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Evaluation of the Correlation between Chondromalacia Patellae and the Thickness of Subcutaneous Knee fat using Magnetic Resonance Imaging

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ABSTRACT

Background and aim: Chondromalacia Patellae is a condition that involves softening and degeneration of the articular hyaline cartilage of the Patellae that articulates with the trochlear groove of the femur. To evaluate the correlation between subcutaneous fat thickness around the knee joint with the presence or absence of chondromalacia Patellae/severity of chondromalacia Patellae in MRI.

Material and methods: A retrospective review were conducted of knee MRIs in 100 patients referred to the department of radiodiagnosis for MRI imaging of the knee. The assessment was done for the presence or absence of chondromalacia Patellae and graded positive studies from 0 (absent) to 3(full cartilage thickness defect). Measurement of subcutaneous knee fat thickness was obtained on the medial, lateral, and prepatellar aspects of the knee.

Results: The subcutaneous thickness values were significantly different between patients with or without chondromalacia Patellae. Mean values of normal and patients with chondromalacia Patellae vary with severity. The proportionate increase in the subcutaneous fat thickness values is observed with higher grades of chondromalacia Patellae. Mean subcutaneous fat thickness values were seen to be on the higher side in female patients compared to male patients.

Conclusions: This is the first study to evaluate the correlation between subcutaneous knee fat thickness in three aspects (medial, anterior, and lateral) of knee circumference and chondromalacia Patellae. The study shows a positive relationship between the subcutaneous knee fat thickness and chondromalacia Patellae. This indirectly indicates the role of obesity in the development of chondromalacia Patellae. This positive relationship can be crucial in spreading awareness and preventive care.

1. Introduction

Chondromalacia Patellae is a condition that involves softening and degeneration of the articular hyaline cartilage of the Patellae that articulates with the trochlear groove of the femur. It is characterized by clinical severity, from partial articular cartilage fissuring to total cartilage loss and subchondral bone erosion. Clinically, patients often present with anterior knee pain. Chondromalacia Patellae can occur in isolation or in association with other conditions: direct trauma, Patella dislocation, chronic Patellar instability, and synovial plicae.[1] It affects both young and older patients.[2] Knee trauma and morphological abnormalities that put mechanical stress on articular cartilage are among the factors that can cause chondromalacia Patellae.[3] Since magnetic resonance imaging (MRI) is non-invasive and offers excellent soft tissue and cartilage detailing, it is the modality of choice for imaging,[4, 5] also assessing other associated reliable aetiology possibly responsible for developing chondromalacia Patellae. Arthroscopy is the gold standard but is invasive. Surgical treatment is indicated only in 5-10% of cases.[6] Obesity is a factor responsible for Patellar cartilage damage.[7] To evaluate the correlation between subcutaneous fat thickness around the knee joint with the presence or absence of chondromalacia Patellae/severity of chondromalacia Patellae in MRI.

2. Material and methods

A retrospective review was conducted of knee MRIs in 100 patients (out of 156) referred to the department of radiodiagnosis of Srinivas Institute of Medical Sciences and Research Centre Mukka, Mangalore (with approval number-SIEC/SIMS & RC/58/06/2024) for MRI imaging of the knee, who satisfied the inclusion criteria and exclusion criteria. Ethical committee clearance was obtained before initiating the study. Patients in the age group

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of 15 to 70 years were included in the study. Patients with a history of acute knee trauma / recent history of surgery were excluded. Imaging performed over 12 months from February 2023 to February 2024 on a 1.5T MRI system (Siemens MAGNETOM Essenza) with a dedicated extremity coil was taken. Assessed for the presence or absence of chondromalacia Patellae and graded positive studies from 0 (absent) to 3(full cartilage thickness defect). Subcutaneous knee fat thickness was measured on the medial, lateral and prepatellar aspects of the knee. Sequences like T1, T2, and T2, fast imaging with steady-state free precession, proton density fat-saturated (PDFS), and short tau inversion recovery (STIR) were taken in axial, sagittal, and coronal planes.

Study measurements and evaluation

All measurements were performed on a 1.5-Tesla MRI machine, 16-channel knee coil in Siemens MAGNETOM Essenza.[8].

