International Journal of Yogic, Human Movement and Sports Sciences 2019; 4(1): 1219-1224

ISSN: 2456-4419
Impact Factor: (RJIF): 5.18
Yoga 2019; 4(1): 1219-1224

www.theyogicjournal.com
Received: 10-11-2018
Accepted: 12-12-2018

Nihar Ranjan Mohanty
PhD Scholar, Department of Physiotherapy, Guru Nanak Dev University, Amritsar, Punjab, India

Avinash Tiwari
PhD Scholar, Department of Physiotherapy, Guru Nanak Dev University, Amritsar, Punjab, India

Shyamal Koley
Professor and Head, Department of Physiotherapy, Guru Nanak Dev University, Amritsar, Punjab, India

Correspondence
Nihar Ranjan Mohanty
PhD Scholar, Department of Physiotherapy, Guru Nanak Dev University, Amritsar, Punjab, India

Study on anthropometric and biomechanical characteristics of lower extremities and their effects on quadriceps angle magnitude in young males

Nihar Ranjan Mohanty, Avinash Tiwari and Shyamal Koley

Abstract
The purpose of the present study was to see the impact of anthropometric variables and lower extremity biomechanical alignments on the magnitude of Quadriceps angle in young males. 50 young males of age group 18-28 years were selected purposively from Cuttack, Odisha, for the study. All the selected lower extremity anthropometric and anatomical alignment variables were recorded thrice and median value considered as criterion to eradicate error. Selected variables such as height, weight, Body Mass Index (BMI), total leg length, lower leg length, tibiofemoral angle, femoral ante version, Quadriceps angle, genu recurvate, tibial torsion, and navicular drop were measured on each subject following standard techniques. The Results showed right Quadriceps angle has significant positive correlation ($p \leq 0.05$) with weight and highly significant positive correlation ($p \leq 0.01$) with right Tibiofemoral angle, right Femoral ante version, and right Tibial torsion; whereas left Quadriceps angle has significant positive correlation ($p \leq 0.05$) with weight and highly significant positive correlation ($p \leq 0.01$) with left Tibiofemoral angle, left Femoral ante version, left Tibial torsion and left Navicular drop. On the basis of results of the study, it may be concluded that weight, Tibiofemoral angle, femoral ante version, Tibia torsion and Navicular drop have significant impact on the magnitude of the Quadriceps angle.

Keywords: Quadriceps angle, anthropometry, navicular drop, tibiofemoral angle

Introduction
The quadriceps femoris muscle angle (Q-angle) is the angle of incidence of quadriceps muscle relative to the patella. It is described as a reflection of the force of the quadriceps muscle on the patella in the frontal plane. Q-angle is defined as drawing an imaginary line from the anterior superior iliac spine (ASIS) to the centre of the patella and from centre of patella to the tibial tuberosity, delineates the Q-angle (Horton and Hall, 1989 and Livingston, 1998) [7, 11].
The Q-angle normally varies between 6° and 27°, with a mean value of approximately 15° (Aglietti *et al*., 1975) [1]. As the Q-angle increases, the lateral component of the resultant force acting on the patella increases. Both an in vitro experimental study (Huberti and Hayes, 1984) [8] and a theoretical modeling study (Hirokawa *et al*., 1991) [6] have shown that increasing the Q-angle tends to increase the lateral patellofemoral contact pressure, while decreasing the Q-angle tends to increase the medial patellofemoral contact pressure.
It has been suggested that the Q-angle angle is a composite measure of pelvic position, hip rotation, tibial torsion, patella position and foot position (Jonson *et al*., 1997; Powers, 2003) [9, 19]. The quadriceps angle is intended to provide some indication of the direction of the net lateral force applied to the patellofemoral joint by contraction of the quadriceps (France and Nester; 2001) [4]. It is responsible for the bowstring effect, whereby the patella tends to move laterally as the quadriceps contract (Grelsamer *et al*., 2005) [5]. When the Q-angle exceeds 15°-20° it is thought to contribute to knee extensor mechanism dysfunction and patellofemoral pain by increasing the tendency for lateral patella malposition (Byl *et al*., 2000) [3].
The present study was undertaken to measure the Q-angle, determine the biomechanical factors those which have impact on the magnitude of Q-angle and to correlate various lower extremity alignments with Q-angle.

