Original Article

DOI: 10.7860/IJARS/2018/37608:2433

Radiology Section

The Reliability and Reproducibility of Patellotrochlear Index as a Measure of Patellar Instability in Indian Population

MEHTAB AHMAD, SHAISTA SIDDIQUI, ZAFAR AHMAD KHAN, JESAN KHAN, SHAGUFTA WAHAB

ABSTRACT

Introduction: The knee joint is one of the most used and abused joint of the body and hence knee discomfort and pain is one of the primary complaint of patients presenting to the orthopaedic out-patient department. There is a long list of conditions affecting the knee joint of which patellar instability and patellofemoral pain is a significant component; however often the most difficult to diagnose. There are numerous ratios, angles and measurements available to quantify the instability but they lack standardization. Mostly these ratios are based on the bony outlines of the joints and do not consider the actual articular surfaces. Patellotrochlear index (PTI) is unique in this regard as this index quantifies and depicts the relation and congruency of the patellar and femoral trochlear articular cartilages.

Aim: To establish normal values of patellotrochlear index in an Indian population.

Materials and Methods: A prospective study was conducted on 100 patients who presented to the orthopaedic out-patient department with knee complaints other than anterior knee pain. All these patients were subjected to MRI and sagittal T2 WI and proton density images and were evaluated for the PTI. The images were evaluated by a musculoskeletal radiologist and an orthopaedic surgeon to look for reliability and reproducibility of the index.

Results: The mean PTI was 0.35 when measured by the radiologist and 0.36 when measured by the orthopaedic surgeon with a standard deviation of 0.13 and 0.14 respectively. A high degree of correlation was noted between these groups, hence establishing its reliability and reproducibility.

Conclusion: PTI is an easy, reliable and reproducible index for the quantification of patellar instability which can be used by the radiologist and orthopaedic surgeon.

Keywords: Articular cartilages, Knee Joint, Patellofemoral joint

INTRODUCTION

Patellofemoral joint is a complex joint with an intricate anatomy and biomechanics [1,2]. Owing to this unique morphology and mechanics this joint is affected with distinctive pathologies commonly referred to as Patellofemoral Pain Syndrome (PFPS) [3]. This pain syndrome affects almost 25% of the population and is touted to be the second most common complaint of patients presenting to the orthopaedic clinics [3]. For smooth and painless working of the joint, there has to be a level of congruency between the patellar cartilage and the trochlear cartilage [1]. This congruency and alignment is measured by various ways, one of which is PTI [1,4]. PTI is defined as the ratio of the trochlear cartilage overlapping with the patellar cartilage in relation to the length of the patellar cartilage [1,4].

The earliest measurements of patellar height labelled either patella alta or baja were done on lateral plain radiographs. These radiographs were only able to document the bony contour of the joint and could not reliably evaluate the cartilage covering the joints. Seil R et al., showed that patellar height classification and subsequent classification of patella alta depends mainly on the chosen ratio and the differing results were primarily due to the anatomical and bony differences [5]. Various ratios are used to quantify the patellar height using the bony silhouette of the patellofemoral joint and an imagined patellar tendon length like the Insall and Salvati ratio, Blackburne and Peel method and Caton-Deschamps index [6-8]. However, various studies have showed that it is actually the articulating cartilages of the patella and the trochlea which are responsible for the biomechanics and pathology of the patellofemoral joint [1,9,10]. Hence, there was a need for a new index which could account for the articular cartilages of the patellofemoral joint.

