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Assessment of the relationship between lower extremity alignment-pelvic angle, genu recurvatum, medial and lateral rotation of the hip in normal and patients with osteoarthritis and quadriceps tendinitis

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Abstract: People who live an extremely active lifestyle, such as participating in sports or running for fitness, a properly positioned lower extremity is very important. The load distribution at the knee may be affected by the lower extremity position, thus subjecting the anterior cruciate ligament to more stress. The current study is aimed at assessing the relationship between lower extremity alignments like the pelvic angle, genu recurvatum, and medial & lateral rotation of the hip in patients with osteoarthritis, and quadriceps tendinitis. The study included 150 asymptomatic (control) male and female patients as well as 150 patients with osteoarthritis, or quadriceps tendinitis. Clinical assessment was done to measure the pelvic angle, genu recurvatum, and medial & lateral rotation of the hip by following standard procedures. The results of the study showed that there was a significant difference in the pelvic angle, but there was no significant difference in the genu recurvatum, medial & lateral rotation of the hip. The conclusion of the study was that the pelvic angle was affected, but the genu recurvatum and medial & lateral of the hip were not affected in the patients with osteoarthritis, and quadriceps tendinitis.

Keywords: Lower extremity; Osteoarthritis; Quadriceps tendinitis; Pelvic angle.

1. Introduction

Lower extremity alignment measurement is an important step in musculoskeletal illness diagnosis and prognosis. Poor lower extremity alignment has also been noted as a risk factor for injuries sustained when engaging in physical activity. Identification of risk factors for musculoskeletal injuries and disorders is made possible by relating anthropometric data and limb alignment to joint stresses during daily activities [1]. The lower extremity should be properly aligned in all three planes, which are the frontal, sagittal, and transverse planes. Common measures describing the alignment of the femur and tibia in the frontal plane are the anatomical axis, the mechanical axis, and the quadriceps angle (Q-angle). The sagittal plane mechanical axis describes the alignment of the lower extremity in the sagittal plane in full extension. Lower extremity alignment in the transverse plane is described by the natural foot

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position during stance [2]. Many investigators evaluated only one number or a small number of the factors, which is inadequate to describe the exact position of the lower extremities and insufficient in determining the clinical relationships [3].

The study of the relationship between lower extremity deformities is important and is widely recognised in the areas of orthopaedics [4], ergonomics [5], physical therapy [6], sports [7], and other disciplines concerned with the prevention, rehabilitation, and treatment of musculoskeletal injuries and diseases [8]. A range of methods have been developed for the measurement of lower extremity alignment. For instance, the use of radiographic images facilitates the direct measurement of skeletal alignment but is limited to specific static or quasi-static postures [9]. While other methods allow for the measurement of lower extremity alignment in different postures or even in dynamic situations, these methods rely on the accurate palpation of anatomical landmarks and the use of anthropometric information to estimate skeletal alignment indirectly [10]. Hence, the current study assessed the magnitude and impact of the occurrence of lower extremity alignment: pelvic angle, genu recurvatum, lateral and medial rotation of the hip in osteoarthritis, and quadriceps tendinitis.

2. Materials and methods

2.1 Study Design

The study is a prospective, parallel and single-centre study. Study participants are grouped into A & B. Group A is the control group of asymptomatic male & female Subjects of the age group 30-60 years. Group B consisted of clinically assessed subjects with grade I osteoarthritis, and quadriceps tendinitis. Group A population was selected from the local community and group B population was selected from the case presented with clinical complaints visiting physiotherapy and orthopaedic OPD.

2.2 Inclusion criteria

All age groups of either gender of Lower extremity alignment, including those with prior knee injury or Osteoarthritis, neutral alignment in the lateral TF compartment category, the lower extremity alignment including the hip, knee, and ankle joints, genu valgum, genu recurvatum, tibial varum, Tibial Torsion, Flat foot and prior to participation subjects are provided with informed consent are included in the study.

2.3 Exclusion criteria

Population with musculoskeletal disease (Myopathies), Poliomyelitis, Osteoporosis, Neurological conditions, and Psychiatric disorders and prior to participation subjects are not provided with informed consent are excluded from the study.

