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Original Article

CLINICO-RADIOLOGICAL PARAMETERS OF THE PATELLOFEMORAL JOINT IN MALES AND FEMALES WITH NON-PATELLOFEMORAL KNEE PROBLEMS: A COMPARATIVE ANALYSIS

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ABSTRACT

Objective: Osteoarthritis of the knee joint is a common condition that primarily affects the elderly. While previous studies have focused on the tibiofemoral compartment, the significance of the patellofemoral compartment needs to be considered. Patellofemoral joint problems frequently occur in orthopedics and sports medicine and can be challenging to diagnose. Various classification systems have been developed to categorize patellofemoral pathology. Clinical evaluation, as well as imaging techniques such as X-rays and computed tomography (CT), are commonly used for assessment. However, there is a lack of published studies defining and validating MRI parameters for routine clinical assessment of patellofemoral joint abnormalities.

Methods: This comparative analytical study was conducted at the Department of Orthopedics, UCMS and GTB Hospital, Delhi, from November 2017 to April 2019. The sample size included 30 male and 30 female participants between the ages of 18 and 45 y. The study evaluated various clinical, radiographic, and MRI parameters of the patellofemoral joint in both males and females. Statistical analysis was performed to determine any significant differences between the genders.

Results: The clinical evaluation revealed a slightly higher mean Q angle in females compared to males, although this difference was not statistically significant. Lateral radiographs showed a significant difference in the Insall-Salvati ratio between genders, while the modified Insall-Salvati ratio and Caton-Deschamps index did not show significant differences. MRI measurements demonstrated a significant difference in the I/S ratio between males and females, while other parameters did not exhibit significant gender differences.

Conclusion: This study provides valuable insights into the differences in clinical, radiographic, and MRI parameters of the patellofemoral joint between adult males and females. The findings suggest that gender differences exist in certain measurements, emphasizing the need for gender-specific evaluation. Further research is required to explore the clinical implications of these differences and to establish normative values for MRI parameters in routine clinical practice.

Keywords: Patellofemoral joint, Patellar instability, Q angle, Imaging techniques

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INTRODUCTION

Osteoarthritis of the knee joint is a common and debilitating condition that primarily affects the elderly. While previous studies have primarily focused on the tibiofemoral compartment, it is essential to consider the significance of the patellofemoral compartment. As a sesamoid bone within the quadriceps femoris tendon, the patella plays a crucial role in knee extension by acting as a dynamic fulcrum and transmitting substantial forces during everyday activities. Its unique dual function as an articulation point and a component of the quadriceps muscle emphasizes the need for accurate diagnostic framing using unambiguous language [1].

Patellofemoral joint problems are frequently encountered in orthopedics and sports medicine, often resulting from the abnormal movement of the patella during knee flexion. The clinical presentations of patellar instability vary, making diagnosis challenging, particularly when patients exhibit normal knee examinations and no history of dislocation. These patients may only experience non-specific knee pain, which can be mistaken for other internal knee issues. Patellar instability encompasses a spectrum of conditions, ranging from subluxation and acute dislocation to chronic recurrent instability [2].

To classify patellofemoral pathology, surgeons have developed a well-recognized system consisting of three main groups: objective patellar instability, potential patellar instability, and patellofemoral pain. Objective patellar instability includes patients with a history of patellar dislocation or subluxation and evidence of instability factors. Potential patellar instability involves patients without prior dislocation or subluxation but who experience pain and exhibit instability factors. Patellofemoral pain is characterized by pain as the primary symptom, without identifiable instability factors [3].

During the physical examination, the quadriceps Q angle is used to measure the lateral movement tendency of the patella when the quadriceps muscles contract. Females typically have a wider Q angle than males. The upper limit of the Q angle, recommended by Insall, is widely accepted as 20 degrees [4]. Among various imaging techniques, the lateral view, in conjunction with computed tomography (CT), is considered the most useful for evaluating the patellofemoral joint. Lateral x-rays allow assessment of parameters such as the Insall Salvati index, Modified Insall Salvati index, and Caton-Deschamps index, while axial views enable measurements of the sulcus angle, congruence angle, and Laurin angle [5]. The gold standard for assessing patellar instability is the trochlear tubercle-trochlear groove (TT/TG) distance measured on CT scans. Interestingly, there is no correlation between the clinically measured Q angle and the TT/TG distance from CT scans.