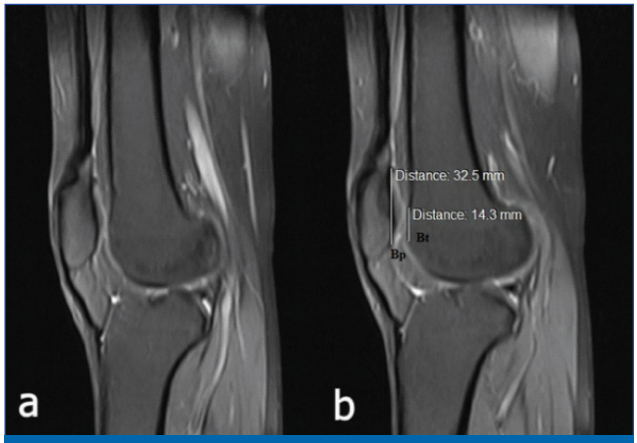
PTI was first described by Biedert RM et al., [4]. They were also of the opinion that the radiological methods used to describe

the relationship between the patellar height and knee instability were variable and lacked standardization [4,11]. They also realized that quantification of the bony outlines was insufficient to realize the actual magnitude of the problem. Hence, they developed a new ratio which took into account the actual articular surfaces of the patellofemoral joint i.e., the patellar articular surface and the congruent portions of the femoral trochlea [4]. The importance of a ratio which considered the articular cartilage of both the patella and the trochlear was also supported by Ali SA et al., [1]. They concluded that to find a correlation between patellofemoral pain and actual pathologies like chondromalacia patella and patellar instability the condition, morphology and relation of the trochlea with the patella is of utmost importance [1]. Hence, the present study was conducted with an aim to establish normal values of patellotrochlear index in an Indian population.

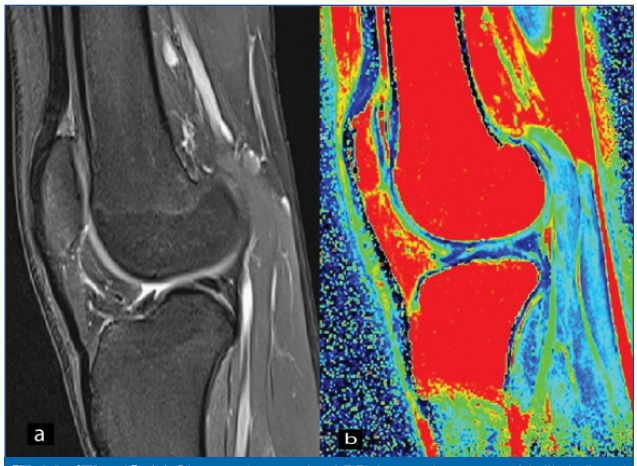
MATERIALS AND METHODS

The study was a prospective study which was conducted on 100 patients over a period of one year from April 2017 to April 2018. Due ethical clearance was taken by the ethics committee of the hospital. Also, informed consent was obtained from the patients regarding the use of their imaging data without disclosure of their identity. The patients who presented to the orthopaedic out-patient department with knee pain as the primary complaint as a result of trauma or degeneration and who underwent an MRI were included in the study. Care was taken to exclude cases with specific anterior knee pain also known as patellofemoral pain syndrome. Patients with patellar complaints like chondromalacia, recurrent/habitual patellar dislocations and large joint effusions were also excluded. Patients with infections and trauma were also excluded from the study. The patients who refused to give consent to be a part of the study were also excluded. The patients were subjected to 1.5 T MRI on MagnetomAvanto Siemens machine. T1, T2, PD and STIR images were obtained in sagittal, coronal and axial planes. Other sequences like T2 relaxometry and contrast study was added as and when required.

The PTI was measured on sagittal Proton Density Fat Saturated (PD-FS) images on a single slice using the caliper tool provided with the syngo. via., a propriety software by the Siemens organisation [Table/Fig-1]. The length of articular cartilage covering the patella (Bp) and the corresponding femoral trochlear articular cartilage (Bt) was measured and the ratio (Bt/Bp= PTI) was calculated and recorded [4]. For every patient the ratio was calculated twice; once by a musculoskeletal radiologist (Group I) and other by an orthopaedic surgeon (Group II) separately. In equivocal cases T2 relaxometry images which showed better delineation of the articular cartilage was used for the measurement of PTI [Table/Fig-2]. The data gathered by the radiologist and the orthopaedic surgeon was analysed separately using SPSS version 20.0 and correlation coefficients drawn. Eventually the data gathered in both the groups were compared and parallel results drawn.



