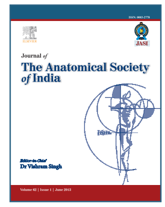
Journal of the Anatomical Society of India 62 (2013) 68–72

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage:www.elsevier.com/locate/jasi



Original article

The ‘quadriceps angle’: correlation between clinical and radiographic measurements from a study in North Bengal

Maitreyee Nandi (Kar)[a,*], Samar Deb[b], Jitendra Nath Pal[c], Arunabha Tapadar[d], Hironmoy Roy[e], Chinmaya Kar[f]

[a]*Assistant Professor, Department of Anatomy, North Bengal Medical College and Hospital, Sushrutanagar, Darjeeling, West Bengal*
[b]*Principal & Professor of Anatomy, Katihar Medical College, Bihar*
[c]*Associate Professor, Department of Orthopaedics, R.G. Kar Medical College and Hospital, Kolkata, West Bengal*
[d]*Assistant Professor, Department of Anatomy, North Bengal Medical College and Hospital, Sushrutanagar, Darjeeling, West Bengal*
[e]*Assistant Professor, Department of Anatomy, North Bengal Medical College and Hospital, Sushrutanagar, Darjeeling, West Bengal*
[f]*Medical Officer of Emergency Unit, North Bengal Medical College and Hospital, Sushrutanagar, Darjeeling, West Bengal*

K E Y W O R D S

Q angle, Patello-femoral joint, Correlation, Reliability.

A B S T R A C T

Introduction: Quadriceps angle (Q angle) is one of the most important indicators of stability of patello-femoral joint. Orthopedic surgeons often measure the Q angle clinically in patients suffering from patello-femoral joint dysfunction or in subjects particularly young active sportspersons who are prone to injury of this joint. But the clinical method of measurement of Q angle is not standardized, and its value depends on various methods used. But the radiological method of measurement of Q angle is more accurate. However, due to the expense and time involved, the clinical method is preferred over the radiological one in practice. *Aim*: This study was aimed at studying the correlation and regression between the radiographic Q-angle values and the clinical ones, so that the former can be predicted easily from the latter. *Materials and methods*: Q angle was measured both clinically and radiographically in both knee joints of 93 adult subjects in North Bengal Medical College and Hospital. *Result*: Statistically significant correlation followed by the regression analysis could reveal simple linear regression equations for predicting the radiological Q-angle values from the clinical Q angle, derived separately in both males and females in right and left sides, separately. *Conclusion*: Thus, from a known clinical Q-angle value, we can derive the respective radiological Q angle, indirectly avoiding the entire troublesome maneuver in regular practice. So the present study recommends this method in clinical fields because this is a more rational and ideal approach to estimate the radiological Q angle. Increase in the Q angle beyond 20–22° predisposes to patellar dislocation which should be kept in mind while screening athletes, especially females. This tendency can be countered by quadriceps exercises and appropriate footwear.

1. Introduction

Quadriceps-angle (Q-angle) measurement is an important parameter to assess patello-femoral joint function. It reflects the vector of combined pull of quadriceps mechanics and patellar tendon at the center of patella in patients suffering from patello-femoral syndrome (runner’s knee), patellar subluxation, or dislocation. Therefore, its measurement is very important especially in the perspective of recent advancement in sports medicine.

It is essential to measure quadriceps angle (Q angle) of knee joint to prevent knee alignment problem. In perspective of recent advancement in sports medicine, Q-angle measurement has become a routine procedure in western countries among young sports persons. Not only in the sports world, dislocation of knee joint and patello-femoral pain syndrome