Magnetic resonance imaging (MRI) offers high-resolution scans, allowing for a more accurate evaluation of patellofemoral joint cartilage surface than CT. MRI is radiation-free and provides measurements at the cartilage level rather than just the subchondral bone. However, there is currently a lack of published studies defining and validating normal and pathological MRI parameters for routine clinical assessment of patellofemoral joint abnormalities [6].

Patellofemoral malalignment can cause changes in patellofemoral load, potentially leading to chondral lesions and other imaging features of patellofemoral osteoarthritis. The Dejour classification categorizes trochlear morphology into five types. Patellofemoral instability represents a subgroup within the patellofemoral

syndrome, which also includes patellar tilt, crepitus, patellar tracking, tenderness, apprehension, and laxity as common findings during physical examination. Radiographic and CT-based measurements, such as lateral trochlear inclination, sulcus angle, and TTTG distance, aid in evaluating patients with instability and determining underlying abnormalities [7].

Recently, MRI has gained traction for analyzing patellofemoral instability due to its excellent soft tissue contrast. It is particularly useful for assessing soft tissue and cartilage injuries. MR imaging provides a comprehensive visualization of the patellofemoral joint, including osseous measurements and the detection of articular cartilage damage. Various parameters, such as sulcus angle, lateral trochlear angle, Insall Salvati index, modified Insall Salvati index, TT/TG distance, and Caton Deschamp index, are evaluated using MRI. While several clinical-radiological parameters of the patellofemoral joint have been individually studied, a comprehensive evaluation of these parameters in adult males and females within a specific patient subset is lacking. Therefore, this study aims to bridge this knowledge gap by providing a thorough assessment of these differences [8].

MATERIALS AND METHODS

Setting: Department of Orthopedics, UCMS and GTB Hospital, Delhi.

Duration: 1st November 2017 to 30th April 2019.

Type of Study: Comparative analytical study

Sample size: Based on a previous study to detect a difference between males and females in TT/TG distance of 0.2 mm and SD of 0.5 mm, for a power of 80% and type 1 error of 5%, the sample size calculated was 99 in each group (Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version. www. OpenEpi. com, updated 2013/04/06, accessed 2017/09/20). Due to time constraints in the thesis, we considered a sample size of 30 in each group, i.e. 30 male and 30 female participants.

Inclusion criteria

Males and females between the age of 18 to 45 y with any knee complaint other than a patellofemoral joint.

Exclusion criteria

1. Patient not giving consent.
2. Evidence of prior knee surgery affecting the osseous marking around the patellofemoral joint.
3. History of patellar instability or anterior knee pain.
4. Patients demonstrating signs of patellofemoral joint involvement on physical examination.
5. Knee showing evidence of osteoarthritis grade 3 and above.
6. Patients with deformity around the knee joint.

Methods

After obtaining the Institutional Ethical Committee's approval, patients were well informed about the nature of the study, and verbal and written consent were taken.

RESULTS

Table 1: Clinical evaluation of the patellofemoral joint

	All	Males	Females
Q angle	12.21(±1.821, range 9-18)	11.73(±1.70, range 10-18)	12.70(±1.83, range 9-15)
p-value	0.15		

The clinical evaluation of the patellofemoral joint revealed that the mean Q angle was 12.21 (±1.821, range 9-18) for all participants. When stratified by gender, males had a slightly lower mean Q angle of 11.73 (±1.70, range 10-18), while females exhibited a slightly higher mean Q angle of 12.70 (±1.83, range 9-15).

Table 2: Evaluation of the lateral radiographs

Index	Total study population mean (n=60)	Females	Males	P value
Insall–Salvati ratio	1.14(±0.15, range 0.74-1.6)	1.14(±0.15, range 0.88-1.58)	1.04(±0.19, range 0.74-1.6)	0.01
Modified Insall–Salvati ratio on X-ray	1.57(±0.287, range 1.1-2.44).	1.58(±0.24, range 1.21-2.44)	1.58(±.33, range 1.1-2.28)	0.86
Caton–Deschamps index	0.923(±0.208, range 0.63-1.4)	0.94 (±0.26, range 0.6-1.4)	0.90(±0.14, range 0.63-1.32)	0.16

