

Comparative Study on Insall-Salvati Index by Radiological and Clinical Methods in a Tertiary Care Centre of North Bengal, India

MAITREYEE KAR¹, DIPANKAR BHAUMIK², SAMAR DEB³, KAUSHIK ISHORE⁴, CHINMAYA KAR⁵

ABSTRACT

Introduction: Patellar height is an important parameter of patellar stability. Its importance is evident from various attempts to measure it, by different scientists from time to time and many indices have been derived among which Insall-Salvati index (IS index) is the most simple, accurate and easy to measure. In this study a new clinical method has been tried to measure patellar height by applying the same principle of IS index.

Aim: To compare clinical method of measurement of IS index with the one derived radiologically and to establish the higher cut off value of the clinical method.

Materials and Methods: In the present study 186 knee joints (93 subjects) were subjected to measurement of patellar height by both clinical and radiological methods. The IS index was measured bilaterally from lateral view of X-ray plates and it was measured clinically in every knee joint. Both the values were

compared using students t-test and higher cut off values were set for normal knee joint for the clinical method.

Results: Among 93 study participants majority were females (54.83%), age of the patients varied from 10-68 years with mean age of 28 years and Standard deviation (SD) of 16.4. It was found that, there was no statistically significant difference between the mean values obtained by clinical method of measurement, compared to conventional one (IS Index) for both the genders and age groups on both the sides. A cut off value of 0.98 cm by clinical method gives sensitivity of 80% and specificity of 36% with area under the ROC curve 0.596.

Conclusion: The subjects with patellar height of less than cut off value by clinical method can avoid radiological investigation as there was no statistically significant difference of IS index between radiological and clinical methods.

Keywords: Age, Indian population, Patella alta, Patellar height

INTRODUCTION

Patellar height is one of the important parameter in assessing patellar stability [1-4]. Its importance has been reflected through attempts by renowned scientists to measure the patellar height by such an index which is simple, accurate, practical and also reproducible. As a result, several radiological indices have been used to measure the height of the patella of which "IS Index" is the most popularly used method so far, as it fulfills all the above criteria [5]. Insall and Salvati in 1971 introduced this index from lateral view X-ray film of knee joint taken at 30° angle of flexion [4]. "IS index" is the ratio of LT and LP where LT indicates length of distal part of tendon of quadriceps femoris (i.e., ligamentum patellae) extending from distal pole of patella to tibial tuberosity and LP means diagonal length of Patella [6].

Though the "IS index" was initially based on radiological findings on lateral view of the knee joint in X-ray films, different studies have been conducted to measure the "IS index", namely through cadaveric dissection, sagittal MRI and ultrasonography, keeping the principle of the index constant [7-9]. Though it is the most popular method of measurement it has many drawbacks including difficulty to identify the soft tissue [10]. So for accurate measurement it is wise to take the help of MRI which is expensive and cannot be applied to all the cases for routine measurement of patellar height particularly when it is very important in sports medicine.

In the present study, a clinical method, based on the criteria of the IS index has been adopted to compare, contrast and correlate the findings with a radiological method which is well validated, in respect to the patellar height among a population in North Bengal, India.

In this background, the present study is an important attempt to measure the patellar height by "IS index" by two separate methods- viz., radiological and clinical, comparing both the findings and to establish a cut off value of patellar height for clinical methods.

MATERIALS AND METHODS

A cross-sectional institution based observational study was conducted among the adolescents (age above 10 years) and adults admitted in the orthopaedics indoor of North Bengal Medical College and Hospital, Darjeeling, West Bengal, India with any reason other than knee related disorders, during the year 2013-2014.

The patients were subdivided into two groups, one group with patients aged 10 to 20 years and another group with patients aged ≥ 20 years. The patients excluded were those having any acute condition, receiving intravenous fluid, those who cannot cooperate during clinical examination, patients with splint and compressive bandages.

Finally a total number of 93 subjects were included in this study. Permission was duly sought from the concerned departments as well as institutional authorities and the Ethical committee at North Bengal Medical College and Hospital before proceeding for the study.

The selected patients were informed about the nature of the study and the procedures involved and permission was obtained for both clinical examination and radiographic investigation. Consents were obtained from all the study subjects. The patient's name, address, age, sex, date of admission, occupation, chief complaint, history of present illness, past illness, other associated illness, complaint of knee pain if any, were all noted as per the format through direct interview of the patients and assistance was taken from available hospital records.