*Corresponding author: Tel: +91 (0) 9433281801
E-mail address: drmkar0@gmail.com. (Maitreyee Nandi (Kar))

have become very common problems nowadays. Clinical conditions such as genu valgum, increased femoral anteversion, external tibial torsion, laterally positioned tibial tuberosity, tight lateral retinaculum, etc. can increase the 'Q angle'. This increase in 'Q angle' can be a contributing factor in recurrent patellar dislocation.[1] Therefore, if one clinical measurement procedure would be available that is accurate, practically feasible physicians could be much more aware of Q-angle measurement. In that scenario, it would be possible not only to screen the persons who have more chances of tear and wear injury of knee joint from abnormal Q angle but it would also be possible to rectify the abnormal Q angle in related clinical conditions by appropriate surgical measure.[2]

The Q angle was first described by Brattström.[3] It denotes the obliquity of the pull of the quadriceps femoris muscles on the patella. The normal Q angle varies from 8° to 10° in males and 10° to 20° in females. A Q angle of >20–22° predisposes to patellar dislocation.[1] But its value depends on a series of procedural and anthropometric variables. The Q angle reflects the effects of quadriceps mechanism on the knee. When assessed correctly, it supplies very useful information concerning the alignment of lower extremity because it represents the oblique placement of femur relative to that of tibia as well as the angle of pull of quadriceps muscle to the axis of patella and tibia. In Indian life style, there is more risk of compressive force on the patello-femoral joint while performing excessive flexion in crossed leg sitting and squatting position.[4] So patello-femoral joint problem and increased Q angle seem to be more common among them.

There is considerable disagreement on reliability and validity of clinical Q-angle measurement.[5] This may be due to lack of standardization in the measurement procedure. As the test's reliability is influenced by a host of procedural and anthropometric variables, the diagnostic relevance of using Q-angle measurement in the clinical assessment of patello-femoral joint alignment has been called into question.[6] But the radiological method is more accurate and scientific. Ideal practice is to deal maximum cases radiologically, but it is not only time consuming but also impractical in clinical setting of outpatient or inpatient department, as it requires the X-ray plate of special dimension to accommodate the entire lower limb from anterior superior iliac spine (ASIS) to tibia. On the other hand, though scientifically inferior, till bedside, the measurement of Q angle is quite easier and more feasible procedure. In this context, the present study is an attempt to redefine the correlation as well as regression between the clinically derived Q angle and radiographically derived Q angle, so that by a simple equation, we can predict the more scientific radiological values from the clinical ones. Such an endeavor which seems to be previously almost not attempted (as far as the latest journal reviews are concerned) is carried out in the purview of a tertiary care hospital in the Northern part of West Bengal.

2. Aims and objective

To explore whether the radiological value of Q angle of a particular individual could be determined from the clinically measured value of Q angle.

3. Materials and methods

This cross-sectional hospital-based study was conducted in the Department of Anatomy in collaboration with the Department(s) of Orthopedic Surgery and Radio-diagnosis in North Bengal Medical College and Hospital, situated in Darjeeling district in the northern part of West Bengal with a huge coverage area of patient care service.

With proper clearance from the Institutional Ethics Committee and due permission from the Principal of the medical college and the heads of the concerned departments, the orthopedic inpatient department was visited thrice a week. Ambulant adolescent and adult patients (i.e., age ≥ 10 years) with normal gait and posture, excluding those patients having any deformities, trauma, operations, bandages, or any diseases in either of the lower limbs as well as vertebral column, were approached randomly. Among such 145 subjects, 35 had to been excluded for past history of illness in lower limb and vertebral column. Finally 93 subjects (42 males and 51 females) could get included in this study with proper informed consent.

At first, each subject was interviewed for his/her age, which was considered in units of years to the nearest birthday. Then he/she was directed to get laid on bed supine with a straight vertebral column and legs side by side having a fully extended knee with fully relaxed quadriceps. The feet were in neutral position in relation to the pronation and supination and hip joints were also neutral in relation to the medial and lateral rotation. It was also ensured that the lower limbs are in a plane at the right angle to the line joining two ASIS. Next in both sides, the bony landmarks of ASIS, center of the patella, and the tibial tubercle were marked with a skin marking pen. The anatomical landmarks were located through palpation, visual estimation, and measurement by a single examiner. A line was drawn from the ASIS to the center of the patella and another from the center of the patella to the center of the tibial tubercle. Finally, the acute angle between the two lines was measured with the help of a goniometer (Fig. 1).