Methodology

Participants

This study was based on cross-sectional research, in which young students (males) of specific age group were included to provide a general description of lower extremity alignment and their correlation with Q-angle. The present study was based on the sample of 50 young males of age group 18-28 years, selected purposively from Cuttack, Odisha. A written consent was obtained from the subjects. The data was collected under natural environment conditions while maintaining the privacy of the students.

Anthropometric measurements

All the five anthropometric variables, viz. height, weight, body mass index, total leg length and lower leg length were measured by the techniques described by Lohman *et al*. 1988. The height was recorded during inspiration using anthropometric rod to nearest 0.1cm. Weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to nearest 0.1kg. Body mass index (BMI) was calculated using the formula weight (kg)/height^2 (m^2). Total leg length and lower leg length were measured by anthropometric rod in cm.

Lower extremity biomechanical measurements

1. Quadriceps angle (QA): Standing Q-angle was measured with the subject in a standing, relaxed position with a standard goniometer (Shultz *et al*., 2008). Q-angle represents the angle formed by a line from the anterior superior iliac spine to the patella center and a line from the patella center to the tibial tuberosity (Livingston *et al*., 1997) [12].
2. Tibiofemoral angle (TFA): It is the angle formed in the frontal plane by the anatomical axes of the femur and tibia (Moreland *et al*., 1987) [17]. With goniometer axis (modified with an extension piece on the stationary arm) over the knee centre (midpoint between the medial and lateral joint line in the frontal plane), the stationary arm was aligned along from the knee centre to a proximal landmark (midpoint between the anterior superior iliac spine and the most proximal aspect of the greater trochanter), and the movable arm was aligned along a line from the knee centre to the distal landmark (midpoint between the medial and lateral malleoli). While there is no universally accepted proximal landmark for clinical measurement methods of tibiofemoral angel, the rationale for using the midpoint between the anterior superior iliac spine and greater trochanter would be based upon on known anatomy, and thought to more closely approximate the anatomical axis of the femur compared to either the greater trochanter and anterior superior iliac spine, which have overestimate and underestimate, respectively, the measure (Nguyen *et al*., 2007) [18]. A positive value indicates a valgus knee angulation.
3. Femoral ante version (FA): It is measured by Craig's test (Magee; 2008) [14] with the subject prone and the knee flexed to 90°. The examiner palpated the greater trochanter while passively rotating the hip until the most prominent part of the greater trochanter reached its most lateral position. The between true vertical (verified by the bubble level) and the shaft of the tibia was measured using standard goniometer.
4. Genu recurvatum (GR): It was measured with the subject in supine and a bolster positioned under the distal tibia. The goniometer axis was positioned over the lateral joint line, the stationary arm aligned with the greater trochanter, and the movable arm aligned with the lateral malleolus. The measurement was recorded while the examiner applying a posteriorly directed force to the anterior knee until passive resistance is achieved (Nguyen *et al*., 2007) [18].
5. Tibial torsion (TT): It was measured using a modified technique (Stuberg *et al*., 1991) [21]. With the subject in supine and the knee extended, the subject had rotated the leg until the line between the femoral epicondyles was parallel to the table. A line should be drawn on the bottom of the heel horizontal to the table top. A second line is drawn on the bottom of the heel in line with both malleoli. The axis of the goniometer centre over the intersection of the two lines and stationary arm align parallel to the table top in line with the horizontal line on the heel. Moving arm align along the line connecting the two malleoli. The angle formed by the line bisecting the bi malleolar axis and the horizontal was measured using a standard goniometer.
6. Navicular drop (ND): It was measured using a modification of a technique described by Brody (Brody; 1982) [2]. The navicular tubercle was palpated and marked with the subject in a bilateral stance. Navicular height was measured with a straight edge ruler, with the subject in subtalar joint neutral, the position in which the medial and lateral aspect of the talar head would be equally palpable on both sides. Then the subject was instructed to relax the stance, and the difference in centimeters or millimeters between the height of navicular in subtalar joint neutral and relaxed stances was recorded.