Examination of both the lower limbs was done meticulously with special references to measurement of patellar height by "IS index". Next, outline of patella, identifying its upper border, apex, and two lateral borders were marked. A small horizontal line on the patella was drawn in the midway between upper border and apex. Another short vertical line was drawn midway between its medial and lateral borders at the level of maximum breadth. At the point of intersection of the two above mentioned lines, was considered as

the centre of patella. The most prominent point on tibial tuberosity was marked. The distance i.e., the maximum available diagonal Length of the Patella (LP) was measured by means of measuring tape. The distance from the lower pole of patella to tibial tuberosity was measured (LT). The ratio of LT/LP was calculated to derive "IS index". Similarly X-ray of lateral view of knee joint was taken from which "IS index" was calculated [Table/Fig-1].

STATISTICAL ANALYSIS

SPSS version 16.0 was used for the statistical analysis (student t-test).

RESULTS

In the present study 186 knee joints were subjected to measurement for patellar height by both clinical and radiological methods in respect to gender and two different age groups (above/equal to and below 20 years) [Table/Fig-2].

It was found that, there was no statistically significant difference between the mean values obtained by clinical method of measurement, and the to conventional one (IS Index) for both the genders and age groups in both right and left sides [Table/Fig-3,4].

On further assessment, to explore a cut off value for clinical measurement it was seen that, a value of 0.98 cm gives sensitivity



[Table/Fig-1]: Lateral view radiograph of knee joint to measure IS index. LP= Length of patella, LT= Length of ligamentum patellae

Age group	Number of cases	
	Males	Females
< 20 years	18	24
≥ 20 years	24	27

[Table/Fig-2]: Age and sex distribution of the study population (n=93).

	Clinical Method	IS Index	Student t-test value at df =1	p-value
Male < 20 years	M-0.993 SD-0.168	M-0.997 SD-0.119	0.024	>0.05*
Female < 20 years	M-1.033 SD-0.208	M-1.039 SD-0.148	0.360	>0.05*
Male ≥ 20 years	M-1.067 SD-0.172	M-0.989 SD-0.072	2.091	>0.05*
Female ≥ 20 years	M-0.989 SD-0.186	M-1.011 SD-0.173	0.391	>0.05*

[Table/Fig-3]: Measurement values as per "IS index" and clinical method in both the genders and age groups in right lower limb (n=93). df= Degree of freedom, M= Mean, SD= Standard deviation, * = Non significant Student t-test applied

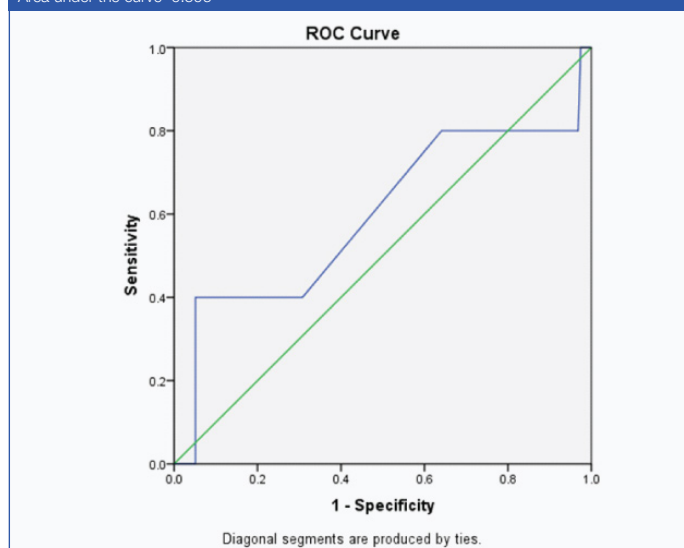
	Clinical Method	IS index	Student t-test value at df =1	p-value
Male < 20 years	M-1.011 SD-0.214	M-0.996 SD-0.133	0.436	>0.05*
Female < 20 years	M-1.023 SD-0.198	M-1.047 SD-0.165	0.722	>0.05*
Male ≥ 20 years	M-1.066 SD-0.175	M-1.017 SD-0.102	1.503	>0.05*
Female ≥ 20 years	M-1.013 SD-0.196	M-0.990 SD-0.117	0.756	>0.05*

[Table/Fig-4]: Measurement values as per "IS index" and clinical method in both the genders and age groups in left lower limb (n=93). df=Degree of freedom, M= Mean, SD= Standard deviation, * = Non significant Student t-test applied

Cut off Points	Sensitivity (True Positives)	1 - Specificity (False Positives)
0.9350	0.800	0.692
0.9850	0.800	0.641
1.0100	0.400	0.308

[Table/Fig-5]: Different percentages of sensitivity and specificity at different cut off values of clinical measurement.

Area under the curve=0.596



[Table/Fig-6]: The graph showing the relation between sensitivity and (1-specificity) at different cut off values of clinical measurement.

of test of 80% and the specificity of 36% with area under the ROC curve 0.596 which is not satisfactory [Table/Fig-5,6].