Then X-rays (AP view) of both the lower limbs from ASIS to the tibial tubercle were taken with the subject in erect stance position so that limbs become perpendicular to the line joining two ASIS. For taking these X-rays, films with larger dimensions were procured. From these X-ray films, the ASIS, center of patella, and tibial tubercle were marked. Then one line was drawn from ASIS to the center of patella and another from the center of patella to tibial tubercle. Then the acute angle between these two lines (Q angle) was measured with a goniometer (Fig. 2). Finally all the data were documented and put in SPSS version 12.0 statistical software for interpretation.

4. Results

Out of total 93 participants, 42 (46%) were male and 51 (54%) were females. Since the overall skeletal framework differed quiet in males and females, data had been interpreted separately in both the sexes.

Fig. 1 – Clinical measurement of Q angle. One line has been drawn from ASIS to the center of patella and another line has been drawn from the center of patella to the tibial tubercle. The angle between these two lines represents the Q angle of patella.

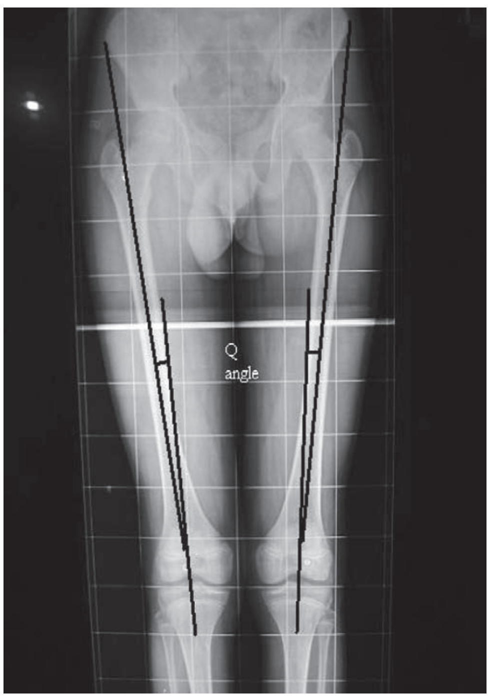


Fig. 2 – Radiological measurement of Q angle. It presents the measurement of Q angle in both sides.

For the right side, in males, the mean Q-angle values were documented as 11.8 ± 2.86 clinically and 10.5 ± 2.06 radiologically. The same was documented for females as 17.4 ± 4.27 and 15.8 ± 3.82, respectively. Since in both the sexes, the clinically derived and radiologically derived values of the Q angle found to possess significant statistical correlation (correlation coefficient in males 0.74, p = 0.000; in females 0.92,

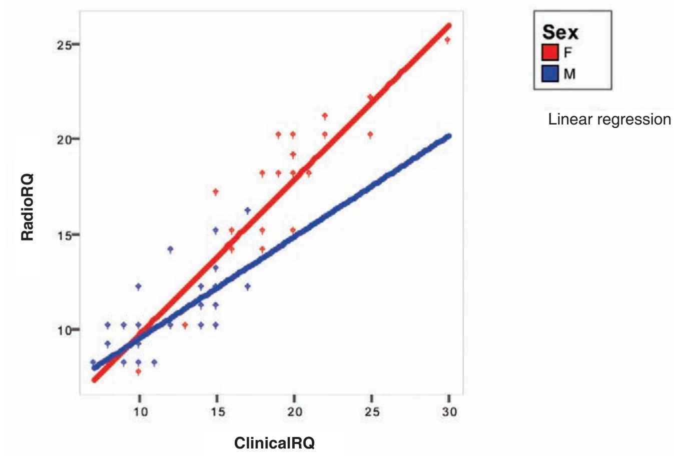


Fig. 3 – Scatter plot showing regression amongst ClinicalRQ and RadioRQ in both male and female subjects in the right side. It represents the prediction of ClinicalRQ from RadioRQ in both male and female subjects in the right side.