Table 1. Parameters used while performing knee MRI.

	TE	TR	NEX	FOV	ST	VS
T2WI Axial	87	5140	2	160	3mm	0.4 x0.4 x 3mm
T1WI Sagittal	13	955	2	160	3mm	10.4 x 0.4 x 3mm

T2WI-T2- weighted imaging; T1WI- T1-weighted imaging; TE- time of echo; TR- time of repetition; NEX - number of excitations; FOV-field of view; ST - slice thickness; VS - voxel size.

The measurement section was taken at the maximum Patellar cartilage thickness level. Subcutaneous fat thickness was measured on T1 sagittal and T2axial sections, similar to the previous study. For medial subcutaneous knee fat thickness – measurement was taken in an axial T2 section at the level of maximum Patellar cartilage, and measurement points were taken from the medial knee skin surface to the posteromedial aspect of the medial femoral condyle. For anterior/prepatellar subcutaneous knee fat thickness – measurement was taken in a mid-sagittal T1 section, and measurement points were taken from the anterior knee skin surface to the anteriormost aspect of the Patellae. For lateral subcutaneous knee fat thickness –measurement was taken in an axial section at the level of maximum Patellar cartilage thickness, and measurement points were taken from the lateral knee skin surface to the postero-lateral aspect of the lateral femoral condyle adjacent to biceps femoris.

Fig. 1. Subcutaneous knee fat was measured on T2 axial sequences at the maximal Patellar cartilage thickness level on the medial and lateral aspects of the knee joint.

Fig. 2. Subcutaneous knee fat was measured on T1 mid-sagittal sequences at the level of maximal Patellar cartilage thickness on the anterior aspect of the knee joint.

Each MRI study was categorized based on the presence or absence of chondromalacia Patellae. Studies positive for chondromalacia Patellae were subsequently graded I, II, and III (Modified Noyes classification).[9] Additionally, facet/ compartment involvement, Patellae subluxation, joint effusion, and other degenerative changes were noted.

Table 2. Modified Noyes classification.

Patellar Cartilage Thickness	Grades
0	Normal cartilage, homogenous signal intensity with intact cartilage surface and thickness
1	Normal cartilage surface but focal abnormal signal intensity
2	Superficial cartilage defect, 50% thickness but less than full thickness (2B)
3	Full cartilage thickness defect with exposed bone

Statistical analysis

After the data collection, data entry was done in Excel. Data entry was done with the help of statistical software Graphpad in Stat v3.0 and Statistical Package for Social Sciences (SPSS). Quantitative data was presented with the help of mean, standard deviation, and Annova table. Qualitative data was represented as frequencies and percentages. Bar diagrams were used when deemed necessary.

3. Results

After selecting the patients based on the inclusion and exclusion criteria MRI study films of 100 patients (63 male and 37 female) were included in the study. MRI studies of patients with motion artifacts/post-operative knee status/ acute traumatic history (which can alter the accuracy of measurement) were not included in the study. The presence and severity of the chondromalacia Patellae were graded according to the Modified Noyes classification (Table 2). A total of 37% (37 patients) of patients were diagnosed with chondromalacia Patellae out of which 24% were male patients and 13% were female patients. Among patients, 11.1% of grade I (males – 12.7% and females- 8.3%), 16.2% of grade II (males – 15.9% and females- 16.7%), and 10.1% of grade III (males – 9.5% and females- 11.1%). The mean age of patients with chondromalacia Patellae was 49.2 years, ranging from 21-67 years. The mean age among men was 51.9 years, and among women was 46.6 years.

Study results involving female participants

Table 3. Subcutaneous fat thickness in medial aspect vs chondromalacia Patellae in female participants.

CP	SCFT- MED IN MM						
	N	Mean	Std. Deviation	Median	Minimum	Maximum	Range
Absent	23	17.61	2.426	18.00	14	23	9
Grade I	3	22.00	3.606	21.00	19	26	7
Grade II	6	26.17	3.430	26.50	22	31	9
Grade III	4	30.25	3.594	31.50	25	33	8

CP- chondromalacia Patellae, SCFT- subcutaneous fat thickness, MED- medial aspect.