Table 2 presents the results of the evaluation of lateral radiographs in the study population. The mean Insall-Salvati ratio was 1.14 (±0.15) for the total study population, with a range of 0.74 to 1.6. Females had a similar mean ratio of 1.14 (±0.15), ranging from 0.88 to 1.58, while males had a slightly lower mean ratio of 1.04 (±0.19), ranging from 0.74 to 1.6. The p-value for this comparison was 0.01, indicating a statistically significant difference between males and females. However, the modified Insall-Salvati ratio on x-ray and the Caton-Deschamps index did not show significant differences between genders. The mean modified Insall-Salvati ratio on x-ray was 1.57 (±0.287) for the total study population, ranging from 1.1 to 2.44. Females and males had similar mean ratios of 1.58 (±0.24) and 1.58 (±0.33), respectively, with ranges of 1.21 to 2.44 and 1.1 to 2.28. The p-value for this comparison was 0.86. Similarly, the mean Caton-Deschamps index was 0.923 (±0.208) for the total study population, ranging from 0.63 to 1.4. Females had a slightly higher mean index of 0.94 (±0.26), ranging from 0.6 to 1.4, while males had a mean index of 0.90 (±0.14), ranging from 0.63 to 1.32. The p-value for this comparison was 0.16.

Table 3: Distribution of various indices calculated on MRI images in the study population

	Study population	Females	Males	P value
I/S ratio on MRI	1.22 (±0.245, range 0.77-2.02)	1.31(±0.24, range 0.98-2.02)	1.14(±0.21, range 0.77-1.84)	<0.01
Modified I/S ratio on MRI	1.752 (±0.275, range 1.1-2.57)	1.76(±0.23, range, 1.3-2.12)	1.75(±0.25, range 1.1-2.57)	0.82
Caton–Deschamps index on MRI	1.10 (±0.242, range 0.63-1.90)	1.16(±0.25, range 0.72-1.9)	1.05(±0.22, range 0.63-1.78)	0.11
Sulcus angle on MRI (degrees)	131.204 (±9.179, range 108.40-168.00 degrees)	130.41(±9.23, range 114.65-162)	132(±9.21, range 108.4-168)	0.21

Table 3 presents the distribution of various indices calculated on MRI images in the study population. The I/S ratio on MRI showed a statistically significant difference between genders (p<0.01), with females having a higher mean ratio of 1.31 (±0.24) and males having a lower mean ratio of 1.14 (±0.21). The modified I/S ratio on MRI, the Caton-Deschamps index on MRI, and the sulcus angle on MRI did not exhibit significant gender differences. Further investigation is required to understand the clinical implications of these findings.

Table 4: Results of the present study

Indices	Whole population	Males	Females	P value
Q angle	12.21(±1.821, range 9-18)	11.73(±1.70, range 10-18)	12.70(±1.83, range 9-15)	0.15
X-ray				
Insall–Salvati ratio	1.14(±0.15, range 0.74-1.6)	1.14(±0.15, range 0.88-1.58)	1.04(±0.19, range 0.74-1.6)	0.01
Modified Insall–Salvati ratio on X-ray	1.57(±0.287, range 1.1-2.44).	1.58(±0.24, range 1.21-2.44)	1.58(±.33, range 1.1-2.28)	0.86
Caton–Deschamps index	0.923(±0.208, range 0.63-1.4)	0.94 (±0.26, range 0.6-1.4)	0.90(±0.14, range 0.63-1.32)	0.16
Sulcus angle	123.20(6.316, range 105-136.8)	122.86 (6.36, range 108-136)	123.56(6.35, range 105-136)	p=0.43
Congruence angle	7.653 (3.181 degrees, range 2.30-19)	7.44 (3.01, range 2.3-17)	7.86(3.37, range 3.70-19)	p=0.78
Laurin angle				
Positive	90%	90.0%	93.3%	0.98
Negative	10%	10.0%	6.7%	
MRI				
I/S ratio on MRI	1.22 (±0.245, range 0.77-2.02)	1.31(±0.24, range 0.98-2.02)	1.14(±0.21, range 0.77-1.84)	<0.01
Modified I/S ratio on MRI	1.752 (±0.275, range 1.1-2.57)	1.76(±0.23, range 1.3-2.12)	1.75(±0.25, range 1.1-2.57)	0.82
Caton–Deschamps index on MRI	1.10 (±0.242, range 0.63-1.90)	1.16(±0.25, range 0.72-1.9)	1.05(±0.22, range 0.63-1.78)	0.11
Sulcus angle on MRI (degrees)	131.204 (±9.179, range 108.40-168.00 degrees)	130.41(±9.23, range 114.65-162)	132(±9.21, range 108.4-168)	0.21
TT-TG	9.15 mm(±2.96, range 5.28-18.79)	9.25 mm (±1.82, range 6.21-13)	9.04 mm(±3.81, range 5.28-18.79)	0.06
LTI	18.15(±4.70,range 5.1-28.4)	17.70(±4.62, range 5.1-26.4)	18.59 (±4.81, range 8-28.4)	0.69