Statistical analysis

Descriptive statistics (mean ± standard deviation) were determined for the directly measured and derived variables. To understand the dimension of relationship of Q-angle as dependent variable with set of anthropometric and lower extremity variables, Karl Pearson's moment correlation coefficients were calculated. All the data were determined using SPSS (Statistical Package for Social Science) version 22.0. A5% level of probability was used to indicate statistical significance.

Results

Table 1: showed the descriptive statistics of baseline data of young males

Variables	Minimum	Maximum	Mean	SD
Age (years)	18.00	28.00	22.2200	2.54181
Height (cm)	162.00	187.00	171.7800	6.43108
Weight (kg)	52.00	93.00	64.3000	8.46180
BMI (kg/m^2)	17.70	29.40	21.8380	3.11054

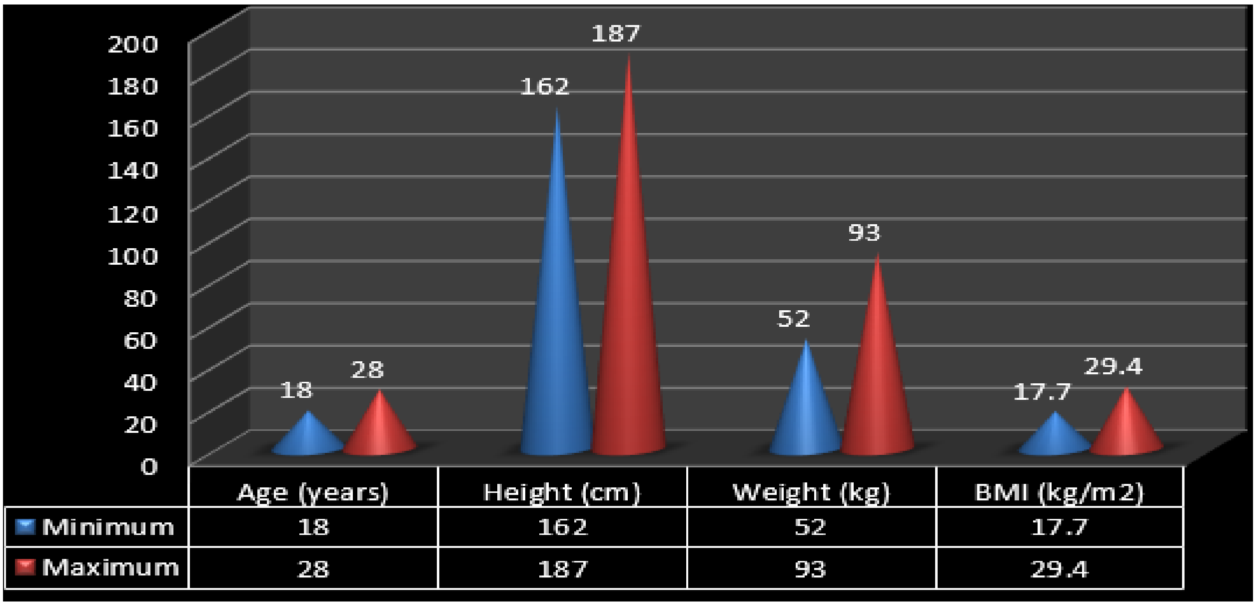

Fig 1: Graphical representation of Baseline Data

Table 2 showed the descriptive statistics of Right anthropometric and biomechanical characteristics of right lower extremity in young males

VARIABLES	Minimum	Maximum	Mean	SD
Right Total Leg Length (cm)	82.00	104.00	91.7400	5.72431
Right Lower Leg Length (cm)	32.00	48.00	41.1800	3.14084
Right Tibiofemoral Angle (degree)	7.00	14.00	10.9400	1.58320
Right Femoral Ante version (degree)	12.00	21.00	17.9600	1.91620
Right Genu Recurvate (degree)	6.00	11.00	7.4800	1.24933
Right Tibial Torsion (degree)	12.00	20.00	17.0000	2.00000
Right Navicular Drop (cm)	0.50	1.20	0.8120	0.18366
Right Q-Angle (degree)	9.00	18.00	14.5200	1.98196

