,4
Anterior knee pain	4	1,4
Synovitis	1	0,4
Venous insufficiency	4	1,4
Soft tissue disorder	1	0,4
Sum	280	100,0

Table 4. MRI signal abnormalities detected in 248 patients.

Diagnosis	Frequency	Percentage
Normal	32	11,4
Contusion	17	6,1
Patellar subluxation	4	1,4
Osteoartrhritis	8	2,9
Popliteal cyst	20	7,1
Osteochondral defect	4	1,9
Fluid collection	194	69,3
Cutaneous and subcutaneous alterations	6	2,1
Fat pad alterations	3	1,1
Tumors and tumor-like lesions	4	1,4
Infective changes	2	0,7
Plica formation	16	5,7
Patellar retinaculum injury	2	0,7
Medial meniscus tear	91	32,5
Medial meniscus degeneration	65	23,2
Lateral meniscus tear	14	5,0
Lateral meniscus degeneration	6	2,1
ACL tear	31	11,1
ACL degeneration	21	7,5
MCL or LCL tears	1	0,4
MCL or LCL degeneration	2	0,7
Patellar chondromalacia	5	1,8

(Table 2).

The patients were referred for MRI examinations of their knees with certain pre-diagnoses including meniscal tears [42.1%], knee pain [27.1 %], arthralgia [15.7 %], gonarthrosis [5.7 %], etc (Table 3).

No pathological signal was detected in 32 (11.4 %) of the 280 patients, and the MRI examinations of these patients were reported as within normal limits. Various signal abnormalities were detected in the remaining 248 patients. Some of the pathological entities found in these patients may be listed as follows: intra or periarticular fluid collections in 194 (69.3 %), medial meniscal tear in 91 (32.5 %), medial meniscus degeneration in 65 (23.2 %), ACL tear in 31 (11.1 %), ACL degeneration in 21 (7.5 %), of the patients, etc (Table 4).

Some of the findings detected in the 275 patients who

Table 5. Frequency of pathological signals in patients not diagnosed with patellar chondromalacia

Diagnosis	Frequency	Percentage
Patellar subluxation	4	15
Osteoartrhritic changes	6	22
Popliteal cyst	19	69
Oseochondral defect	3	11
Fluid collection	192	698
Tumors and tumor-like lesions	4	15
Infective changes	2	07
Patellar retinaculum injury	2	07
Plica formation	16	58
Medial meniscus tear	89	324
Medial meniscus degeneration	65	236
Lateral meniscus tear	14	51
Lateral meniscus degeneration	5	18
ACL tear	30	109
ACL degeneration	21	76

Table 6. Correlation between the MRI-detected pathological conditions and patellar chondromalacia

Pathological condition	Number of patients pathological entitiy	Number of patients diagnosed with patellar chondromalacia	P – value
Patellar subluxation	4	0	0,930
Osteoarhritis	6	2	0,0007
Popliteal cyst	256	4	0,512
Osteochondral defect	3	1	0,07
Fluid collection	192	2	0,171
Cutaneous and subcutaneous changes	6	0	1,0
Fat pad alterations	3	0	1,0
Tumors and tumor-like lesions	4	0	1,0
Infective changes	2	0	1,0
Plica formation	16	0	1,0
Patellar retinaculum injury	2	0	1,0
Medial meniscus tear	89	2	0,671
Other pathological conditions of the medial meniscus	65	0	0,593
Lateral meniscus tear	14	0	1,0
Other pathological conditions of the lateral meniscus	5	1	0,103
ACL tear	30	1	0,446
Other pathological conditions of the ACL	21	0	1,0
MCL-LCL tear	1	0	1,0
Other pathological conditions of the MCL-LCL	2	0	1,0

showed no signal abnormalities compatible with patellar chondromalacia may be listed as follows: fluid collection in 192 (69.8 %), medial meniscal tear in 89 (32.4 %), medial meniscal degeneration in 65 (23.6 %), anterior cruciate ligament tear in 30 (10.9 %), anterior cruciate ligament degeneration in 21 (7.6 %), popliteal cyst in 19 (6.9 %), lateral meniscal tear in 16 (5.8 %), lateral meniscal degeneration in 14 (5.1 %), of the patients, etc (Table 5).