Table 4. Subcutaneous fat thickness in anterior aspect vs. chondromalacia Patellae in female participants.

CP	SCFT- ANT						
	N	Mean	Std. Deviation	Median	Minimum	Maximum	Range
Absent	23	3.43	0.896	3.00	2	5	3
Grade I	3	6.33	1.528	6.00	5	8	3
Grade II	6	5.83	0.753	6.00	5	7	2
Grade III	4	6.75	2.500	8.00	3	8	5

CP- chondromalacia Patellae, SCFT- subcutaneous fat thickness, ANT- anterior aspect.

Table 5. Subcutaneous fat thickness in lateral aspect vs chondromalacia Patellae in female participants.

CP	SCFT- LAT						
	N	Mean	Std. Deviation	Median	Minimum	Maximum	Range
Absent	23	6.83	1.154	7.00	5	9	4
Grade I	3	10.00	1.000	10.00	9	11	2
Grade II	6	9.67	1.211	9.00	9	12	3
Grade III	4	10.25	0.500	10.00	10	11	1

CP- chondromalacia Patellae, SCFT- subcutaneous fat thickness, LAT- lateral aspect.

Table 6. Annova table of female participants showing the statistically significant F values within the groups with P<o.o5.

			Sum of Squares	Df	Mean Square	F	Sig.
SCFT-MED IN MM * CP	Between Groups	(Combined)	768.577	3	256.192	32.396	0.000
	Within Groups		253.062	32	7.908		
	Total		1021.639	35			
SCFT-ANT * CP	Between Groups	(Combined)	66.987	3	22.329	16.275	0.000
	Within Groups		43.902	32	1.372		
	Total		110.889	35			
SCFT-LAT * CP	Between Groups	(Combined)	80.501	3	26.834	21.801	0.000
	Within Groups		39.388	32	1.231		
	Total		119.889	35			

a. SEX = F

The statistically significant increased mean value was seen in patients with chondromalacia.

Study results involving male participants

Table 7. Subcutaneous fat thickness in medial aspect vs chondromalacia Patellae in male participants.

CP	SCFT- MED IN MM						
	N	Mean	Std. Deviation	Median	Minimum	Maximum	Range
Absent	39	17.23	2.422	17.00	13	23	10
Grade I	8	21.00	3.665	20.50	16	26	10
Grade II	10	24.20	3.994	24.00	19	30	11
Grade III	6	29.00	2.828	29.00	26	33	7

CP- chondromalacia Patellae, SCFT- subcutaneous fat thickness, MED- medial aspect.

Table 8. Subcutaneous fat thickness in anterior aspect vs chondromalacia Patellae in male participants.

CP	SCFT- ANT						
	N	Mean	Std. Deviation	Median	Minimum	Maximum	Range
Absent	39	3.51	0.756	4.00	2	5	3
Grade I	8	5.25	1.669	5.50	2	7	5
Grade II	10	5.60	1.265	5.50	4	8	4
Grade III	6	6.67	1.366	6.50	5	9	4

CP- chondromalacia Patellae, SCFT- subcutaneous fat thickness, ANT- anterior aspect.

Table 9. Subcutaneous fat thickness in lateral aspect vs chondromalacia Patellae in male participants.

CP	SCFT- LAT						
	N	Mean	Std. Deviation	Median	Minimum	Maximum	Range
Absent	39	6.95	1.234	7.00	4	9	5
Grade I	8	9.00	1.195	8.50	8	11	3
Grade II	10	9.60	1.350	9.50	7	12	5
Grade III	6	10.33	1.751	10.50	8	13	5

CP- chondromalacia Patellae, SCFT- subcutaneous fat thickness, LAT- lateral aspect.

Table 10. Annova table of male participants showing the statistically significant F values within the groups with P<o.o5.