DISCUSSION

There are so many methods of measurement of patellar height. They can be classified broadly into two groups- direct and indirect methods depending upon whether femur or tibia is taken as a reference point in relation to patella respectively [5]. Though femoro-patellar compartment is more important in cases of anterior knee pathologies due to alteration of patellar height but there are some disadvantages of using femur for measuring patellar height. It has to be measured from lateral radiograph in fixed flexion angle-90° and if patella alta is diagnosed, with 90° angle in flexion, the patella looks towards the ceiling not towards the torso [5]. The commonly used four methods namely (The Insall-Salvati, Modified Insall-Salvati, Blackburn-Peel and Caton-Deschamps) are indirect methods [6, 11-13].

Among all the methods IS index is the most popular, accurate and simple due to the following factors. It can be obtained from lateral radiograph without any specific flexion angle. It is easy to remember the range of normal value. In the present study we have measured patellar height using conventional radiograph following the IS index.

There are some studies in China done by Leung YF et al., and India done by Upadhyay S et al., have shown that the IS index does

not bear the same normal value for Western population and the population of China or India where squatting, cross-legging and kneeling are customs [14,15]. The value is slightly higher for the latter population. But our study failed to show such difference significantly though the value is slightly more following clinical method but this difference was not statistically significant.

Patella Alta is associated with several clinical conditions. Significant cause of recurrent patellar dislocation can be associated with Patella alta [13,14,16-24]. This dislocation due to patella alta had been explained in the light of delay in tendo-femoral contact and concomitant increase in the magnitude of patello-femoral contact with increased flexion of knee [25].

The diagnosis of patella alta should be considered in all cases of knee pain [18]. In a study, 45 patients of unilateral patello-femoral pain syndrome were examined and results suggested that high-riding of the patella due to long patellar tendon (patella alta) was the only definite finding in the affected knees. Kannus PA in 1992 concluded that idiopathic retropatellar pain is closely associated with Patella Alta after analyzing the result of this study [26].

Jerold EL and John AC in 1975 measured a series of roentgenograms of knees with chondromalacia patellae, knees with apophysitis of tibial tubercle (Osgood-Schlatter disease) [24]. The IS index in patients with chondromalacia patellae was 0.86 (patella infera). It may be the cause or effect. But other studies support the view that patella alta is a cause of symptomatic idiopathic chondromalacia patellae [22,27]. The IS index was 1.2 for those with apophysitis of tibial tubercle (Osgood-Schlatter disease) in the study done by Jerold EL and John AC [24]. Patella alta is classically described as the residuum of Osgood-Schlatter disease in other studies too [22,27]. But according to another study where patella infera is associated with Osgood-Schlatter disease may be the result of short tendon due to inflammation and fibrosis and patella infera is not the cause of the lesion [28].

Hence, it seems that patella alta should receive more importance in all the cases of knee pain [19]. Some of the cases were associated with Sinding-Larsen Johansson's disease; ruptured ligamentum patellae, genu recurvatum pathology and trauma of extensor apparatus of knee, malposition, gonarthrosis or supratrochlear erosion of the femur [14,18].

LIMITATION

Firstly, it does not include the relevant pathological conditions like Osgood Schlatter's disease, Larsen Johanssen's disease or recurrent dislocation of patella. Secondly, it is important to do a large scale study for identifying the accurate cut off value for clinical measurement of patellar height.

CONCLUSION

There is no statistically significant difference of IS index between radiological and clinical methods. So, one can opt for clinical measurement techniques for measurement of patellar height as a primary procedure. If the measurement is above the cut off value

(0.98 in the present study) the person should undergo more sensitive tests like MRI.

