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Evaluation of Quadriceps angle in women with unilateral osteoarthritis of the knee

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ABSTRACT

Background & Aim

Osteoarthritis is a progressive musculoskeletal condition leading to disability. Misalignment of knee joint is one of the main predisposing factors for the onset and progression of osteoarthritis. The present study aimed to compare the quadriceps angle between osteoarthritis knee and normal.

Methodology

A cross-sectional study with purposive sampling method in 84 subjects in the age group of 50 -65 years including 42 women diagnosed with unilateral osteoarthritis knee and 42 healthy women was conducted. Women diagnosed with unilateral osteoarthritis knee on the basis of American College of Rheumatology (ACR) Clinical Classification Criteria for Osteoarthritis of the knee were recruited. Healthy women were age matched controls without any history of pain, trauma or surgeries in both the lower extremities. Quadriceps angle was measured using goniometric method.

Results

The mean age of the participants in osteoarthritis knee and normal was 55.21 ± 4.32 and 56.45 ± 5.16 years respectively. Comparison of mean values of quadriceps angle between osteoarthritis knee and normal subjects using unpaired t test was statistically significant (p = 0.014) with quadriceps angle higher in osteoarthritis knee group. Also, comparison of mean values of quadriceps angle between affected and unaffected side in osteoarthritis knee subjects using paired t test was statistically significant (p = 0.000) with quadriceps angle higher in affected side of osteoarthritis knee group.

Conclusion

The results of the present study show that quadriceps angle is greater in osteoarthritis knee patients as compared to healthy individuals.

Keywords: Quadriceps angle, Osteoarthritis, knee, Lower extremity alignment.

INTRODUCTION

Osteoarthritis (OA) is a broad term that constitutes of heterogeneous group of conditions that lead to pain and dysfunction which are associated with breakdown of the articular cartilage and in addition cause changes in the underlying bone at the joint margins [1]. It is a major source of impairment and disability and also poses a significant economic burden on the community. It is characterized by pain, loss of joint mobility, progressive loss of function and is associated with significant health and welfare cost. World Health Organization has reported knee osteoarthritis as the 4th most common cause of disability in women and the 8th in men [2]. Knee joint is a weight bearing joint. Misalignment of the knee joint is considered to be one of the main predisposing factors for the onset and progression of OA [3]. According to Hinman et al. [4], knee alignment variations larger than 5 degrees both in varus and in valgus are sufficient to influence the knee function. OA presents with characteristics like osteophytes formation, articular cartilage degeneration and also the sclerosis of subchondral bone which has an effect on alignment of the knee joint. These lesions could lead to a consequent loss of joint biomechanics and alignment leading to alteration in the amplitude of the quadriceps angle [5].

The quadriceps angle (Q-angle) is defined as the acute angle formed between lines from the anterior superior iliac spine to the center of the patella, and from the center of the patella to the center of the tibial tubercle [6]. The Q-angle provides an estimate of the vector force between the quadriceps muscle and patellar tendon [6, 7]. A stronger vastus lateralis pulls the patella laterally, resulting in a larger Q-angle, while a stronger vastus medialis pulls the patella medially, resulting in a smaller Q-angle. Therefore, the Q-angle is an indicator of the imbalance between components of the quadriceps muscle [8]. The Q angle has come to be accepted as an important factor in assessing knee joint function. The present study aimed to compare the quadriceps angle between osteoarthritis knee and healthy individuals.

MATERIALS AND METHODS

The study was conducted after the approval of Institutional Research Review Committee. It was a cross-sectional study. 42 women in the age group of 50 -65 years diagnosed with unilateral osteoarthritis knee were selected purposively and formed the experimental group. Subjects with unilateral osteoarthritis knee were recruited on the basis of American College of Rheumatology (ACR) Clinical Classification Criteria for Osteoarthritis of the knee [9]. Subjects with history of any knee surgery, traumatic injury to knee or on steroidal injection were excluded from the study. 42 healthy women were age matched controls without any history of pain, trauma or surgeries in both the lower extremities.

Subjects were explained about the nature of the study in the language best understood by them. A duly signed written informed consent was taken from the subjects who were willing to participate in the study. The demographic information of participants, such as, age, gender, dominance and duration of disease were recorded.

Measurement of Quadriceps angle

The starting position of the subject was in supine lying. Quadriceps angle was measured on both the knees – affected and unaffected of the osteoarthritis knee group and also in the healthy women group. Three landmarks were identified namely; anterior superior iliac spine (ASIS), center of the patella and tibial tuberosity. For marking center of patella, borders of patella were palpated and outline of patella was drawn using a body marker without stretching the skin over the patella. The intersecting point of maximum vertical and transverse diameter of patella was taken as the point for center of patella. The point of maximum prominence at anterior upper end of tibia is marked as the tibial tuberosity. Then the squaring of pelvis was done. Subjects were instructed to relax the quadriceps muscle with lower limbs in neutral rotation and the foot pointing upwards as well as perpendicular to the resting surface. The axis of goniometer was placed on center of the patella, fixed arm aligned with the ASIS and the movable arm with the tibial tuberosity. The first line was drawn from the ASIS to the center of the patella using the straight edge of measuring tape. The second line was drawn from the tibial tuberosity to the center of patella & then extending the second line upwards, the angle formed between these two upper lines was Quadriceps angle [10]. The quadriceps angle was documented in degrees.