			Sum of Squares	Df	Mean Square	F	Sig.
SCFT-MED IN MM * CP	Between Groups	(Combined)	969.223	3	323.074	38.083	0.000
	Within Groups		500.523	59	8.483		
	Total		1469.746	62			
SCFT-ANT * CP	Between Groups	(Combined)	81.626	3	27.209	24.706	0.000
	Within Groups		64.977	59	1.101		
	Total		146.603	62			
SCFT-LAT * CP	Between Groups	(Combined)	109.226	3	36.409	21.561	0.000
	Within Groups		99.631	59	1.689		
	Total		208.857	62			

a. SEX = M

The statistically significant increased mean value was seen in patients with chondromalacia.

The mean subcutaneous fat thickness in the medial aspect shows that in normal knees, it was 17.37+/-2.4mm, measuring 17.6+/-2.4mm in females and 17.23+/-2.4 mm in males. In grade I chondromalacia Patellae, the mean SCFT is 21.27+/-3.4mm, measuring 22.0+/-3.6mm in females and measuring 21.00+/-3.6mm in in males. In grade II chondromalacia Patellae patients, the mean value was 24.94+/-3.8mm, measuring 26.17+/-3.4mm in females and measuring 24.20+/-3.99mm in males. In grade III chondromalacia Patellae, the patient mean value is 29.50+/-3.0mm, with measurements of 30.25+/-

3.5mm in females and 29.00+/-2.8mm in males. (Fig. 3) Anterior aspect-Mean subcutaneous fat thickness: a mean value of 3.48+/-0.8 mm in normal knees, measuring 3.43+/-0.89mm in females and 3.51+/-0.7mm in males. In grade I chondromalacia Patellae, the mean SCFT is 5.55+/-1.6mm, measuring 6.3+/-1.5mm in females and 5.25+/-1.6mm in males. In grade II chondromalacia Patellae patients, the mean value was 5.69+/-1.07mm, measuring 5.83+/-.07mm in females and 5.6+/-1.2mm in males. In grade III chondromalacia Patellae patients, the mean value is 6.70+/-1.7mm, measuring 6.75+/-2.5mm in females and 6.67+/-1.3mm in males. (Fig. 4) Lateral aspect -Mean subcutaneous fat thickness in normal knees mean value of 6.9+/-1.1mm, measuring 6.83+/-1.1mm in females and 6.95+/-1.2mm in males. In grade I chondromalacia Patellae, the mean SCFT is 27+/-1.1mm, measuring measuring10+/-1.0mm in females and 9.00+/-1.1mm in males. The mean value in grade II chondromalacia Patellae patients is 9.63mm+/-1.25, measuring 9.67+/-1.2mm in females and 9.6+/-1.3mm in males. In grade III chondromalacia Patellae patients, the mean value is 10.30+/-1.3mm, with measurements of 10.25+/-0.5mm in females and 10.33+/-1.7mm in males. (Fig. 5)

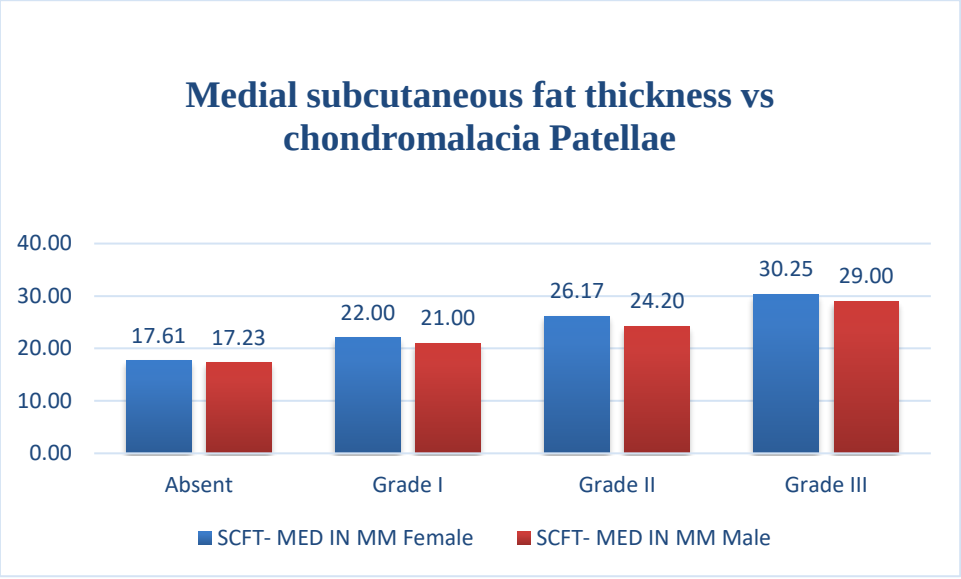

Fig. 3. Demonstrating mean values of medial SCFT in normal and different grades of chondromalacia Patellae in male and female participants.