p = 0.000), simple linear regressions were carried on. This successfully could derive the regression equations with predictive regression curves in both the sexes as follows (Vide Table 1, Fig. 3):

In males:

$$RRQ = 4.18 + 0.53 \times CRQ \pm 2.74$$

In females:

$$RRQ = 1.58 + 0.82 \times CRQ \pm 3.12$$

Table 1 –Estimation of radiological value of Q angle of right side (RRQ) from the clinical value of Q angle of right side (CRQ) in both sexes. It represents the correlation and regression of CRQ to RRQ in both the sexes in the right side.

	Male n = 43		Female n = 52	
	CRQ	RRQ	CRQ	RRQ
Mean	11.81	10.49	17.44	15.80
Std. Dev.	2.86	2.06	4.27	3.82
Correlation coefficient	0.74 (p = 0.000)		0.92 (p = 0.000)	
Regression coefficient	0.53 (p = 0.000)		0.82 (p = 0.006)	
Regression constant	4.18		1.58	
Std. Error of estimate	1.40		1.59	
Wald statistics (F value)	243.12 (p = 0.000)		49.71 (p = 0.006)	

Independent variable: Clinical value of Q angle (right side) (CRQ).
Dependent variable: Radiological value of Q angle (right side) (RRQ).

Similar statistical analysis carried on for left side revealed the Q-angle values in males clinically to be 11.8 ± 2.54 and radiologically 10.6 ± 2.09, whereas those in females to be clinically 17.1 ± 4.27 and radiologically 15.5 ± 3.82. Correlation coefficients between clinical and radiological values were detected as 0.82 (p = 0.000) and 0.90 (p = 0.000) in males and females, respectively. In these cases also simple linear

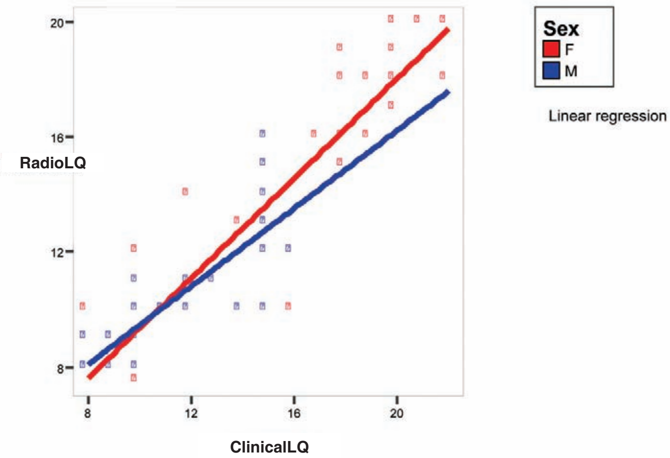


Fig. 4 – Scatter plot showing regression amongst ClinicalLQ and RadioLQ in both male and female subjects in the left side. It represents the prediction of ClinicalLQ from RadioLQ in both male and female subjects in the left side.

regression could be successfully established with predictive curves and mathematical equations as follows (Vide Table 2, Fig. 4):

In males:

RLQ = 2.66 + 0.68 × CLQ ± 2.35

In females:

RLQ = 0.66 + 0.87 × CLQ ± 3.12

Table 2 –Estimation of radiological value of Q angle of left side (RLQ) from the clinical value of Q angle of left side (CLQ) in both sexes. It represents the correlation and regression of CLQ to RLQ in both the sexes in the left side.