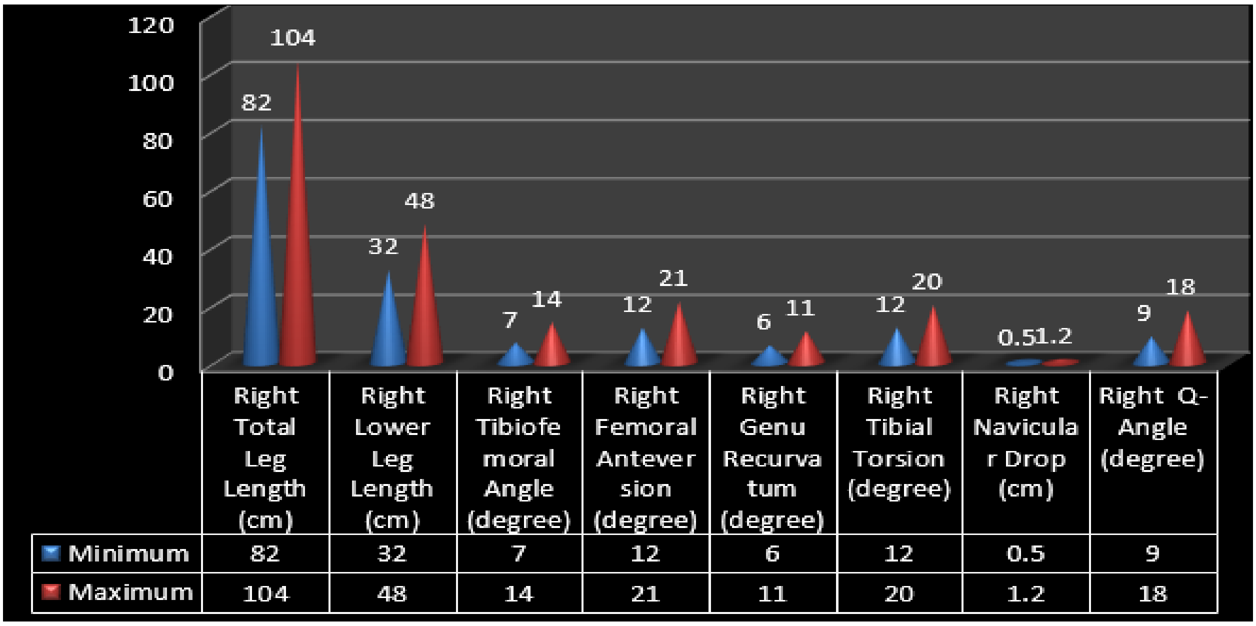

Fig 2: Graphical representation Right Variables

Table 3: showed the descriptive statistics of Left anthropometric and biomechanical characteristics of left lower extremity in young males

VARIABLES	Minimum	Maximum	Mean	SD
Left Total Leg Length (cm)	81.00	104.00	91.3800	5.75305
Left Lower Leg Length (cm)	32.00	48.00	40.8800	3.04818
Left Tibiofemoral Angle (degree)	8.00	14.00	10.5400	1.41724
Left Femoral Ante version (degree)	13.00	21.00	17.5200	1.91918
Left Genu Recurvate (degree)	5.00	11.00	7.3800	1.41263
Left Tibial Torsion (degree)	11.00	21.00	16.8600	2.29471
Left Navicular Drop (cm)	0.50	1.20	0.8140	0.17844
Left Q-Angle (degree)	10.00	18.00	14.2800	2.03078