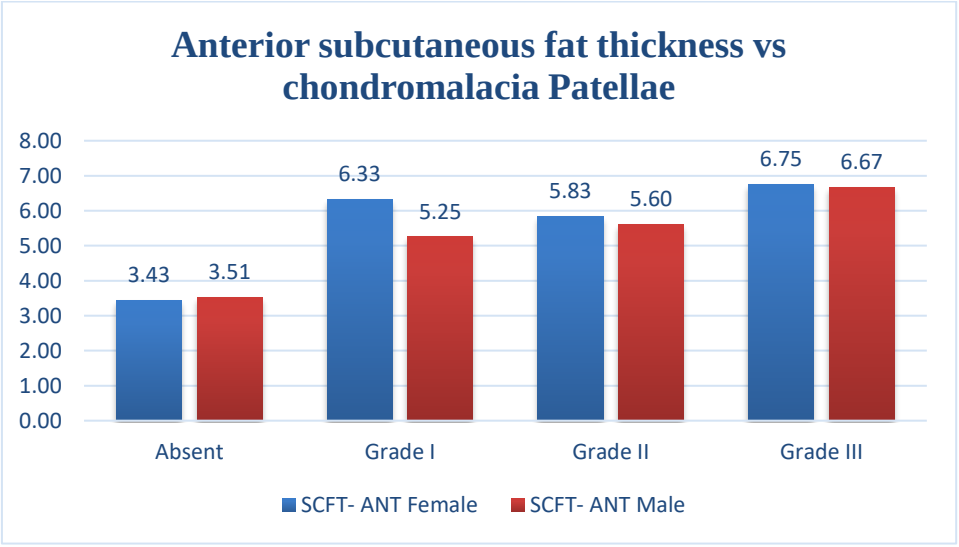

Fig. 4. Demonstrating mean values of SCFT in normal and different grades of chondromalacia Patellae in male and female participants.

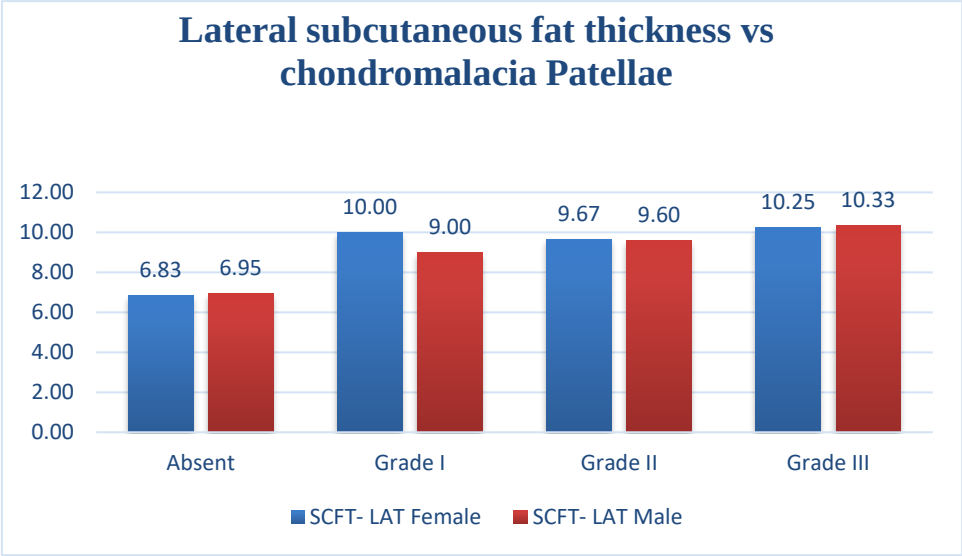

Fig. 5. Demonstrating mean values of SCFT in normal and different grades of chondromalacia Patellae in male and female participants.

