A Study to Find Out Relationship Between Q-Angle, Tibial Torsion and Leg-Heel Alignment amongst Osteoarthritis Knee Patients – A Cross Sectional Observational Study

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Abstract

Background: Osteoarthritis (OA) is the most frequent cause of disability in the India, with the medial compartment of the knee being most commonly affected. Osteoarthritis of knee joint is common musculoskeletal problem now days in Indian population. It is most disabling in day to day activities of life.

Purpose: Due to Osteoarthritis of knee joint, multiple changes occur in structure in and around knee joint. Due to these structural changes, biomechanics of knee joint is altered, which in turn leads to secondary changes in muscles, ligaments and other soft tissues also. So, energy cost of walking increases.

Objective: Objective of this study is to correlate Q angle, tibial torsion and leg heel alignment in OA knee patients.

Setting: Different physiotherapy centres of Surat city

Method: Co relational study was done in Surat city. Selection of OA knee patients was done as per selection criteria. Subjects were explained about the study. Informed consent forms were signed by the patient and/or relatives. Subjects selected by purposive sampling were assessed.

Participants: Total 63 male and female OA knee patients

Outcome measure: Q angle, Tibial torsion & Leg heel alignment

Results: Data were entered in Microsoft Excel for Microsoft Windows. Descriptive analysis and corelational test was applied by SPSS version 20 for Microsoft Windows. Moderate positive correlation was found between Q angle & Tibial torsion, between Tibial Torsion & Leg heel alignment, between Leg heel alignment & Q angle.

Conclusion: These findings may suggest that Q angle, Tibial torsion & Leg heel alignment are moderate positively correlated in OA knee joint. So any change in any of above three values may alter values of other remaining values.

Keywords: *Osteoarthrits, OA patients, Q angle, Tibial torsion & Leg heel alignment*

Introduction

Osteoarthritis (OA) is the most frequent cause of disability in the India, with the medial compartment of the knee being most commonly affected. OA is a condition with a multifaceted etiology that affects both load-bearing and non–weight-bearing joints. The risk of developing OA substantially increases with each decade after the age of 40 years. Among reported upper and lower extremity sites, the most common region for OA to manifest is the medial compartment of the knee.[1]

Osteoarthritis (OA) is defined as an idiopathic slowly progressive degenerative joint disease affecting the arthrodial joints mainly in elderly people.[2] It is a chronic localized joint disease and a leading cause of musculoskeletal pain and disability. Osteoarthritic process involves the whole joint including cartilage,

bone, ligament, muscle with changes such as joint space narrowing, bony osteophytes and sclerosis.[3]

Overall prevalence of knee OA was found to be 28.7% in India with age more than 40 years.[4] Andhra Pradesh reported as highly prevalent (68%) and Rajasthan as minimal prevalent (8.42%) state in India for Knee OA. Generally, in all studies from different regions females were reported to be more affected by OA knee than males.[5]

Osteoarthritis occurs when the cartilage that cushions the ends of bones in your joints gradually deteriorates. Cartilage is a firm, slippery tissue that permits nearly frictionless joint motion. In osteoarthritis, the slick surface of the cartilage becomes rough. Eventually, if the cartilage wears down completely, it may be left with bone rubbing on bone. The most common causes of knee OA is age (40 years and older) and gender (more in female). Osteoarthritis predominantly involves the weight-bearing joints, including the knees, hips, cervical and lumbosacral spine, and feet. Other commonly affected joints include the distal interphalangeal, proximal interphalangeal, and carpometacarpal joints.[6,7,8]

As OA progresses, however, the level of proteoglycans eventually drops very low, causing the cartilage to soften and lose elasticity and thereby further compromising joint surface integrity. Over time, the loss of cartilage results in loss of joint space. In major weight-bearing joints of persons with osteoarthritis, a greater loss of joint space occurs at those areas experiencing the highest loads.[8]

Individuals with knee OA experience pain, stiffness, and decreased range of motion of the joints. These symptoms significantly limit an individual's ability to rise from a chair, stand comfortably, walk, or climb stairs. Ultimately, these limitations lead to a loss of functional independence.[9] Risk factors are multifactorial and include older age, female gender, obesity (particularly in knee OA), previous joint injury, genetics and muscle weakness, repetitive use of joints, bone density, joint laxity. All play roles in the development of joint OA determination of risk factors particularly in the weight-bearing joints and their modification may reduce the risk of OA and prevent subsequent pain and disability.[3,10]