REFERENCES

- [1] Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: An anatomical radiographic study. *Knee Surg Sports Traumatol Arthrosc.* 1994;2:19-26.
- [2] Escala JS, Mellado JM, Olona M, Gine J, Sauri A, Neyret P. Objective patellar instability: MR-based assessment of potentially associated anatomical features. *Knee Surg Sports Traumatol Arthrosc* 2006;14:264-72.
- [3] Fithian DC, Paxton EW, Cohen AB. Indication in the treatment of patellar instability. *J Knee Surg.* 2004;17:47-56.
- [4] Insall J, Salvati E. Patella position in the normal knee. *Radiology.* 1971;101:101-04.
- [5] Phillips CL, Silver DAT, Schranz PJ, Mandalia V. The measurement of patellar height: a review of the methods of imaging. *The Journal of Bone and Joint Surgery.* 2010;92:1045-53.
- [6] Schlenzka D, Schwesinger G. The height of the patella: An anatomical study. *Eur J Radiol.* 1990;11:19-21.
- [7] Ali S, Heimer R, Terk MR. Patella Alta: Lack of Correlation between patello-trochlear cartilage congruence and commonly used patellar height ratios. *AJR.* 2009;193:1361-66
- [8] Shabshin N, Schweitzer ME, Morrison WB, Parker L. MRI criteria for patella alta and baja. *Skeletal Radiol.* 2004;33:445-50.
- [9] Cone III RO. MRI Web Clinic. Cone III; 2010 [cited on 27/09/2016]. Available from: <http://radsource.us/patella-alta-and-baja/> Last access date 27/09/2016.
- [10] Leung YF, Wai YL, Leung YC. Patella alta in southern China. A new method of measurement. *Int Orthop.* 1996;20:305-10.
- [11] Blackburne JS, Peel TE. A new method of measuring patellar height. *J Bone Joint Surg Br.* 1977;59:241-42.
- [12] Caton J, Deschamps G, Chambat P, Lerat JL, Dejour H. Les rotules basses: A propos de 128 observations. *Rev Chir Orthop Reparatrice Appar Mot.* 1982;68:317-25.
- [13] Blumensaat C. Die Lagaebweichungen und Verrenkungen der kniescheibe. *Ergebn Chir Ortho.* 1938;31:149-223.
- [14] Leung YF, Wai YL, Leung YC. Patella alta in Southern China. A new method of measurement. *Int Orthop.* 1996;20:305-10.
- [15] Upadhyay S, Raza HKT, Srivastava P. Position of the patella in adults in central India: Evaluation of the Insall-Salvati ratio. *Journal of Orthopaedic Surgery.* 2013;21:23-27.
- [16] Aglietti P, Insall JN, Cerulli G. Patellar pain and incongruence-I. Measurements of incongruence. *Clin Orthop.* 1983;176:217.
- [17] Andersen PT. Congenital deformities of the knee joint in Dislocation of the Patella and Achondroplasia. *Acta Orthop Scandi.* 1958;28:27-50.
- [18] David-Chausse J, Vignes L. Critical study of patella alta II. Patella alta and femoropatellar pathology. *Rev Rhym Mal Osteoartic.* 1982;49:507-13.
- [19] Hauser EDW. Total tendon transfer for slipping patella. A new operation for recurrent dislocation of the patella. *Surg Gynaecol Obst.* 1938;66:199-214.
- [20] Insall J, Goldberg V, Salvati E. Recurrent dislocation and the high-riding patella. *Clin Orthop* 1972;88:67-69.
- [21] Runow A. The dislocating patella. Etiology and prognosis in relation to generalized joint laxity and anatomy of the patellar articulation. *Acta Orthop Scand Suppl.* 1983;202:1-53.
- [22] Singerman R, Davy DF, Gold Berg VM. Effects of patella alta and patella infera on patello-femoral contact forces. *J Biomech.* 1994;27(8):1059-65.
- [23] Lancourt JE, Cristini JA. Patella alta and patella infera. Their etiological role in patellar dislocation, chondromalacia, and apophysitis of the tibial tubercle. *J Bone Joint Surg.* 1975;57(8):1112-15.
- [24] Jerold EL, John AC. Patella alta and patella infera: *J Bone Joint Surg.* 1975;57: 112-15.
- [25] Simmons EJ, Cameron JC. Patella alta and recurrent dislocation of the patella. *Clin Orthop Relat Res.* 1992;274:265-69.
- [26] Kannus PA. Long patellar tendon: Radiographic sign of patella-femoral pain syndrome - A prospective study. *Radiology.* 1992;185:859-63.
- [27] McKeever DC. Recurrent Dislocation of patella. *Clin Orthop.* 1954;3:55-60.
- [28] 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;8:231-36.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Anatomy, North Bengal Medical College, Sushrutanagar, West Bengal, India.
2. Assistant Professor, Department of Anatomy, North Bengal Medical College, Sushrutanagar, West Bengal, India.
3. Principal, MGM Medical College, Kishanganj, Bihar, India.
4. Assistant Professor, Department of Community Medicine, North Bengal Medical College, Sushrutanagar, West Bengal, India.
5. Medical Officer, RBTC, North Bengal Medical College, Sushrutanagar, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Maitreyee Kar,
Alphonsa School Road, Village Kalamjote, P.O. Sushrutanagar, Dist.-Darjeeling-734012, West Bengal, India.
E-mail: drmkar0@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Nov 14, 2016**
Date of Peer Review: **Dec 01, 2016**
Date of Acceptance: **Dec 13, 2016**
Date of Publishing: **Mar 01, 2017**