

Original Communication**BILATERAL VARIABILITY OF Q ANGLE IN SYMPTOMATIC UNILATERAL AND SYMPTOMATIC BILATERAL KNEE PAIN IN INDIAN ADULTS OF DECCAN PLATEAU REGION****Jyothinath Kothapalli¹, Rishika R. Kaneti², Ashwithananda Kurella², Shiva S. K. Kothireddy², Satyanarayana MV², Anusha Kovuru², Krishna C. Meduri²**¹*Department of Anatomy, Tomo Riba Institute of Health and Medical Sciences, Naharlagun, Arunachal Pradesh, India*²*Maheshwara Medical College and Hospital, Isnapur, Telangana, India***ABSTRACT**

Objectives: Quadriceps angle (Q angle) is a lonesome clinical measure, appraised as a critical factor for the posture maintenance and knee related complications. The excessive Q angle increases the lateral patellofemoral junction pressure, which have a tendency to add biomechanical stress over the knee, leads to patellofemoral complications. This study was attempted to determine the right and left Q angle variability between asymptomatic or control (ASY), symptomatic unilateral knee pain (SUKP), and symptomatic bilateral knee pain (SBKP) in people of Deccan plateau in India. **Material and methods:** The bilateral Q angles were measured by universal goniometer in 235 subjects of both genders including asymptomatic (n=135), symptomatic unilateral knee pain (n=60) and symptomatic bilateral knee pain (n=40), in upright standing position, with relaxed quadriceps and fully extended knee. Subjects with clinically determined anterior knee pain considered as symptomatic. **Results:** The higher bilateral variability of Q angle was noticed in females than males between asymptomatic and SUKP (-5.92°) and SBKP (-4.09°) on right side and between asymptomatic and SUKP (-4.98°) on left side. There was bilateral significant difference in mean Q angle between asymptomatic and SUKP, and between asymptomatic and SBKP in both sexes. However, the above difference was statistically not significant between SBKP and SUKP. **Conclusion:** Moderate Q angle bilateral variability was noticed in symptomatic subjects due to malalignment of limbs by trauma, unilateral stance of limb and other influencing factors.

Keywords: Quadriceps angle, symptomatic unilateral knee pain; symptomatic bilateral knee pain, bilateral variability.

RESUMEN

Objetivos: El ángulo del cuádriceps (ángulo Q) es una medida clínica solitaria, valorada como un factor crítico

para el mantenimiento de la postura y las complicaciones relacionadas con la rodilla. El ángulo Q excesivo aumenta la presión de la unión femoro-rotuliana lateral, que tiende a añadir tensión biomecánica sobre la rodilla, lo que conduce a complicaciones femoro-rotulianas. Este estudio se intentó determinar la variabilidad del ángulo Q derecho e izquierdo entre el dolor asintomático o de control (ASY), el dolor unilateral de rodilla sintomático (SUKP) y el dolor de rodilla bilateral sintomático (SBKP) en personas de la meseta de Deccan en la India. **Material y métodos:** Los ángulos Q bilaterales se midieron mediante goniómetro universal en 235 sujetos de ambos sexos, incluidos dolor asintomático (n=135), dolor de rodilla unilateral sintomático (n=60) y dolor de rodilla bilateral sintomático (n=40), en bipedestación. posición, con cuádriceps relajados y rodilla completamente extendida. Sujetos con dolor anterior de rodilla determinado clínicamente considerados sintomáticos. **Resultados:** La mayor variabilidad bilateral del ángulo Q se observó en mujeres que en hombres entre asintomáticos y SUKP (-5.92°) y SBKP (-4.09°) en el lado derecho y entre asintomáticos y SUKP (-4.98°) en el lado izquierdo. Hubo una diferencia significativa bilateral en el ángulo Q medio entre asintomáticos y SUKP, y entre asintomáticos y SBKP en ambos sexos. Sin embargo, la diferencia anterior no fue estadísticamente significativa entre SBKP y SUKP. **Conclusión:** Se observe una variabilidad bilateral moderada del ángulo Q en sujetos sintomáticos debido a la mala alineación de las extremidades por traumatismo, la postura unilateral de la extremidad y otros factores influyentes.