On examination, there is swelling due to synovial thickening and/or effusion, muscle wasting and prominence of the articular margins due to osteophytes. Movement are painful and restricted. Crepitus is felt on joint movement in late stage of the disease, loose bodies develop in the joint, which may cause recurrent joint effusion, pain, swelling and locking of the joint.[11]

At the knee, alignment (i.e., the hip knee-ankle angle) is a key determinant of load distribution. The load-bearing axis is represented by a line drawn from mid femoral head to mid ankle. In a Varus knee, this line passes medial to the knee and a moment arm is created, which increases force across the medial compartment. In a valgus knee, the load-bearing axis passes lateral to the knee, and the resulting moment arm increases force across the lateral compartment. These mechanical effects of alignment on load distribution make it biologically plausible that both varus and valgus alignment contribute to OA progression. The position and function of the foot and ankle affect the stresses transmitted to the knee. Foot problems are frequent because the interface between body and ground is subjected to high stresses and load. In weight bearing foot, subtalar motion and tibial rotations are interdependent.[12,13]

Q angle or patellofemoral angle is the angle between the quadriceps muscles and the patellar tendon, it is an important indicator of biomechanical function in the lower extremity.[12]

Tibial torsion is the measurement of angle of lateral rotation of the tibia.[12] It is an important morphological feature of human tibia and is defined as any twisting of the tibia on its longitudinal axis which produces a change in alignment of the planes of motion of the proximal and distal articulations.[14]

Leg-heel alignment is measuring angle between calcaneus and tibia.[12] It plays an important role in knee OA from a biomechanical perspective owing to rotational coupling between the rear foot and tibia.[15]

Osteoarthritis of knee joint is common musculoskeletal problem now days in Indian population. It is most disabling in day to day activities of life. Due to this, multiple changes occur in structure in and around knee joint. Due to these structural changes, biomechanics of knee joint is altered, which in turn leads to secondary changes in muscles, ligaments and other soft tissues also; So, energy cost of walking is more. Very few studies are done to correlate different measurements like Q angle, tibial torsion and leg heel alignment. So, the purpose of this study is to correlate Q angle, tibial torsion and leg heel in OA knee patients.

Materials and Methodology

- **Study design:** Co relational study
- **Source of data:** Different physiotherapy clinics in Surat city
- **Sampling technique:** Purposive
- **Study population:** OA knee patients

Age - ≥40 years

- **Sample size:** 63 OA knee patients

(40 unilateral involvement, 23 bilateral involvements)

- **Search duration :** 6 months

Patients were selected based on following inclusion and exclusion criteria:

- **Inclusion criteria[16]:**

1) Knee osteoarthritis diagnosed by orthopedic surgeon.

2) Subjective complain of knee pain with knee flexion and extension.

3) Morning stiffness ≤ 60 min.

4) Both sexes (male and female).

5) Unilateral or Bilateral knee involvement.

6) Age ≥ 40 years.

- **Exclusion criteria[16]:**

1) Previous knee arthroplasty, history of congenital/adolescent knee disease.

2) Clinical signs of hip and ankle joint disease.

3) Pregnancy

4) Knee fracture

5) Rheumatic disease.

- **Method:**

A B C

Q angle was measured with patient in standing position by placing lower limb at right angle to the line joining to ASIS (Anterior Superior Iliac Spine). A line was drawn from ASIS to base of patella. Second line was drawn from tibial tuberosity to base of patella. The angle formed by crossing these two lines was measured. (Figure A)

For measuring tibial torsion, patient was in prone position with affected knee in 90 degree flexed. A line was drawn between lateral and medial malleoli on the sole of foot. Second line was drawn between lateral and medial femoral condyle on the sole of foot. The angle formed by crossing these two lines was measured. (Figure B)

For measuring leg-heel alignment, patient was in standing position. A mark was placed over the midline of the calcaneus at the insertion of the Achilles tendon. Second mark was placed approximately 1 cm distal to the first mark and as close to the midline of calcaneus as possible. A calcaneal line was drawn to join the two marks. Then tibial line was drawn to make two marks on the lower third of leg in the midline. The angle formed

by crossing these two lines was measured. (Figure C)

Data Analysis & Result

The present study was done to study to find out relation among Q angle, Tibial torsion and Leg heel alignment in OA knee patients. The study comprised of total 63 subjects (19 males & 44 females). Data were entered in Microsoft Excel for Microsoft Windows. Mean ± Standard Deviation values for Q angle, tibial torsion and leg heel alignment found were $27.78^{o} \pm 4.64^{o}$, $13.5^{o} \pm 4.06^{o}$ and $12.86^{o} \pm 3.55^{o}$ respectively. 40 patients had unilateral osteoarthritis and 23 patients had bilateral osteoarthritis of knee.