The subcutaneous thickness values significantly differed between patients with or without chondromalacia Patellae. Mean values of normal and patients with chondromalacia Patellae vary with severity. The proportionate increase in the subcutaneous fat thickness values is observed with higher grades of chondromalacia Patellae. Mean subcutaneous fat thickness values were on the higher side in female patients compared to male patients.

4. Discussion

Chondromalacia Patellae is a common patellofemoral disorder causing anterior knee pain in young and adult populations. Common aetiologies are direct trauma, Patellar dislocation, chronic Patellar instability/subluxation/dislocation, cartilage abnormality including congenital conditions and post-operative conditions, synovial plicae, type of Patellae,[10] morphology of Patellae[11] abnormal kinematics of knee (Patellae alta/Baja, valgus deformity).[12] Since MRI is non-invasive, it is the recommended mode of investigation over invasive arthroscopic surgery. Chondromalacia Patellae can show a variety of imaging appearances, including edema, fissuring, partial and full-thickness cartilage loss, mild cartilage softening, and osteoarthritic changes. Of a total of 100 patients who were included in the study, chondromalacia Patellae was seen in 37% of studies, of which 10.1% were in the most severe category, with involvement of the subchondral bone. The association between obesity and chondromalacia Patellae has not been well established; however, Berry PA et al.[13] revealed in their study that obesity and increased fat mass were associated with more cartilage defects in the knee.[14] Our results show a similar outcome: a strong positive correlation between subcutaneous knee fat thickness (representing obesity) and the presence and severity of chondromalacia Patellae on MRI. The study data helps implement early lifestyle modification in the form of weight reduction and bariatric surgery to reverse chondromalacia conditions. Many strengths and few limitations are included in the study, the strengths being a significant unbiased study patient population that underwent MRI of the knee representing the general population. However, a selected cohort would have resulted in more positive results. The study population represented various age groups, both young and adult. This is the first study to evaluate the correlation between subcutaneous knee fat thickness in three aspects (medial, anterior, and lateral) of knee circumference and chondromalacia Patellae. Our study has few limitations due to the retrospective nature of physical measurement /BMI. However, subcutaneous fat thickness is considered a surrogate marker of obesity. Similar methodologies and classifications were chosen in this study to compare the results with those of other studies. This study result revealed a significantly higher association between SFTT and CP in medial and lateral measurement approaches and a medium association in the anterior measurement approach. The study has identified certain statistically significant cutoff values with high sensitivity and specificity for the presence of CP in all three aspects. There was a significant increase in values between the normal population and patients with chondromalacia Patellae and in men and women separately. Increased values are seen associated with higher grades as per Modified Noyes classification of chondromalacia Patellae. The relationships are separately evaluated for men and women. It was seen to be on the higher side for women than men in our current study, similar to a previous study done by Kok HK et al.[15] Medial and lateral subcutaneous fat thickness is associated significantly with higher grades of chondromalacia Patellae. Anterior subcutaneous fat thickness shows higher values in grade III, followed by grades I and II. In their studies, Ostojic M et al.[16] showed that chondromalacia in middle-aged adults can be better treated with platelet-rich plasma and hyaluronic acid. Early and accurate imaging diagnosis plays a greater role in better patient care and avoids needless surgical interventions.

5. Conclusion

The study results show a positive relationship between the subcutaneous knee fat thickness and chondromalacia Patellae. The presence of chondromalacia Patellae and its severity were found to be higher with higher subcutaneous fat thickness on MRI. This indirectly indicates the role of obesity in the development of chondromalacia Patellae. This positive relationship can be crucial in spreading awareness and preventive care.

Conflict of Interest

The authors declared that there is no conflict of interest.

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References

[1] Derek Armfield MD, Patrick J, McMahon MD. Current Diagnosis & Treatment in Sports Medicine. 2007.

[2] Sirik M, Uludag A. Assessment of the relationship between patellar volume and chondromalacia patellae using knee magnetic resonance imaging. Northern clinics of Istanbul. 2020;7(3):280-3. Htps://doi.org/10.14744/nci.2019.65882.