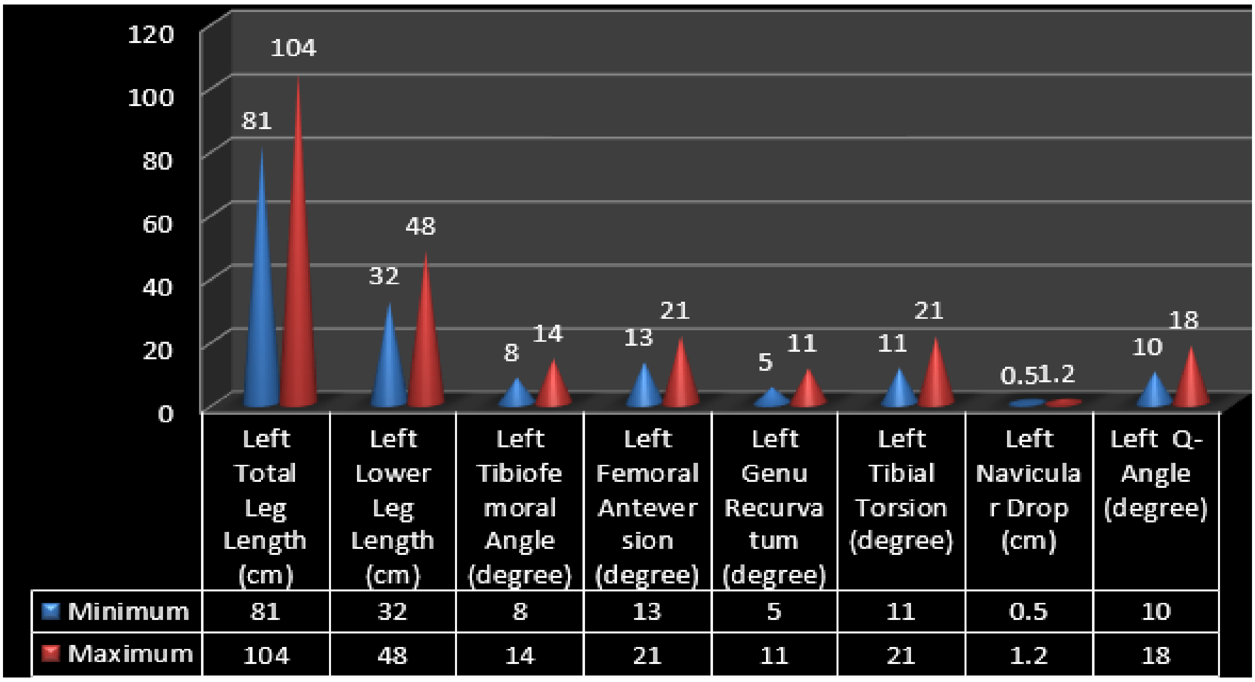

Fig 3: Graphical representation Left Variables

Table 4: showed the correlation coefficient of Right Quadriceps angle with anthropometric and biomechanical characteristics of right lower extremity in young males

	Subjects (n=50)	
Variables	**r value**	**p value**
Height (cm)	.180	.210
Weight (kg)	.341*	.015
BMI (kg/m²)	.221	.123
Right Total Leg Length (cm)	.251	.078
Right Lower Leg Length (cm)	.240	.093
Right Tibiofemoral Angle (degree)	.843**	.000
Right Femoral Ante version (degree)	.414**	.003
Right Genu recurvate (degree)	-.358*	.011
Right Tibial Torsion (degree)	.469**	.001
Right Navicular Drop (cm)	.246	.085