Palabras clave: Ángulo del cuádriceps, dolor de rodilla sintomático unilateral; dolor de rodilla sintomático bilateral, variación bilateral

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INTRODUCTION

The Q angle is an indispensable factor and reliable clinical measure in the assay of knee joint and patellofemoral complications (Woodall, 1990; Schulthies et al., 1995; Jaiyesimi and Jegede, 2009). The Q angle was incipiently represented by a line of quadriceps force and a line of pull of the patellar ligament (Hungerford and Barry, 1979). However, new trends explicate as “the angle at relay point of line from anterior superior iliac spine (ASIS) to tuberosity of tibia through anterior mid patella” (Freedman et al., 1979). Q angle is a quantitative measure of knee alignment and disposition of patella in connection with orientation of lower limb and its skeletal frame (France and Nester, 2001; Greene, 2001; Sendur, 2005). The range of Q angle is dominant in females (15° - 20°) than males (12° - 15°) due to their broad pelvic width and lesser mean height (Livingston and Mandingo, 1997; Heiderscheit, 2000).

The exaggerated Q angle (20° - 22°) delivers intemperate lateral patellofemoral junction pressure leads to patella femoral complications. Whereas, understated Q-angle have a tendency to pressurize medial patellofemoral proximity (Olagbegiet al., 2014). An exaggerated Q angle leads to excessive lateral patellofemoral articulation pressure which inflicts patellofemoral malfunction, resulting anterior knee pain syndrome or patella femoral pain syndrome (Livingston and Mandingo, 1997). Patellofemoral pain occurs as a result of weak quadriceps femoris muscle which fails to track patella in the groove over femur (Livingston and Mandingo, 1997). There is a literature lack to ensure standard Q-angle values by the reason of inadequate coefficient of reliability of different measures and procedures (Melo de Paula et al., 2004). Whereas, Q angle evaluation comprises pelvis orientation, hip rotation, tibial torsion, alignment of patella and foot position (Powers, 2003).

A study by Hahn and Foldspangs (1997) was foremost to condemn a statement that the bilateral Q angle symmetry was inaccurate, and supported by Livingston and Mandingo (1999). There is available evidence on bilateral symmetry and unilateral symmetry of Q angle, but the literature is lacking in the evaluation of differences in the right and left Q angle between asymptomatic (Control), symptomatic unilateral knee pain, and symptomatic bilateral knee pain in people of Deccan plateau in India. In this context, the present study was attained to evaluate the difference of Q angle in asymptomatic subjects, symptomatic unilateral knee pain and symptomatic bilateral knee pain subjects.

MATERIALS AND METHODS

Two hundred and thirty five subjects of both genders with asymptomatic (n=135), symptomatic unilateral knee pain (n=60) and symptomatic bilateral knee pain (n=40) between age group 18-52 years, had given consent were recruited. Study subjects were recruited from the Maheshwara Medical College and Hospital (MMCH) and people living in nearby gated communities of MMCH. Written informed consent was obtained from all the study subjects and study protocol was approved by the institutional ethics committee of Maheshwara Medical College and Hospital, Patancheru, Telangana, India (No. MMCH/IEC/2018/04/11).

Inclusion criteria: Subjects who had no history of anterior knee pain were considered as asymptomatic (controls). Subjects with clinically determined anterior knee pain during physical activity, prolonged standing, weight bearing and taking staircase were included; Exclusion criteria: Subjects with congenital anomalies, knee swellings, gait abnormality, chronic knee pains and areas of localized knee tenderness were exempted.

The Q angle of right and left sides were measured with a commercially available full circle plastic universal goniometer with 30 cm long arms (Samrat stainless steel manual goniometer, Mfd. Samrat stainless steel, Chennai, Tamilnadu, India). Subjects were instructed to stand in upright position, with relaxed quadriceps muscle and fully extended knee. We palpated the anterior superior iliac spine, midventral point of the patella and prominence on tibial tuberosity. Fixed arm of goniometer was taped on anterior superior iliac spine, fulcrum of goniometer on midventral point of patella and moved arm on prominence of tibial tuberosity. In each participant, Q angle was measured bilaterally and data was documented.

Extracted data were statistically analyzed by using IBM SPSS version 16.0 (IBM Co., Armonk, New York, USA). Descriptive statistics were used to estimate mean and standard error of mean. The mean differences between right and left Q angle by groups i.e. asymptomatic, symptomatic unilateral and symptomatic bilateral were analyzed by using ANOVA. The $p < 0.005$ was considered as statistically significant.