[3] Teichtahl AJ, Wluka AE, Wang Y, Hanna F, English DR, Giles GG, Cicuttini FM. Obesity and adiposity are associated with the rate of patella cartilage volume loss over 2 years in adults without knee osteoarthritis. Annals of the rheumatic diseases. 2009;68(6):909-13. https://doi.org/10.1136/ard.2008.093310.

[4] Habusta SF, Coffey R, Ponnarasu S, Mabrouk A, Griffin EE. Chondromalacia patella. Stat Pearls Publishing; 2023.

[5] Markhardt BK, Huang BK, Spiker AM, Chang EY. Interpretation of cartilage damage at routine clinical MRI: how to match arthroscopic findings. Radiographics. 2022;42(5):1457-73. https://doi.org/10.1148/rg.220051.

[6] Pihlajamäki HK, Kuikka PI, Leppänen VV, Kiuru MJ, Mattila VM. Reliability of clinical findings and magnetic resonance imaging for the diagnosis of chondromalacia patellae. JBJS. 2010;92(4):927-34. https://doi.org/10.2106/JBJS.H.01527.

[7] Endo Y, Schweitzer ME, Bordalo-Rodrigues M, Rokito AS, Babb JS. MRI quantitative morphologic analysis of patellofemoral region: lack of correlation with chondromalacia patellae at surgery. American Journal of Roentgenology. 2007 Nov;189(5):1165-8. https://doi.org/10.2214/AJR.07.2236.

[8] Duran S, Çavuşoğlu M, Elverici E, Günaydın E. Kondromalazik Patella İle Diz Subkutan Yağ Kalınlığı Arasındaki Korelasyon: Manyetik Rezonans Görüntüleme Çalışması. Sakarya Tıp Dergisi. 2015;5(3):125-9. https://doi.org/ 10.5505/sakaryamj.2015.03360.

[9]Thomas M. Link. Cartilage Imaging. (2011-04-06) ISBN:9781441984388.

[10] Dursun M, Ozsahın M, Altun G. Prevalence of chondromalacia patella according to patella type and patellofemoral geometry: a retrospective study. Sao Paulo Medical Journal. 2022;140(6):755-61. https://doi.org/10.1590/1516-3180.2021.0206.R2.10012022.

[11] Öğüt E, Kabakcı AG, Saygılı H, Bozkır MG. Morphometric analysis of chondromalacia patella and patella types. Journal of Medicine and Palliative Care. 2023;4(6):663-71. https://doi.org/10.47582/jompac.1377942.

[12] Zheng W, Li H, Hu K, Li L, Bei M. Chondromalacia patellae: current options and emerging cell therapies. Stem Cell Research & Therapy. 2021;12:412. https://doi.org/10.1186/s13287-021-02478-4.

[13] Berry PA, Wluka AE, Davies-Tuck ML, Wang Y, Strauss BJ, Dixon JB, Proietto J, Jones G, Cicuttini FM. The relationship between body composition and structural changes at the knee. Rheumatology. 2010;49(12):2362-9. https://doi.org/10.1093/rheumatology/keq255.

[14] Anandacoomarasamy A, Smith G, Leibman S, Caterson I, Giuffre B, Fransen M, Sambrook P, March L. Cartilage defects are associated with physical disability in obese adults. Rheumatology. 2009;48(10):1290-3. https://doi.org/10.1093/rheumatology/kep246.

[15] Kok HK, Donnellan J, Ryan D, Torreggiani WC. Correlation between subcutaneous knee fat thickness and chondromalacia patellae on magnetic resonance imaging of the knee. Canadian Association of Radiologists Journal. 2013;64(3):182-6. https://doi.org/10.1016/j.carj.2012.04.003.

[16] Ostojic M, Hakam HT, Lovrekovic B, Ramadanov N, Prill R. Treatment of anterior knee pain due to chondromalacia patellae with platelet-rich plasma and hyaluronic acid in young and middle-aged adults, a cohort study. Archives of Orthopaedic and Trauma Surgery. 2024:1-8. https://doi.org/10.1007/s00402-024-05363-w.

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