[Table/Fig-1]: a) Sagittal proton density Fat-Sat image through mid-patella demonstrates the optimal level to measure the PTI, where the cartilage thickness is maximum illustrates the method to calculate the PTI. b)Length of the cartilage covering the patella and the femoral trochea are measured as shown in the mid-sagittal plane and the ratio of patellar length to trochlear length is calculated.



[Table/Fig-2]: (a) Shows the sagittal PD fat sat images with ill defined cartilagenous margins of the patellar articular cartilage; however, the T2 relaxometry images (b) is clearly showing the cartilage outline in blue colour. T2 relaxometry can be used to delineate cartilage for calculations in difficult cases.

RESULTS

Of the total 100 patients 78 were males and 22 were females. The mean PTI was 0.35 when measured by the radiologist (Group I) and 0.36 when measured by the orthopaedic surgeon (Group II) with a standard deviation of 0.13 and 0.14 respectively. Taking the cut off as 2 SD above and below the mean; patella alta was designated below 0.09 and baja above 0.61 in Group I [Table/Fig-3]. There was only a minor difference in Group II with values for patella alta being below 0.08 and baja above 0.64. When the correlation coefficient between the

two groups was calculated using Microsoft Excel, it came out to be 0.92 indicating a strong correlation between the two groups. There was no significant difference in the values of PTI in male and female patients.

[Table/Fig-3]: Demonstrates the increased patellar height evident by the a low PTI measured on this mid-sagittal MRI image in an asymptomatic patient with patella alta.

DISCUSSION

The mean value of the patellotrochlear index as measured by Biedert RM et al., was 0.31 which is very near to the values observed in this study [4]. Also, the standard deviation as observed by them was very close to the present study of 0.11 and 0.13 respectively [4]. Another study conducted by Ali SA et al., showed the PTI to be slightly on the higher side i.e., about 0.49 with patella alta at values < 0.18 and baja at values >0.80 [1]. In present study, the cut off for patella alta was 0.09 and for patella baja was 0.61. The lack of significant difference in the values points towards reliability of the ratio. Biedert RM et al., also analysed their data by three different individuals in a blinded manner with one of the readers being an orthopaedic surgeon and found a high and significant interobserver correlation as in our study [4]. Hence, establishing both the reliability and reproducibility of PTI.

There are a few drawbacks with this index which need to be addressed. Firstly, the resolution of MRI images is greatly dependant on its strength. Higher the strength of the magnet better is the depiction of the articular cartilage and hence better evaluation. This was the possible cause of difference in values projected by Biedert RM et al., and Ali SA et al., as the studies was conducted on 1.0 T and 1.5 T respectively [1,4].

Secondly, in pathological knees with overt patellofemoral instability and dislocation it may not be possible to measure the patellar and trochlear cartilage on a single frame sagittal image and two or more sagittal frames may be required to obtain accurate measurements. In such cases Dejour D et al., proposed the Sagittal Patellofemoral Engagement (SPE) index which was in essence like PTI but took into account cases with dislocation. The measurements obtained using this method were also similar to the present study and the studies mentioned previously [1,4,12].

Thirdly, few authors are of the opinion that cartilage changes on account of patellar instability do not entire conform to the patellar height ratios but are more dependent on the trochlear morphology, tilt, trochlear depth and lateral trochlear inclination [1,9,11].

Lastly, a more extensive and exhaustive study is required both in normal patients and in patients with gross patellar instability and dislocation to obtain broad-spectrum patellotrochlear index values.