RESULTS

A total of 235 subjects between 18-52 years, height ranged 140-187 cm and weight ranged between 37.5-88 kg were recruited. The mean

age of asymptomatic, SUKP and SBKP subjects were 18.2 ± 0.63 years, 43.2 ± 5.67 years and 44.6 ± 4.23 years respectively. The mean height of asymptomatic, SUKP and SBKP subjects were 1.55 ± 33.36 m, 1.64 ± 6.78 m and of SBKP subjects were 1.65 ± 5.30 m respectively (Table 1).

The higher mean right and left Q angle levels was observed in asymptomatic, SUKP and SBKP subjects of both genders. However, female dominance was observed in symptomatic unilateral subjects (Table 2).

Demographic parameter	Asymptomatic		Symptomatic unilateral		Symptomatic bilateral	
	Mean \pm SD	Std.Er	Mean \pm SD	Std.Er	Mean \pm SD	Std.Er
Age (In years)	38.2 ± 0.63	0.14	43.2 ± 5.67	1.26	44.6 ± 4.23	0.94
Height (In mtr.)	1.55 ± 33.36	7.46	1.64 ± 6.78	1.51	1.65 ± 5.30	1.18

Table 1- Descriptive analysis of data on demographic parameters among study subjects

Q-Angle	Asymptomatic	Symptomatic unilateral	Symptomatic bilateral
	Mean \pm Std. Error	Mean \pm Std. Error	Mean \pm Std. Error
Male			
Right side	15.89 ± 0.466	19.10 ± 0.665	19.25 ± 0.815
Left side	16.89 ± 0.510	19.30 ± 0.727	17.70 ± 0.891
Female			
Right side	14.71 ± 0.563	20.63 ± 0.891	18.80 ± 1.091
Left side	15.19 ± 0.481	20.17 ± 0.761	17.50 ± 0.933

Table 2- Descriptive data of Q - angle in asymptomatic, symptomatic unilateral and symptomatic bilateral knee pain subjects

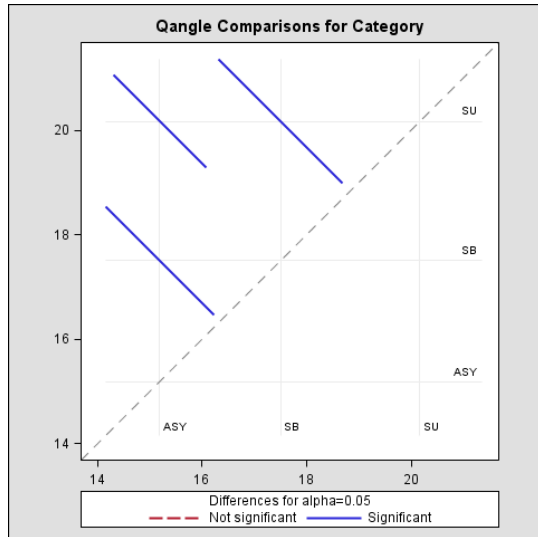
The mean difference of Q angle was statistically significant between asymptomatic and symptomatic unilateral group ($P<0.005$) and between asymptomatic and symptomatic bilateral group on both sides ($p<0.005$). However, this difference was not significant between symptomatic unilateral and symptomatic bilateral

knee pain subjects on both sides ($P=0.429$) (Table 3, Graphics A, B, C, D).

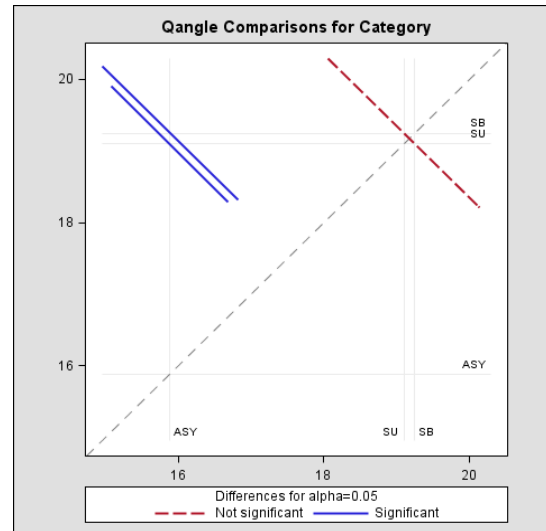
The higher mean difference of Q angle was noticed in female subjects between asymptomatic and SUKP (-4.093 right side) and between asymptomatic and SBKP groups (-5.926 right side and -4.980 left side) (Table 3).