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

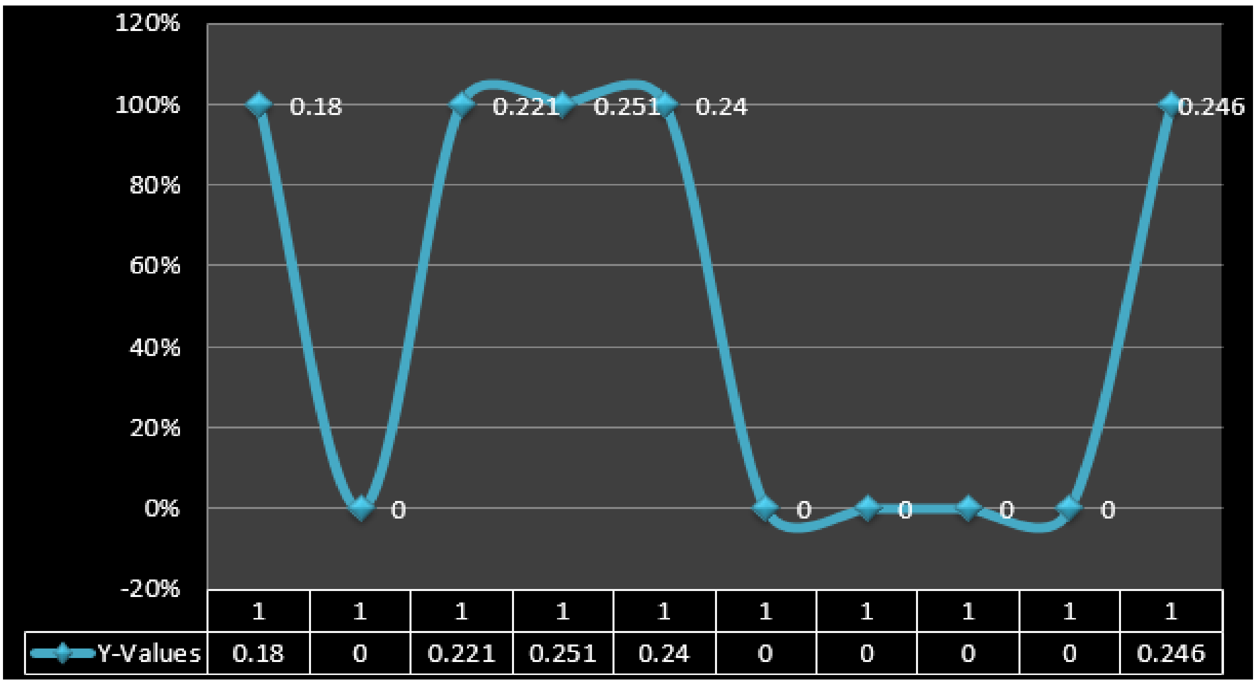

Fig 4: Graphical representation Right Q-Angle Correlation

Table 5: showed the correlation coefficient of Left Quadriceps angle with anthropometric and biomechanical characteristics of left lower extremity in young males

	Subjects (n=50)	
Variables	**r value**	**p value**
Height (cm)	.117	.417
Weight (kg)	.333*	.018
BMI (kg/m^2)	.253	.076
Left Total Leg Length (cm)	.209	.145
Left Lower Leg Length (cm)	.253	.077
Left Tibiofemoral Angle (degree)	.726**	.000
Left Femoral Ante version (degree)	.459**	.001
Left Genu recurvate (degree)	-.145	.317
Left Tibial Torsion (degree)	.517**	.000
Left Navicular Drop (cm)	.372**	.008