	Male n = 43		Female n = 52	
	CLQ	RLQ	CLQ	RLQ
Mean	11.79	10.65	17.13	15.53
Std. Dev.	2.54	2.09	4.27	3.82
Correlation coefficient	0.82 (p = 0.000)		0.90 (p = 0.000)	
Regression coefficient	0.68 (p = 0.000)		0.87 (p = 0.006)	
Regression constant	2.66		0.66	
Std. Error of estimate	1.2		1.59	
Wald statistics (F value)	86.53 (p = 0.000)		222.09 (p = 0.006)	

Independent variable: Clinical value of Q angle (left side) (CLQ).
Dependent variable: Radiological value of Q angle (left side) (RLQ).

5. Discussion

Essence of this study was to reveal the easiest way to derive the radiological Q-angle value by passing the actual radiological maneuvers, so that a clinician can predict it indirectly from a standardized method what he can perform at bedside.

Due to variable opinions described in the pertinent literature to perform an accurate measurement of Q angle, research has failed to reach any consensus about the methodology of Q-angle measurement. The clinical measurement of Q angle depends upon the variety of factors in the same individual in the same lower extremity such as the position of foot, position of body, state of quadriceps muscle, observer, etc.

Even the Q-angle value increases or decreases with medial and lateral rotation of the foot, respectively.[7] This view is also supported by another study done by Livingston and Spaulding.[8] Therefore, in the present study a standard position of foot has been opted for. During clinical measurement, both the feet were in neutral position and during the radiological method of measurement, medial borders of the feet were placed together side by side.

As per the present literature, the Q angle can be clinically measured in many ways: (i) supine position with quadriceps relaxed, (ii) Q angle in the standing position, and (iii) Q angle in the supine position with quadriceps contracted.[3] All these methods have their own advantages and drawbacks. The first method is considered as the easiest and simplest method of measuring Q angle. The Q angle measured by this technique also has found to have a moderate level of reliability. So during the clinical method of measurement of Q angle, the patient was in supine position with quadriceps relaxed. But during the radiological method of measurement of Q angle, the patient was in standing position for technical reason, to cover the whole span from ASIS to tibial tubercle. When measured in standing position, the weight bearing stress is included giving the idea of functional position.

In this study, we can also compare the effects of body position on Q-angle measurements. The present study has determined Q-angle values in the same individual on the same side clinically in supine position and radiographically in standing position.

Though the previous studies have enlightened a little about the correlation between these two methods of measuring the Q angle, the present study can boldly show simple linear regression of Q-angle values between these two body positions with obvious significant correlation.[9,10]

As the Q-angle value decreases with quadriceps muscle contraction, it is very important to standardize the state of quadriceps muscle during the measurement procedure. So in the present study, the quadriceps muscle was relaxed both during the clinical and radiographic method of measurement.[9,11–13]

Q angle being a bony angulation, the radiological method of measurement is more scientific and accurate. Though in few earlier studies poor correlations were found between the clinical and radiographic methods of measurement,[14–16] our study has successfully demonstrated significant linear regression between these two methods of measurement of Q angle.

As the Q-angle value is more in females compared to males, we have analyzed the Q-angle value separately in males and females to nullify the gender effect.[1,10,17,18]

The assumption that the Q angles in right and left lower limbs are equal is debatable as there are findings of asymmetric Q angle.[19,20] Therefore, for universal representation, lower extremity being a bilateral structure of our body, all measurements have been taken on both lower limbs of the subjects, throughout this study.

Finally, studies available till date have mainly focused on establishing the correlation between the clinical method and radiographic method in western countries but a regression analysis in both sexes easily usable in regular medical practice was not available. This study successfully could show that the radiographically derived Q-angle value could be obtained from the value derived from the clinical method.

6. Conclusion

This study keeps an impression for the indirect assessment of radiological Q angle for male and female subjects in right and left sides separately: from the clinical Q angle, by simple linear equation, almost never described before. As the clinical Q-angle measurement method is usually practiced, it is incomplete till the obtained value is converted to the radiological Q angle. The results of this study will be helpful in screening the general population and sportspersons in particular for common knee problems. It will be useful in assessing patellar stability by the measurement of the Q angle of the patella both in sportspersons and suffering from instability of patella. It is evident from the present study that attempts to decrease the Q angle by quadriceps physiotherapy or in cases of recurrent patellar dislocation by surgery will help to stabilize the knee joint. Further studies are awaited to study the effects of surgical alterations of the quadriceps angle on knee function.