Category	Male				Female			
	Right		Left		Right		Left	
	Mean Diff.	P value	Mean Diff.	P value	Mean Diff.	P value	Mean Diff.	P value
ASY vs SB	-3.364	0.0005	-0.814	0.429	-4.093	0.001	-2.313	0.029
ASY vs SU	-3.214	0.0001	-2.414	0.007	-5.926	0.0001	-4.980	0.0001
SB vs SU	0.150	0.886	-1.600	0.167	-1.833	0.195	-2.666	0.028

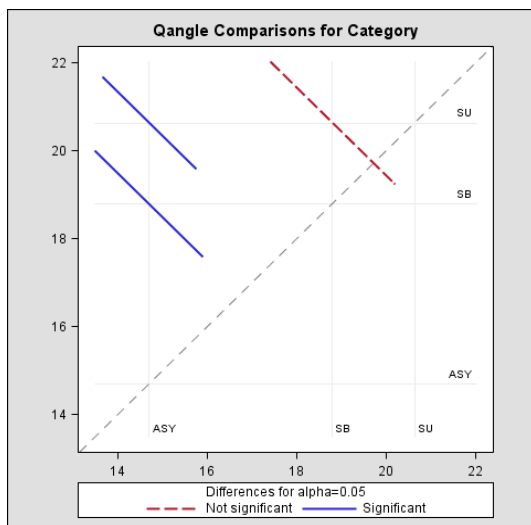
Table 3- Multiple comparison by ANOVA between asymptomatic, symptomatic unilateral and symptomatic bilateral knee pain



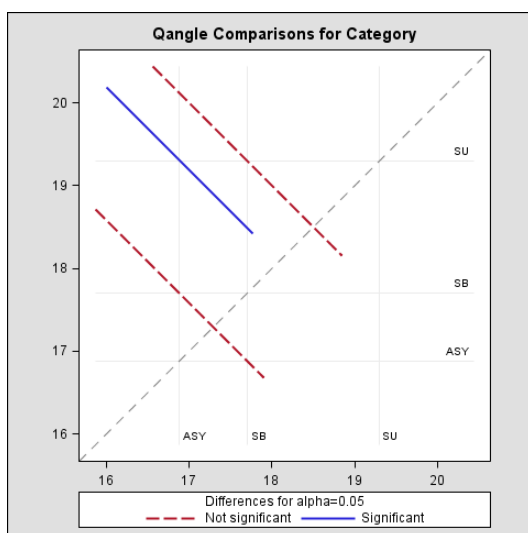
A. Female - Left side



D. Male – Right side



B. Female – Right side



C. Male - Left side

Graphics A-B-C-D- Diffogram for pairwise comparisons of the mean Q angle of asymptomatic, symptomatic unilateral and symptomatic bilateral subjects. Linear segments representing the difference between mean Q angles of each category. A. Female left side; B. Female right side; C. Male left side; D. Male right side.

DISCUSSION

Q angle is a lonesome clinical measure, with unpredictable and restricted clinical value (Khasawneh, 2019). Increased Q angle may connect with raise in femoral anteversion, knee valgus, excessive external tibial rotation and patellar position (Powers, 2003). Olagbegiet al. (2014) noticed significant increase in Q angle with age and Jha and Raza et al. (2000) reported that Q angle has a significant positive correlation with sex, height, Interspinous distance and negative correlation with lower limb length. Jaiyesimi and Jegede (2009) reported that males tend to be taller than females and the level of Q angle is usually smaller in taller persons. The present study findings are not in accordance with the above finding, where males reported higher Q angle than female except in symptomatic unilateral group. The exact reason for higher Q angle levels in male subjects is unknown. However, it may have geographical and racial linkage. The higher Q angle in females increase the compression force on articulating surfaces and makes females more vulnerable to patella-femoral pain. In addition, high Q angle levels associated with increase in cartilage thickness and cartilage grading in female cases of osteoarthritis (Tsakonitiet al., 2011). In males, the mean right Q angle was higher in SBKP (19.25⁰) than SUKP (19.10⁰), and