Pearson co-relation test was applied by SPSS version 20 for Microsoft Windows among above measurements and results were found as below:

Table 1: Correlation Test between Q angle and Tibial torsion

Pearson Correlation	**.150**
Sig. (2-tailed)	.191
N	78

Table 2: Correlation Test between Tibial torsion and Leg heel alignment

Pearson Correlation	.048
Sig. (2-tailed)	.675
N	78

Table 3: Correlation Test between Q angle and Leg heel alignment

Pearson Correlation	.211
Sig. (2-tailed)	.064
N	78

Discussion

Purpose of the present study was to find out the relation among Q angle, Tibial torsion and Leg heel alignment in OA knee patients. In study, moderate positive correlation was found between Q angle and Tibial torsion; Tibial torsion and Leg heel alignment; Q angle and Leg heel alignment of the patients with knee joint OA, which suggest that as Q angle value increase, Tibial torsion value increase as well as Leg heel alignment value also increase and vice versa.

A study by Anand Heggannavar, et.al. (2016) previously done indicate that the Q angle increases with increased tibial external rotation. There is increased load of weight bearing joint, and also changes in compensatory gait patterns like slow walking and increased toe-out angle.[12] A study Anh D N, Michelle B C, et.al. (2009) previously done indicate that increased tibiofemoral angle, which represents the valgus angle formed by the anatomical axes of the femur and tibia, would move the patella medially relative to the anterior superior iliac spine and the tibial tuberosity laterally thus increasing the Q angle. When femoral anteversion is excessive, it may lead to more medial rotation of femur leading to displacement of patella medially. Femoral anteversion may be related to in toeing gait which is compensated with external rotation of tibia on femur causing tibial tuberosity to displace more laterally.[17]

A study by Anand Heggannavar, et.al. (2016) previously done indicate that 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.[12]

A study by Nüesch C, Barg A, et.al. (2013) previously done indicate that the asymmetric alignment of the ankle joint leads to changes in the intra-articular pressure distribution and the contact area. A varus alignment of the hind foot leads a shift of the pressure in anteromedial direction and a reduction of the contact area. For a valgus alignment a pressure shift in posterolateral direction and a reduced contact area. However, in the specimens with an intact fibula and ankle joint, opposite changes were seen: varus lead to posterolateral pressure shifts and increased contact areas, while valgus lead to anteromedial pressure shifts and decreased contact areas.[18]

Holister et. Al. (2011) suggested that in the externally rotated knee the coupled rotation of the femur and tibia in the screw home mechanism may be reversed. With the knee externally rotated, the bony attachments for the

extensor musculature are shifted.[19] G.C. Michael et. Al. (2016) found that with greater externally rotated legs, there was significant increase in calcaneal eversion.[12] Development of degenerative changes after ACL injury was associated with varus deformity knees in the cohort evaluation by McDaniel Jr. And Dameron Jr. (2015)[20] Hiroshi Ohi et. Al. (2017) suggested that the existence of a connection between altered frontal knee alignment and foot posture, which would be helpful to understand the pathogenesis of altered foot posture observed in patients with knee OA.[15]

It is observed in present study that measurement of Q angle, Tibial torsion and Leg heel alignment may be affected by difficulty to palpate bony prominence because of fat.

Limitations:

- Sample size was small
- Only knee joint arthritic patients were included in this study
- Limited age of patients were included in this study
- Females included were more than males in this study

Future recommendations:

- Study can be done with large sample size.
- Biomechanical markers other than Q angle, Tibial torsion and Leg heel alignment can be added.
- Study can be done including other arthritic joints like, hip and ankle.

Conclusion

From this study, it is concluded that Q angle, Tibial torsion & Leg heel alignment are moderate positively correlated in OA knee joint. So any change in any of above three values may alter values of other remaining values.

Ethical Clearance: Permission was taken from college and physiotherapy centres from where data collection was done. Ethical issues were cleared.

Conflict of Interest: None

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