REFERENCES

1. Phillips BB (ed). Recurrent dislocation. Patella (Ch 45). In: *Campbell's Operative Orthopedics* Terry Canale S, Beaty JH, eds., 11th edn, Philadelphia: Mosby Elsevier 2008:2655–61.
2. Horikawa A, Kodama H, Miyakoshi N, et al. Recurrent dislocation of the patella accompanying hypotrochlea of the femur and malalignment of the patella. *Ups J Med Sci* 2011;116:285–8.
3. Brattström H. Patella alta in non-dislocating knee joints. *Acta Orthop Scand* 1970;41:578–88.
4. Verma B. Measurement of Q-angle clinically: an analytic overview. *Indian J Physiother Occup Ther* 2007;1:10–12.
5. Smith TO, Hunt NJ, Donell ST. The reliability and validity of the Q-angle: a systematic review. *Knee Surg Sports Traumatol Arthrosc* 2008;16:1068–79.
6. Peeler JD, Leiter J, Anderson JE. Reproducibility of a simplified Q-angle measurement technique. *Curr Orthop Pract* 2010;21:158–64.
7. Olerud C, Berg P. The variation of the Q angle with different positions of the foot. *Clin Orthop Relat Res* 1984;191:162–5.
8. Livingston LA, Spaulding SJ. OPTOTRAK measurement of the quadriceps angle using standardized foot positions. *J Athl Train* 2002;37:252–5.
9. Guerra JP, Arnold MJ, Gajdosik RL. Q angle: effects of isometric quadriceps contraction and body position. *J Orthop Sports Phys Ther* 1994;19:200–4.
10. Woodland LH, Francis RS. Parameters and comparisons of the quadriceps angle of college-aged men and women in the supine and standing positions. *Am J Sports Med* 1992;20:208–11.
11. Lathinghouse LH, Trimble MH. Effects of isometric quadriceps activation on the Q-angle in women before and after quadriceps exercise. *J Orthop Sports Phys Ther* 2000;30:211–6.
12. Bayraktar B, Yucesir I, Ozturk A, et al. Changes of quadriceps angle values with age and activity. *Saudi Med J* 2004; 25:756–60.
13. Sarkar A, Razdan S, Yadav J, et al. Effect of isometric quadricep activation on "Q" angle in young females. *Indian J Physiol Pharmacol* 2009;53:275–8.
14. Greene CC, Edwards TB, Wade MR, et al. Reliability of the quadriceps angle measurement. *Am J Knee Surg* 2001;14:97–103.
15. Stensdotter AK, Andersson PI, Rydh A, et al. Q-angle variations in standing and supine positions and for different measurement methods in women with and without patellofemoral pain. *Adv Physiother* 2009;11:88–96.
16. Sanfridsson J, Arnbjörnsson A, Fridén T, et al. Femorotibial rotation and the Q-angle related to the dislocating patella. *Acta Radiol* 2001;42:218–24.
17. Horton MG, Hall TL. Quadriceps femoris muscle angle: normal values and relationships with gender and selected skeletal measures. *Phys Ther* 1989;69:897–901.
18. Herrington L, Nester C. Q-angle undervalued? The relationship between Q-angle and medio-lateral position of the patella. *Clin Biomech (Bristol, Avon)* 2004;19:1070–3.
19. Livingston LA, Mandigo JL. Bilateral Q angle asymmetry and anterior knee pain syndrome. *Clin Biomech (Bristol, Avon)* 1999;14:7–13.
20. Jaiyesimi AO, Jegede OO. Influence of gender and leg dominance on Q-angle among young adult Nigerians. *AJPARS* 2009; 1:18–23.