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

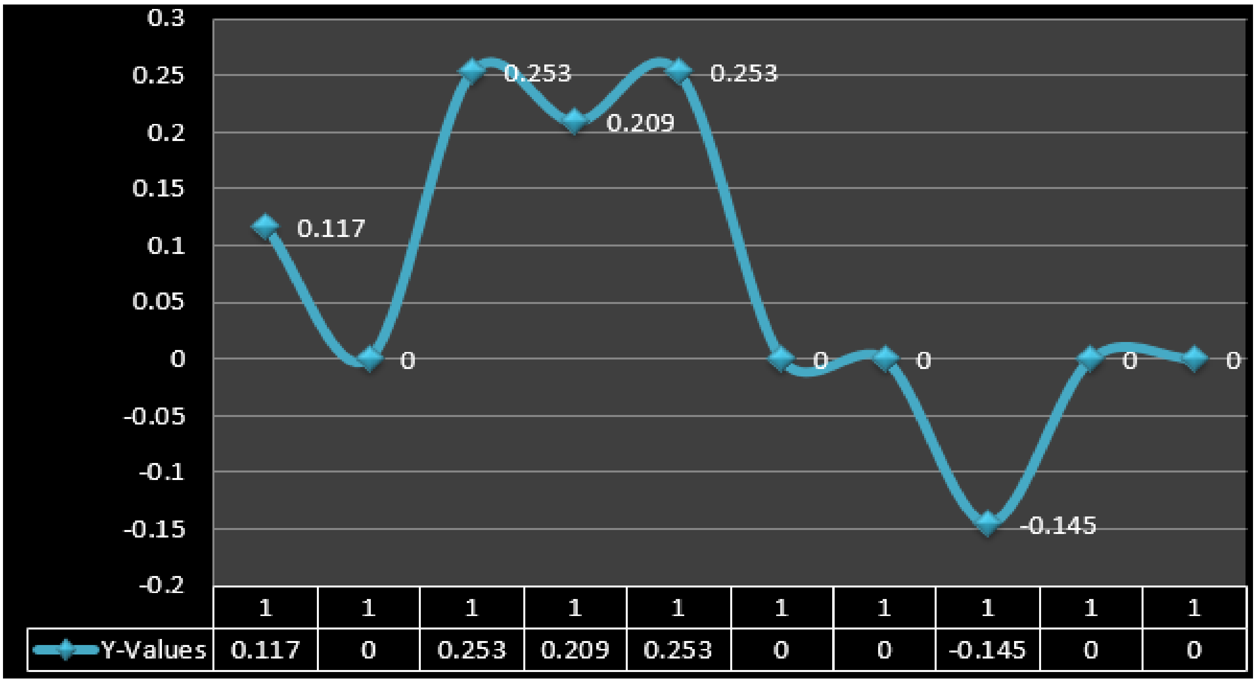

Fig 5: Graphical representation Left Q-Angle Correlation

Discussion

The anatomical, anthropometric and biomechanical relationship of lower extremity alignments are most frequent area to be studied frequently for diagnosing the faulty alignments and preventing future injuries which may occur during any activity or various athletic events. The finding of the study indicates that Q-angle has significant positive correlation ($p \le 0.05$) with weight and highly significant positive correlation ($p \le 0.01$) with TFA, FA, TT and ND. Mohanty and Koley, (2018) [15] recorded significant differences ($p \le 0.001$) between male and female state level athletes in anthropometric variables, viz., height, weight, right total leg length, left total leg length, right lower leg length, left lower leg length and; in lower extremity alignment variables, viz., right femoral ante version, left femoral ante version, right Q-angle, left Q-angle, right tibial torsion, left tibial torsion. However, statistically significant difference ($p<0.05$) were seen in right tibiofemoral angle, right navicular drop and left navicular drop. Significant positive correlation ($p \le 0.001$) of right Q-angle was noted with right femoral ante version, right tibial torsion and right navicular drop. It may be concluded that femoral ante version, tibial torsion and navicular drop have significant impact on the magnitude of Q-angle; and the sex difference may influence the static lower extremity alignments.

The present study showed that right Q-angle had significantly positive correlation with right TFA, right FA, and right TT. Mohanty *et al*., (2019) [16] reported that in state level female basket-ball players, significant positive correlation ($p<0.01$) of right Q-angle was noted with right tibiofemoral angle, right femoral ante version, right genu recurvate and right navicular drop. Whereas, significant positive correlation ($p<0.01$) of left Q-angle was noted with left tibiofemoral angle, left tibial torsion and left navicular drop. Significant positive correlation ($p<0.05$) of left Q-angle was noted with left femoral anteverting.

The present study also showed that left Q-angle also had highly significant positive correlation with left TFA, left FA, left TT and left ND. Karukunchit *et al*., (2015) [10] reported that the highest prevalence of lower extremity malalignment was foot pronation (36.14%), followed by the abnormal Q-angle (34.94%), tibiofemoral angle (31.73%), pelvic tilt angle (30.52%), femoral ante torsion (28.11%), leg length inequality (22.49%), tibial torsion (21.29%) and genu recur vatum (11.24%).

The finding of the lower extremity biomechanical variables in the study indicates that TFA, FA, TT, and ND have significant impact on magnitude of Q-angle.

Conclusion

In locomotion, lower extremity is one that plays important role. Thus identifying the postural factors that influences Q-angle, excessive stress and potential injury is of considerable importance. The result of this study would be implicated for clinical diagnosis and treatment of patients. Various corrective exercises programs would be started as preventive measure in case of any malalignment persisting before and can be modified, which would prevent future injuries. Moreover, in rehabilitating stage of an injured individual, regular checking of lower extremity would provide proper information towards treatment strategies.