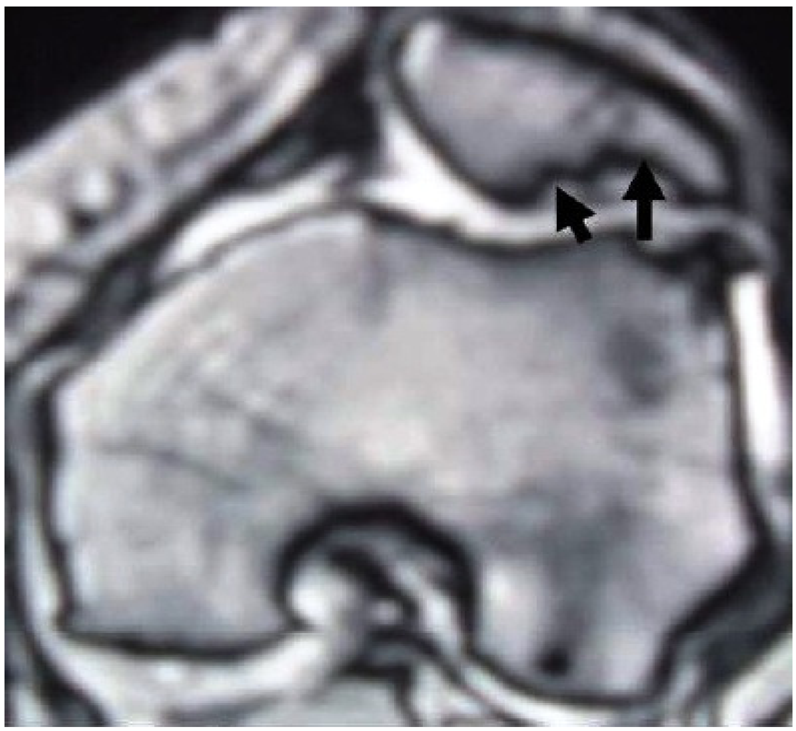
Chondromalacia was detected in 2 of the 8 patients diagnosed with osteoarthritis (Table 6). A statistically significant correlation was found between the presence of MRI findings of osteoarthritic changes and chondromalacia (p = 0.007).

Table 7. Correlation between the MRI findings of the patients and patellar chondromalacia (ODDS ratios)

Finding	Sum (%)	Number of chondromalacia patients (%)	ODDS ratio (%95 CI)*
Osteoarthritis	8 (2,9)	2 (25,0)	29,88 (4,19-212,96)
Popliteal cyst	20 (7,1)	1 (5,0)	3,37 (0,36-31,65)
Osteochondral defect	4 (1,9)	1 (25,0)	22,67 (1,92-267,74)
Fluid	194 (69,3)	2 (1,0)	0,29 (0,05-1,76)
Medial meniscus tear	91 (32,5)	2 (2,2)	1,39 (0,23-8,49)
Lateral meniscüs degeneration	6 (2,1)	1 (16,7)	13,50 (1,27-143,43)

* CI: Confidence Interval

Figure 1. Axial GRE T2* image demonstrating chondral defect at the articular margin of the patella in a patient with patellar chondromalacia.



Using the ODDS ratio (OR), it was found that the chance of development of patellar chondromalacia increases with a mean of 29.9 fold (4.19 – 212.96) in patients with osteoarthritis, in contrast to those who do not. Similarly, it was found that this chance increases with a mean of 22.7 fold (1.92 – 67.74) in patients who have an osteochondral defect, against those who do not. It was also found that patients with lateral meniscus degeneration demonstrated a clear increase of this risk by a mean of 13.50 fold (1.27 – 43.43) against those who do not possess this abnormality. No increase in the risk of development of chondromalacia was found in patients who demonstrated fluid collections in the joint spaces and / or periarticular bursae. Similarly, patients with medial meniscal tears presented no increase in the risk of developing patellar chondromalacia (Table 7).

DISCUSSION

Nowadays MRI has become the modality of choice in the imaging and diagnosis of the pathological processes of the bone, cartilage, and soft tissue components of the knee joint in general. When evaluated together with the clinical findings of the patient, MRI may contribute much to the diagnosis of the situation and may even direct the course of the therapeutic process.

MRI possesses prominent dominant features in comparison to other imaging modalities due to its capacity to provide a high tissue contrast and high visualization efficiency especially in the imaging of bone lesions. MRI is also superior in that it does not utilize ionizing radiation and it is not an invasive modality.

Various investigators have tried to assess the morphologic changes and signal alterations in the articular cartilage of the knee, utilizing MRI (Rubenstein et al, 1997).

The best imaging modality to visualize the joint cartilage so far has been MRI. In order to achieve this goal, various sequences have been used to provide a better visualization of the hyaline cartilage, including T1, T2, and Proton Density (PD), -weighted spin echo (SE) sequences, together with 2D and 3D gradient recalled echo (GRE) and magnetization transfer contrast techniques. But still a consensus over an optimal sequence has not been reached yet (Bredella et al, 1999; Chandnani et al, 1991; Disler et al, 1995; Gylys-Morin et al, 1987; Heron et al, 1992; Peterfy et al, 1995; Recht et al, 1993; Rose et al, 1994; Van Leersum et al, 1995). SE and GRE sequences have been well defined as efficient techniques in the visualization of ligamentous and meniscal structures and their pathological conditions. Studies guided with the purpose of detecting hyaline cartilage conditions effectively with MRI have been long going and are still on the way of scientific research (Sonin et al, 2002).

Rubenstein et al have claimed that routine MRI sequences were not fully satisfactory in unveiling early cartilage alterations (Rubenstein et al, 1997)).

Mc Cauley et al have claimed that the PD sequences were insufficient in discriminating cartilage from effusion. The authors have concluded that it seemed that detecting focal signal abnormalities was a better way than detecting contour abnormalities in the quest for the detection of patellar chondromalacia by means of SE sequences (Mc Cauley et al, 1992).