asymptomatic (15.89°) subjects. However, higher left Q angle was recorded in SUKP (19.30°) than SBKP (17.70°) and asymptomatic subjects (16.89°). In females, higher right Q angle was noted in SUKP (20.63°), than SBKP (18.80°), asymptomatic (14.71°) and higher left Q angle was reported in SUKP (20.17°) than SBKP (17.50°), asymptomatic (15.19°) (Table 2). Livingston and Mandingo (1999) reported higher Q angle on left side than right side. Shivaprakash et al. (2019) noticed bilateral variability of Q angle in asymptomatic subjects with right dominance. The mean right Q angle of symptomatic subjects was higher than the left due to functional dominance of the right limb or else subjects may have suffered greater trauma on right side (Sra et al., 2007). In present study, higher right Q angle was noticed in symptomatic subjects except in males with symptomatic unilateral knee pain. Sra et al. (2007) observed significantly increased Q angle in anterior knee pain cases. Similarly, Q angle was significantly higher in subjects with SUKP and SBKP than asymptomatic subjects in this study.

Several studies reported higher Q angle in females with bilateral asymmetry (Horton and Hall, 1989; Jaiyesimi and Jegede, 2009; Olagbegiet al., 2014; Choudhary et al., 2019) or bilateral variability (Shivaprakash et al., 2019) in symptomatic and asymptomatic subjects. Raveendranath et al. (2011) reported higher Q angle in male subjects with bilateral variability and in 96% of subjects the Q angle difference was <3° on both sides. Horton and Hall, (1989) reported 4.6° higher mean Q angle in females (15.8°) than males (11.2°). In present study, the average difference of right and left Q angle in male and female was 1° and 0.48° in asymptomatic subjects, 0.20° and 0.46° in symptomatic unilateral group and 1.55° and 0.50° in symptomatic bilateral group. Sra et al. (2007) reported the mean Q angle difference of right and left limb was 2.82° in asymptomatic and 0.07° in symptomatic subjects with unilateral knee pain. Livingston and Mandigol (1999) reported the average difference of right and left Q angle in male and female was 0.9° and 1.7° in asymptomatic, 5.3° and 3.5° in SBKP and 3.5° and 3.6° in SUKP respectively. In this study, the higher bilateral variability of Q angle was noticed in females than males between asymptomatic and SUKP (-5.92°) and SBKP (-4.09°) subjects on right side and between asymptomatic and SUKP (-4.98°) on left side. The mean Q angle difference was statistically significant between asymptomatic and SUKP, asymptomatic and SBKP on both sides in both genders. However, the above difference was statistically not significant between SBKP and SUKP on both

sides in both genders except on left side of females ($p < 0.028$) (Table 3, Graphics A, B, C, D). The factors like hip rotation, position of pelvis, position of patella, tibial torsion and position of foot together maintains normal Q angle, alterations in any of above factors may influence the normal position of landmarks use in the Q angle measurement. In addition, Q angle values may be influenced by gender, height, race, ethnicity, adopted position for the measurement and state of contraction of quadriceps femoris muscle (Smith, 2008).

The intraobserver variation in the measurement of Q angle is main limitation of the study because measurement was done by the students in community setting. In this study, the higher Q angle was reported in male subjects with unknown reason. Further evaluation may require finding the reason behind higher Q angle value in male subjects and about its geographical and racial linkage.

The results of this study documented moderate bilateral variability of Q angle in symptomatic unilateral and symptomatic bilateral groups. The higher bilateral variability was noticed in females than males between asymptomatic and SUKP (-5.92°) and SBKP (-4.09°) subjects on right side and between asymptomatic and SUKP (-4.98°) on left side.

Conflict of interest

None

Funding

None

Ethical approval

Obtained from Maheshwara Medical College and Hospital, Patancheru, Telangana, India (No: MMCH/IEC/2018/04/11).

Informed consent

All the subjects were informed about the scope of the project and clarified their queries.

Contributions

Conceptualization: JK, Data Acquisition: RRK, ASK, SSKK, SMV, ANK, KCM, JK, Data analysis and interpretation, manuscript preparation, revision of manuscript: JK, approval of final version of manuscript: JK, RRK, ASK, SSKK, SMV, ANK, KCM

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