International Journal of Physiotherapy and Research,
Int J Physiother Res 2016, Vol 4(3):1530-34. ISSN 2321-1822
DOI: http://dx.doi.org/10.16965/ijpr.2016.125

Original Research Article

A CORRELATION BETWEEN LEG-HEEL ALIGNMENT, TIBIAL TORSION AND Q ANGLE AMONGST NORMAL, OVERWEIGHT AND OBESE INDIVIDUALS

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ABSTRACT

Background: Excess weight puts a strain on every part of your body. Foot problems in obese adults are most important. The position and function of the foot and ankle affect the stresses transmitted to the knee.

Purpose: To measure and to find correlation between leg-heel alignment, tibial torsion and Q angle in normal, overweight and obese individuals.

Materials and Methods: 60 normal, overweight and obese subjects were include with mean age 30.6±5.98, 30.9±5.98 and 29.6±4.87 respectively, with each group 20 subjects. Normal subjects with BMI prime between 0.74 to 1.0 were group A, overweight subjects with BMI prime 1.0 to 1.2 were group B and obese subjects with BMI >1.2 were group C. Of each subject leg-heel alignment, tibial torsion and Q angle will be measured using measuring tape, plumb line and goniometer and correlation is studied.

Results: Q angle, tibial torsion and leg-heel alignment were statistically analysed amongst normal, overweight and obese using ANOVA and comparison between 2 groups with ANCOVA. Mean Q angle, tibial torsion and leg heel alignment in normal right leg were 17.9, 13.35, 4.7 and for left leg were 18, 14.25, 4.55 respectively. Similarly, in overweight right leg the values were 19.5, 16.5, 5.8 and in left leg were 20, 16.18, 5.35 respectively. Whereas, in obese right leg values were 21.2, 15.5, 6.35 and in left were 22.6,15.5, 6.6 respectively. There was significant difference in Q angle between normal and obese in right (p=0.022); left (p=0.001), In right, tibial torsion between normal and overweight (p=0.001); normal and obese (p=0.031) and in leg-heel alignment significant difference is seen between normal and obese in right (p=0.032).

Conclusion: With increase in weight there are changes seen in Q angle, tibial torsion and leg heel alignment.

KEY WORDS: Obesity, Q angle, Tibial Torsion, Leg-heel Alignment.

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Quick Response code	International Journal of Physiotherapy and Research ISSN 2321- 1822 www.ijmhr.org/ijpr.html	
DOI: 10.16965/ijpr.2016.125	Received: 31-03-2016 Peer Review: 01-04-2016 Revised: None	Accepted: 22-04-2016 Published (O): 11-06-2016 Published (P): 11-06-2016

INTRODUCTION

Obesity is the excess or abnormal accumulation of the body fat or adipose tissue mass [1]. Incidence of obesity is increasing rapidly [2].

Worldwide overweight and obesity are major health problems where body weight is >20% of the ideal [3]. Obesity affects the quality and quantity of life and increases risk of mortality due to associated co-morbidites like hypertension, dyslipidemia, diabetes mellitus, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, respiratory problems, cardiovascular disease, gout, cardiac arrhythmias and cancers like endometrial, breast, prostate & colon cancer and many musculoskeletal disorders [1,2,4,5]. WHO has given classification of BMI to categorize people at risk of co-morbidities [5], 18.5-22.9 is considered to be normal, 23.0-24.9 over-weight, 25.0-29.9 as an obese class I and more than 30.0 as an obese class II[6].

Modification in BMI system is done which is known as BMI prime. It is the ratio of actual BMI to upper limit BMI i.e. 25. BMI prime is dimensionless number which shows by what percentage person deviates from their upper weight limit. Individuals with BMI prime less than 0.74 are under weight, 0.74 to 1.0 are normal, 1.0 to 1.2 are overweight and more than 1.2 are obese [7].

Stress on bones, tendons and ligaments increases due to additional weight [2]. Locomotor system is additionally loaded due to obesity which leads to functional and structural limitations, thereby raising the stress within connective tissue structures and the risk of musculoskeletal injuries [8].

Musculoskelatal function impairment such as abnormal mechanics of the body is a consequence of increased stress within the bones, joints and soft tissues due to excess weight[9]. Foot problems are frequent because the interface between body and ground is subjected to high stresses and load[10]. In weight bearing foot, subtalar motion and tibial rotations are interdependent [11].

Leg-heel alignment is measuring angle between calcaneus and tibia. Tibial torsion is the measurement of angle of lateral rotation of the tibia [12].

The position and function of the foot and ankle affect the stresses transmitted to the knee [11]. Q angle or patellofemoral angle is defined as the angle between the quadriceps muscles and the patellar tendon, it is an important indicator of biomechanical function in the lower extremity [3].

There are studies done which shows relation between knee and tibial rotation and tibial rotation and foot, but correlation between leg-heel alignment, tibial torsion and Q angle lack literature.

The purpose of the study is to find correlation between calcaneal eversion, tibial torsion and Q angle amongst normal, overweight and obese individuals and to find the structure that is more affected.