LIMITATION

The study has few limitations. Firstly, the study aims to set standard reference values for PTI in Indian subcontinent. Though the sample size was 100 patients; larger cross sectional studies are required for more accurate quantification of PTI values which could be extrapolated to the population in general. Secondly, the inclusion criterion consisted of patients presenting with knee pathologies other than anterior knee conditions. Hence patients with ACL, PCL and other ligamentous injuries were a part of the study. In patients with ACL injuries and laxity of the ligaments the flexion angles of the knee are supposedly disturbed and this could have affected the PTI measurements.

CONCLUSION

Patellotrochlear index is a reliable and reproducible index which depicts the actual relation between the articular cartilage of the patella and the femoral trochlea. If used meticulously and in appropriate settings the major causes for patellofemoral pain syndrome can be explained by it and can be taken care of.

REFERENCES

[1] Ali SA, Helmer R, Terk MR. Analysis of the patellofemoral region on MRI: association of abnormal trochlear morphology with severe cartilage defects. AJR. 2010;194(3):721-27.
[2] Christoforakis JJ, Strachan RK. Internal derangements of the knee associated with patellofemoral joint degeneration. Knee Surg Sports Traumatol Arthrosc. 2005;13(7):581-84.
[3] Wilson T. The measurement of patellar alignment in patellofemoral pain syndrome: are we confusing assumptions with evidence. Journal of Orthopaedic & Sports Physical Therapy. 2007;37(6):330-41.
[4] Biedert RM, Albrecht A. The patellotrochlear index: a new index for assessing patellar height. Knee Surg Sports Traumatol Arthrosc. 2006;14(8):707-12.
[5] Seil R, Muller B, Georg T, Kohn D, Rupp S. Reliability and interobserver variability in radiological patellar height ratios. Knee Surg Sports Traumatol Arthrosc. 2000;8(4):231-36.
[6] Insall J, Salvati E. Patella position in the normal knee joint. Radiology. 1971;101(1):101-04.
[7] Blackburne JS, Peel TE. A new method of measuring patellar height. J Bone Joint Surg Br. 1977;59(2):241-42.

[8] Caton J, Deschamps G, Chambat P, Lerat JL, Dejour H. Patella infera. A propos of 128 cases. Rev Chir Orthop Reparatrice Appar Mot. 1982;68(5):317-25.
[9] Diederichs G, Issever SA, Scheffler S. MR Imaging of patellar instability: injury patterns and assessment of risk factors. RadioGraphics. 2010;30(4):961-81.
[10] Laugharne E, Bali N, Purushothamdas S, Almallah F, Kundra R. Variability of measurement of patellofemoral indices with knee flexion and quadriceps Contraction: An MRI-based anatomical study. Knee Surg Relat Res. 2016;28(4):297-301.
[11] Berruto M, Ferrua P, Carimati G, Uboldi F, Gala L. Patellofemoral instability: classification and imaging. Joints. 2013;1(2):07-13.
[12] Dejour D, Ferrua P, Ntagiopoulos PG, Radier C, Hulet C, Rémy F, et al. The introduction of a new MRI index to evaluate sagittal patellofemoral engagement. Orthopaedics & Traumatology: Surgery & Research. 2013;99(8):S391-98.

AUTHOR(S):
1. Dr. Mehtab Ahmad
2. Dr. Shaista Siddiqui
3. Dr. Zafar Ahmad Khan
4. Dr. Jesan Khan
5. Dr. Shagufta Wahab

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Radiodiagnosis, J.N. Medical College, Aligarh Muslim University, Aligarh,Uttar Pradesh, India.
2. Assistant Professor, Department of Radiodiagnosis, J.N. Medical College, Aligarh Muslim University, Aligarh,Uttar Pradesh, India.
3. Senior Resident, Department of Orthopaedic Surgery, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh, India.
4. Assistant Professor, Department of Orthopaedic Surgery, Jawaharlal Nehru, Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh, India.
5. Associate Professor, Department of Radiodiagnosis, J.N. Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Shaista Siddiqui,
Department of Radiodiagnosis, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh-202002, Uttar Pradesh, India.
E-mail: shaistasiddiqui13@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Publishing: **Oct 01, 2018**