Table 4 summarizes the results of the present study. Among the evaluated indices, the Q angle showed no significant gender difference (p=0.15). On X-ray imaging, the Insall-Salvati ratio exhibited a significant difference between genders (p=0.01), with males having a lower mean ratio than females. However, no significant gender differences were observed in the modified Insall-Salvati ratio, Caton-Deschamps index, sulcus angle, or congruence angle on X-ray. For MRI evaluations, the I/S ratio on MRI demonstrated a significant difference between genders (p<0.01), with females having a higher mean ratio than males. No significant gender differences were found in the modified I/S ratio on MRI, Caton-Deschamps index on MRI, sulcus angle on MRI, TT-TG distance, or LTI. The Laurin angle showed a positive result in the majority of cases, with no significant gender difference. Further analysis is needed to fully interpret these findings.

DISCUSSION

The results of our study on the clinical evaluation of the patellofemoral joint, as presented in table 1, provide valuable insights into the Q angle in both male and female participants. The mean Q angle for the entire study population was 12.21 degrees, with a range of 9 to 18 degrees. When comparing genders, we observed a slightly lower mean Q angle in males (11.73 degrees) and a slightly higher mean Q angle in females (12.70 degrees). Although this difference did not reach statistical significance (p=0.15), it is consistent with previous research indicating that females tend to have a slightly higher Q angle compared to males. This finding aligns with the existing literature, which suggests that females are more predisposed to patellofemoral joint issues due to anatomical and biomechanical differences [9].

Moving on to table 2, which focuses on the evaluation of lateral radiographs, we assessed various indices related to patellofemoral alignment. The Insall-Salvati ratio, a commonly used measurement, exhibited a statistically significant difference between males and females (p=0.01). Males had a lower mean ratio (1.04) compared to females (1.14), indicating a potential difference in patellar height between the genders. However, other indices, such as the modified Insall-Salvati ratio on X-ray and the Caton-Deschamps index did not show significant gender differences. These findings are consistent with some previous studies while contrasting with others, highlighting the complexity and variability of patellofemoral alignment measurements [10].

Table 3 presents the distribution of various indices calculated from MRI images. The I/S ratio on MRI demonstrated a statistically significant difference between males and females (p<0.01). Females had a higher mean ratio (1.31) compared to males (1.14), indicating potential differences in patellar height on MRI. However, the modified I/S ratio on MRI, the Caton-Deschamps index on MRI, and the sulcus angle on MRI did not show significant gender differences. These findings suggest that MRI-based measurements may provide additional information about the patellofemoral alignment that is not captured by X-ray evaluations alone [11].

Comparing our results with other studies, it is important to consider the variability in study populations, sample sizes, and measurement techniques. Some studies have reported similar trends in Q angle and patellar alignment between genders, supporting our findings. However, discrepancies can arise due to differences in methodologies, participant characteristics, and underlying musculoskeletal conditions. Therefore, it is crucial to interpret these results in the context of the specific study and consider the broader body of literature to draw meaningful conclusions [12].

CONCLUSION

In conclusion, our study provides valuable insights into the clinical evaluation of the patellofemoral joint, with a focus on Q angle and various radiographic and MRI indices. We observed gender differences in some measurements, such as the Insall-Salvati ratio on X-ray and the I/S ratio on MRI. However, other indices did not exhibit significant gender differences. These findings contribute to the existing knowledge on patellofemoral alignment and highlight the importance of comprehensive assessments to better understand the complex interactions within the joint. Further research with larger sample sizes and diverse populations is necessary to validate these findings and refine our understanding of patellofemoral joint biomechanics.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

Declared none

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