MATERIALS AND METHODS

A cross-sectional studywas conducted on 60 subjects which were divided in 3 groups considering BMI prime. There were 20 subjects in each group.Both males and females between age 25 to 40 years with BMI prime between 0.74 to more than 1.2 were included in the study and subjects with BMI prime less than 0.74 and with history of lower limb injuries or fractures and surgeries were excluded.

Material required:

1. Assessment form
2. Weighing machine
3. Calculator
4. Measuring tape
5. Goniometer
6. Plumb line

Outcome Measures:

1. Leg-heel alignment
2. Tibial torsion
3. Q angle

Procedure: An ethical clearance will be obtained from institutional ethical committee. Considering inclusion and exclusion criteria subjects will be selected and divided in particular group according to their BMI. Normal subjects with BMI prime between 0.74 to 1.0 will be group A, overweight subjects with BMI prime 1.0 to 1.2 will be group B and obese subjects with BMI >1.2 will be group C. Of each subject leg-heel alignment, tibial torsion and Q angle will be measured using measuring tape and goniometer. For measuring leg-heel alignment (Fig. A), the subject lies in the prone position with the foot extending over the end of the examining table. A mark will be placed over the midline of the calcaneus at the insertion of the Achilles tendon. Second mark will be placed approximately 1cm distal to the first mark and as close to the midline of the calcaneus as possible. A calcaneal line will be then made to join the two marks. Then tibial line will be drawn making two marks on the lower third of leg in the midline. Subtalar joint is then placed in prone neutral position and the lines are studied. If the line are parallel or in slight varus, that is 2degree to 8 degree, the leg-to-heel alignment is considered normal. If the heel is inverted, the patient has hindfootvarus, if heel is everted, the patient has hindfoot valgus.

Measurement of tibial torsion is taken with subject taken in sitting position with knees flexed to 90 degrees over the edge of the examination table (Fig. B). The footprints will be taken on blank paper. Using plumb line medial and lateral condyles of tibia and medial and lateral malleolus points will be marked on paper and then these points will be joined to form tibial torsion angle which will be measured. The angle formed is 12 degrees to 18 degrees normally.

Q angle will be measured by placing lower limbs at right angle to the line joining two ASIS. A line will be drawn from ASIS to midpoint of patella on the same side and from the tibial tubercle to the midpoint of patella (Fig C). The angle formed by crossing these two lines is Q angle which normally is 13 degrees for males and 18 degrees for females. The correlation between leg-heel alignment, tibial torsion and Q angle will be studied.

Fig. A: leg-heel alignment

Fig. B: Tibial torsion

Fig. C: Q angle.

RESULTS

Table 1: Demographic details

	Female	Male	Age
Normal (n=20)	18	2	30.6±5.98
Overweight (n=20)	14	6	30.9±5.98
Obese (n=20)	14	6	29.6±4.87

Q Angle tibial torsion and leg-heel alignment were statistically analysed amongst normal, overweight and obese using ANOVA and comparison between 2 groups was analysed using ANCOVA

Table 2: Showing the Q angle on both sides

	Right	Left
Normal	17.9	18
Overweight	19.5	20
Obese	21.2	22.6
F value	3.89	7.213
P value	**0.26**	**0.002**

There was significant difference in Q angle between normal and obese in right (p=0.022) and left (p=0.001). There was no significant difference between normal- overweight and overweight- obese (p>0.05)

Graph 1: Showing the Q Angle in different groups.

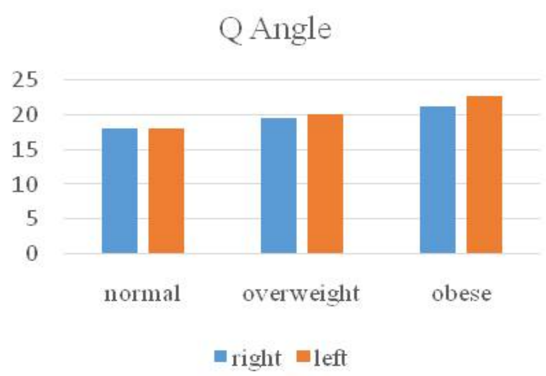

Table 3: Showing the Tibial Torsion on both sides.

	Right	Left
Normal	13.35	14.25
Overweight	16.5	16.8
Obese	15.5	15.05
F value	7.886	2.109
P value	**0.001**	0.131

There was significant difference tibial torsion between normal- overweight (p=0.001) and normal- obese (p=0.031) in right

Graph 2: Showing the Tibial Torsion in different groups.