Statistical analysis

All statistical analysis was done using SPSS Statistics v20.0. Descriptive statistics was used to calculate mean and standard deviation. Comparison of mean values of quadriceps angle between osteoarthritis knee and normal subjects was evaluated using unpaired t test. Comparison of mean values of quadriceps angle between affected and unaffected side in osteoarthritis knee subjects was evaluated using paired t test. The level of significance was set at $p < 0.05$.

RESULTS

In this study, there were total 84 subjects, of which 42 women were diagnosed with osteoarthritis knee and 42 were healthy females in the age group of 50 to 65 years. The mean age of the participants in osteoarthritis knee and normal was 55.21 ± 4.32 and 56.45 ± 5.16 years respectively (Table 1). The comparison of mean values of quadriceps angle between osteoarthritis knee and normal subjects evaluated using unpaired t test was statistically significant ($p = 0.014$) with quadriceps angle higher in osteoarthritis knee group (Table 2). Also, the comparison of mean values of quadriceps angle between affected and unaffected side in osteoarthritis knee subjects evaluated using paired t test was statistically significant ($p = 0.000$) with quadriceps angle higher in affected side of osteoarthritis knee group (Table 3).

Table 1 Demographic Data of the participants.

Variable	Osteoarthritis knee		Normal	
	N = 42		N = 42	
	Mean	Standard deviation	Mean	Standard deviation
Age (in years)	55.21	4.32	56.45	5.16

Table 2. Comparison of mean values of quadriceps angle between osteoarthritis knee and normal subjects.

	Osteoarthritis knee	Normal	Significance
	Mean ± SD	Mean ± SD	p value
Quadriceps angle (in degrees)	18.5 ± 3.11	16.76 ± 3.25	0.014*

* p value is significant at < 0.05.

Table 3. Comparison of mean values of quadriceps angle between affected and unaffected side in osteoarthritis knee subjects.

	Osteoarthritis knee		Significance
	Affected side	Unaffected side	
	Mean ± SD	Mean ± SD	p value
Quadriceps angle (in degrees)	18.5 ± 3.11	15.19 ± 2.79	0.000*

* p value is significant at < 0.05.

DISCUSSION

Osteoarthritis is a progressive musculoskeletal condition. It leads to pain, movement dysfunction and difficulty in performance of daily activities which affects the wellbeing of an individual. The present study showed that quadriceps angle was higher in osteoarthritis knee as compared to normal. Also, the quadriceps angle was greater in affected side as compared to unaffected side in osteoarthritis knee group. The incidence and progression of OA knee are multifactorial. Alignment plays the pivotal role in the etiology and progression of severity of OA. Alteration of knee alignment in the frontal plane is one of the vital factors that is responsible for variations in the amount of forces that are directed at the knee. Knee extensor mechanism is of prime importance in providing stabilization at knee joint during performance of any activity. Quadriceps angle is the angle formed between the pull of the quadriceps muscles superiorly and the patellar tendon

inferiorly, and it represents the resultant vector which exerts a lateral force on the patella. It has been reported that a 10% increase in the quadriceps angle will increase the stress on the patellofemoral joint by 45% [11].

A high quadriceps angle increases the chance of developing various knee problems. Increased quadriceps angle interferes with the smooth gliding movement between the patella and the knee. After performance of repetitive activities, there is increased friction which leads to microtrauma that causes non-specific knee pain. Due to the abnormal patellar tracking, there is imbalance in functioning of knee muscles like hamstrings, quadriceps & gastrosoleus muscle. Slowly, the cartilage on the underside of the patella begins to wear & thin which leads to degeneration process and development of knee osteoarthritis [12,13]. In a recently published study, that quadriceps angle was reported as the significant predictor of the overall clinical deficits in OA knee. The possible mechanism cited in the study was that any alteration in knee joint alignment that increases quadriceps angle is thought to increase the lateral force on the patella leading to lateral pull and thus potentiates patellofemoral disorders [13].

Q-angle is a clinical measure of lower extremity alignment that represents the resultant quadriceps muscle force orientation in the frontal plane [14]. It has been reported that the biomechanical changes resulting from abnormal knee joint alignment may increase joint loads, affect the mechanical efficiency of muscles, proprioceptive orientation and feedback from the hip and knee and thus resulting in altered neuromuscular control of the lower extremities [15, 16]. All these multiple factors may have direct clinical consequences on knee leading to osteoarthritis. Hence, measurement of quadriceps angle is of prime importance and has considerable influence on decision making and assessing outcomes of the various operative procedures like high tibial osteotomy and total knee replacement.

CONCLUSIONS

The results of the present study provide evidence that quadriceps angle is greater in osteoarthritis knee patients as compared to healthy individuals. These results suggest that it should be mandatory to routinely assess quadriceps angle as a measure of lower extremity alignment in osteoarthritis knee patients, investigate the risk factors causing increase in quadriceps angle and targeting it in the rehabilitation program.

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