References

1. Aglietti P, Insall JN, Walker PS, Trent P. A new patella prosthesis. Design and application. Clinical orthopedics and related research. 1975; 107:175-187.
2. Brody DM. Techniques in the evaluation and treatment of the injured runner. The orthopedic clinics of North America. 1982; 13(3):541-558.
3. Byl T, Cole JA, Livingston LA. What determines the magnitude of the Q angle? A preliminary study of selected skeletal and muscular measures. Journal of Sport Rehabilitation. 2000; 9(1):26-34.
4. France L, Nester C. Effect of errors in the identification of anatomical landmarks on the accuracy of Q angle values. Clinical biomechanics. 2001; 16(8):710-713.
5. Grelsamer RP, Dubey A, Weinstein CH. Men and women have similar Q angles: A clinical and trigonometric evaluation. The Journal of bone and joint surgery. British volume. 2005; 87(11):1498-1501.
6. Hirokawa S, Solomonow M, Luo Z, Lu Y, D'ambrosia R. Muscular co-contraction and control of knee stability. Journal of Electromyography and Kinesiology. 1991; 1(3):199-208.
7. Horton MG, Hall TL. Quadriceps femoris muscle angle: normal values and relationships with gender and selected skeletal measures. Physical therapy. 1989; 69(11):897-901.
8. Huberti HH, Hayes WC. Patellofemoral contact pressures. The influence of q-angle and tendo femoral contact. The Journal of bone and joint surgery. 1984; 66(5):715-724.
9. Jonson LSR, Gross MT. Intra examiner reliability, inter examiner reliability, and mean values for nine lower extremity skeletal measures in healthy naval midshipmen. Journal of Orthopedic & Sports Physical Therapy. 1997; 25(4):253-263.
10. Karukunchit U, Puntumetakul R, Swangnetr M, Boucaut R. Prevalence and risk factor analysis of lower extremity abnormal alignment characteristics among rice farmers. Patient preference and adherence. 2015; 9:785.
11. Livingston LA. The quadriceps angle: a review of the literature. Journal of Orthopedic & Sports Physical Therapy. 1998; 28(2):105-109.
12. Livingston LA, Mandigo JL. Bilateral within-subject Q angle asymmetry in young adult females and males. Biomedical sciences instrumentation. 1997; 33:112-117.
13. Lohman TG, Roche AF, Martorell R. Anthropometric standardization reference manual. Human kinetics books, 1988.
14. Magee DJ. Orthopedic physical assessment. Elsevier South Asia Edition, 2008.
15. Mohanty NR, Koley S. A Study on Lower Extremity Malalignment and Its Correlation to Q-Angle in State Level Athletes of Odisha. Int. J Health Sci. Res. 2018; 8(11):31-36.
16. Mohanty NR, Tiwari A, Koley S. Bilateral Correlation of Q-Angle With Selected Lower Extremity Biomechanical Alignment Variables In State Level Female Basket-Ball Players. European Journal of Physical Education and Sport Science. 2019; 5(7):26-35.
17. Moreland JR, Bassett LW, Hanker GJ. Radiographic analysis of the axial alignment of the lower extremity. The Journal of bone and joint surgery. American volume. 1987; 69(5):745-749.
18. Nguyen AD, Shultz SJ. Sex differences in clinical measures of lower extremity alignment. Journal of orthopedic & sports physical therapy. 2007; 37(7):389-398.
19. Powers CM. The influence of altered lower-extremity kinematics on patellofemoral joint dysfunction: a theoretical perspective. Journal of Orthopedic & Sports Physical Therapy. 2003; 33(11):639-646.
20. Shultz SJ, Nguyen AD, Schmitz RJ. Differences in lower extremity anatomical and postural characteristics in males and females between maturation groups. Journal of orthopedic & sports physical therapy. 2008; 38(3):137-149.
21. Stuberg W, Temme J, Kaplan P, Clarke A, Fuchs R. Measurement of tibial torsion and thigh-foot angle using goniometry and computed tomography. Clinical orthopedics and related research. 1991; 272:208-212.