Disler et al have found a sensitivity of 93 % and a specificity of 94 % in a study in which they utilized the fat-suppressed 3D spoiled GRE sequence in order to diagnose cartilage defects (Disler et al, 1995). The same authors have later conducted studies on the same subject but with bigger groups, and this time they found the sensitivity to be between 75-85 %, and the specificity to be 97 %. These studies showed that there was a 63 % congruence between the evaluation outcomes of cartilage lesions done by MRI and arthroscopy (Disler et al, 1996).

Broderick et al have reported a 68 % compatibility rate between the MRI and arthroscopic evaluation outcomes of all the joint facets studied in osteoarthritis patients utilizing fast SE (FSE) sequences (Broderick et al, 1994).

Cartilage pathologies demonstrating inhomogenous signal characteristics may well be discriminated from joint effusion and subchondral bone on FSE sequences. While conventional T2W-SE sequences have long durations and produce rather insufficient signal-to-noise ratios (SNR), T2W-FSE sequences on the other hand provide substantial T2 weighting and high resolution (17-20). T2W-FSE sequences create more contrast between the cartilage tissue and joint effusion, in contrast to fat-suppressed T1W sequences. However, their spatial resolution capacity is lower when compared to fat-suppressed 3D spoiled GRE sequences. T2W images bear the characteristic features of demonstrating collagen loss and increased fluid content in degenerated cartilage tissue, together with extended T2 relaxation times and increased proton density weighting. Both of these pathological entities lead to signal intensity increases in fat-suppressed T2W-FSE sequences (Peterfy et al, 1994). Fat suppression is usually added to imaging protocols in order to increase the sensitivity to bone marrow abnormalities. Fat suppression decreases the chemical shift artefacts which exaggerate articular cartilage thickness (Petterson et al, 1988).

In a study conducted by Zhang et al over 4068 students, the prevalance of patellar chondromalacia and its correlation with sports injuries were investigated. Two groups of students were involved in this study: one comprising those from the gymnnastics division and the other consisting of those coming from other divisions. At the end of the study the prevalance of patellar chondromalacia in different appointed groups were reported as follows: concerning the gymnastics group, 20.1 % in girls and 11.6 % in boys; and concerning the non-gymnastics group, 5.61 % in girls and 4.92 % in boys. This study revealed that the prevalance of patellar chondromalacia was higher in both the female and male populations in people dealing with sports, in comparison to those not involved in such activities. The study also demonstrated that sports injuries constitute an important risk factor for the development of patellar chondromalacia (Zhang et al, 2003).

Freire et al have compared the patellar chondromalacia findings they revealed by using a 0.2 T low-field and a 1.5 T high-field MR scanner. The researchers acquired the axial images from the knees of 20 symptomatic and 20 asymptomatic volunteers. In this study, selective presaturation inversion recovery and Turbo SE T2W imaging protocols were utilized with the 1.5 T system, while GRE-2D, GRE-3D, FSE-T2W and Short Time Inversion Recovery [STIR] sequences were administered in the 0.2 T low-field scanner. The authors have concluded at the end of their study that high-degree lesions were demonstrated in a better fashion in the low-field scanner, but it was rather difficult to evaluate the signal increases in the medial facet cartilage of the patella by using the low-field system (Freire et al, 2006).

The MRI examinations of our study were conducted in a 0.2 T low-field, permanent open scanner. The following sequences were utilized in our study: axial T2W-SE and GRE sequences, sagittal GRE, T1W-SE, PD/T2W-SE sequences, and coronal T1SE, PD/T2W-SE and GRE sequences.

Our study revealed a 1.8 % prevalance of patellar chondromalacia. In addition to this finding, the following rates for contributing factors to patellar chondromalacia were assessed: ACL tears 11.1 %, medial meniscus tears 32.5 %, lateral meniscus tears 5 %.

It was revealed in our study that the risk of patellar chondromalacia increases by 29.9 fold in patients with osteoarthritis in comparison to those without osteoarthritis. This ratio is 22.7 fold in patients with osteochondral defects, and 13. 5 fold in patients with lateral meniscal degenerations, in comparison to those who do not possess these abnormalities, in sequence order. Based on the afforementioned criteriae, we have come to the conclusion that no matter what the patients' clinical findings are, it is wise to examine the MRI images of such patients in a thoroughly manner in terms of patellar chondromalacia, in the presence of MRI findings which contribute to the increase of risk of the develeopment of this condition.

It may be initially thought that detecting MRI signal alterations in favor of patellar chondromalacia or evaluating patients for a risk of possessing patellar chondromalacia may be a bit difficult if a low-field MRI scanner is used, utilizing conventional SE sequences. But it must not be forgotten that MRI evaluation differs in a way from reader to reader. This is because MRI is a user-dependent modality like ultrasound (US), and the assessment of images may show variations among readers. We think that the images of the patients obtained from the 0.2 T open scanner were good enough to demonstrate the morphologic changes of patellar chondromalacia.

At the end of our study we have come to the conclusion that low-field MRI scanners may generally be accepted good enough in the task of unveiling the findings of chondromalacia, and also the pathological processes that predispose to its development, despite the fact that MRI is a user-dependent modality and evaluations may show alterations among various evaluators.

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