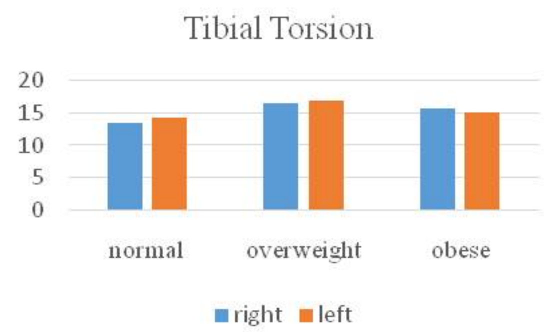

Table 4: Showing the Leg-heel Alignment

	Right	Left
Normal	4.7	4.55
Overweight	5.8	5.35
Obese	6.35	6.6
F value	3.625	3.168
P value	**0.033**	0.05

There was significant difference between normal and obese in right (p=0.032)

Graph 3: Showing the Leg-Heel Alignment in various groups.

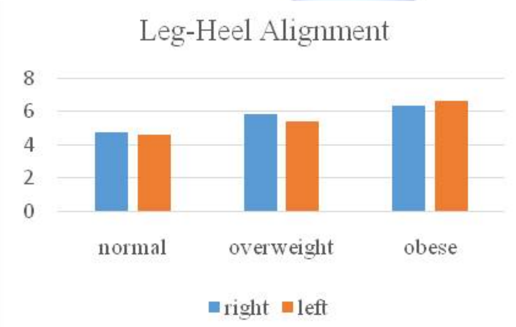

Table 5: All groups combined comparison (Karl Pearsons's correlation coefficient)

	Right	Left
Q angle - tibialtosion	0.195 (0.136)	0.155 (0.383)
Q angle- leg heel alignment	0.425 **(0.001)**	0.366 **(0.005)**
Tibial torsion-leg heel alignment	0.71 (0.588)	0.067 (0.609)

Table 6: Showing the comparison between the groups.

	Normal		Overweight		Obese	
	Right	Left	Right	Left	Right	Left
Q angle- Tibial torsion	0.294 -0.208	0.209 (0.377)	0.046 (0.848)	0.26 (0.268)	-0.255 -0.278	-0.317 (0.174)
Q angle- Leg heel alignment	0.597 **(0.005)**	0.644 **(0.002)**	0.249 (0.289)	0.356 (0.129)	-0.005 (0.984)	-0.282 (0.229)
Tibial torsion- Leg heel alignment	0.415 (0.069)	0.240 (0.309)	-0.463 **(0.040)**	-0.189 (0.424)	-0.212 (0.369)	-0.004 (0.987)

DISCUSSION

A study was done to find correlation between Q angle, tibial torsion and calaneal angle amongst 20 normal, overweight and obese individuals each group. When Q angle was analysed using ANOVA between normal, overweight and obese there was significant difference seen in right and left. There was significant difference seen between normal and obese when analysed using ANCOVA.

Amongst 3 groups significant tibial torsion angle difference was seen in right (0.001). There was also significant difference between normal overweight and normal obese. In leg-heel alignment there was significant difference in right amongst 3 groups. There was significant difference in between normal and obese as well. Study conducted by P. P. Popat, A. R. Parekh to study biomechanical variation of joint angles in overweight females found that there was significant increase in calcaneal eversion and angle toe out in overweight than compared to normal females. They also found that there is positive correlation between calcaneal eversion and angle toe out [3].

In the present study there was significant difference in Q angle between normal and obese in right (p=0.022) and left (p=0.001), in right, tibial torsion between normal and overweight (p=0.001), normal and obese (p=0.031) and in leg-heel alignment significant difference is seen between normal and obese in right (p=0.032).

A study previously done indicate that the Q angle increases with increased tibial external rotation There is increased load of weight bearing joint with increase in weight. Due to increased body mass obese people have greater absolute knee adduction moments and also compensatory gait patterns like slow walking and increased toe-out angle [13]. When femoral anteversion is excess it may lead to more medial rotation of femur leading to displacement of patella medially. Femoral anteversion may be related to intoeing gait which is compensated with external rotation of tibia on femur causing tibial tuberosity to displace more laterally [14].

The torsion is transmitted to hind foot and ankle joint. Increased anterior pelvic tilt and navicular drop result in rotational changes in the femur and tibia displacing the patella medially and the tibial tuberosity laterally. Increased medial joint loading, is evidenced by a greater knee-joint adduction moment, has also been frequently noted in individuals with OA [15].

Study done by G. C. Michael et al. found that with greater externally rotated legs there was significant increase in calcaneal eversion [16].

We can conclude from the study that due to weight there are alterations in Q angle, tibial torsion and leg-heel alignment. The limitations of the study were that female to male ratio was more and the compensatory changes at hip were not studied. The changes at hip if studied will help to investigate correlation between hip, knee and ankle.

ACKNOWLEDGEMENTS

Thanks to everyone who helped in study directly or indirectly.

Conflicts of interest: None

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How to cite this article:

Anand Heggannavar, Laxmi Battula, Santosh Metgud. A CORRELATION BETWEEN LEG-HEEL ALIGNMENT, TIBIAL TORSION AND Q ANGLE AMONGST NORMAL, OVERWEIGHT AND OBESE INDIVIDUALS. Int J Physiother Res 2016;4(3):1530-1534. **DOI:** 10.16965/ijpr.2016.125