2.4 Sample size

The sample size of 150 participants was determined using the precision (confidence intervals) of the estimated limits of agreement according to Bland and Altman (1986) 283; the 95% CI of the estimated limits of agreement are 1.96 +/- $\sqrt{(3/n)}$ s, where n is the number of subjects and s is the standard deviation of the differences between the two repeated measurements. A sample size of 150 would thus give a 95% CI of 0.34s, so if we expect to be approximately 2 on our scale of 0-13, the 95% CI would be 0.68, which is reasonable [11].

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2.5 Ethical consideration

The study was conducted according to the guidelines of the Declaration of Helsinki for biomedical research involving human subjects after obtaining the IEC clearance from the Saveetha Medical College Hospital, approval number 002/04/2021/IEC/SMCH.

2.6 Data collection and processing

The data were collected from Saveetha College of Physiotherapy and Medical College Hospital, Thandalam, Chennai. The clinical measurements like pelvic angle, genu recurvatum and medial & lateral of the hip were recorded using standard procedures.

2.7 Procedures

Before the assessment of alignment characteristics, demographics of age, height, and weight will be recorded for each subject. Eight alignment characteristics will be measured on the left pelvis and lower extremities. These alignment characteristics will be based on commonly identified variables suggested to influence dynamic motion and risk of lower extremity injuries. All measurement procedures will be performed by a single examiner who had previously established well to excellent test–retest reliability on all measures ($ICC_{2,3} \geq 0.87$). All standing measures will be taken in a standardized stance with the left and right feet spaced equal to the width of the left and right acromion processes and toes facing forward. The stance was achieved by instructing subjects to march in place and then take a step forward. Subjects will be instructed to look straight ahead during all standing measures with equal weight over both feet. Each measure was repeated 3 times.

2.8 Measurement of pelvic angle

The pelvic angle will be measured in the standardized stance using an inclinometer and represented the angle formed by a line from the anterior superior iliac spine to the posterior superior iliac spine relative to the horizontal plane. The calculated angle (θ1) was obtained from two measured values: the pelvic foramen height (H) on AP radiographs and the pelvic foramen distance (D) on lateral radiography. The formula used was as follows: $\sin \theta = H/D$ [12].

An inclinometer has a 23 Cm length base and two 15 Cm arms on each side that freely move 360 degrees in the horizontal plane. The ends of the arms are placed on the bony landmarks. A goniometer is placed on the base of the inclinometer with a plumb line hanging from it. When the arms are placed on the right points of the body, the angle between this line and the point of 90 degrees on the goniometer shows the pelvic inclination angle (Figure 1) [13].

2.9 Measurement of genu recurvatum

Genu recurvatum will be measured with a goniometer in a supine position with a bolster positioned under the distal tibia and represented the sagittal plane alignment of the femur and tibia (Figure 2) [14].

2.10 Measurement of medial and lateral rotation of the hip

Hip medial rotation and lateral rotation were measured with the patient in a prone position with the knees flexed to 90 degrees and the pelvis firmly stabilized with one hand. The other

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hand grasped the ankle and moved until a firm resistance was felt. Another physical therapist measured hip rotation with a 30.48-cm (12-in) plastic goniometer as described by Staheli et al [15] and Ellison et al [16] while the hip was moved to the end of hip medial and lateral rotation (Figure 3) [17].

2.10 Statistical analysis

The data were expressed as mean and standard error of mean (SEM). The means were compared by One-way repeated measures analysis of variance (one-way RM ANOVA). For between group comparison, control and case were taken. For within group repetition comparison, right and left side were taken. For post hoc multiple comparisons, Bonferroni 't' test was carried after ANOVA, for between group and within group comparisons. A probability of 0.05 and less was considered statistically significant. Sigma Plot 14.5 version (Systat Software Inc., San Jose, USA) was used for the statistical analysis.

3. Results

The demographic details of the participants in the control and case (osteoarthritis and quadriceps tendinitis) are given in the (Table 1).

The social/employment history and medication history of the participants in the control and case (osteoarthritis and quadriceps tendinitis) are given in the (Table 2 and Table 3).

The mean and standard error of pelvic angle of control and case (osteoarthritis and quadriceps tendinitis) are given in Table 4. The mean of pelvic angle of control and case right side, and control and case left side are 7.979, 6.630, 7.532 and 7.721 degrees, respectively. It was found to be statistically significant ($P < 0.001$). Between the group comparison of control and case on the right side showed statistical significance ($P < 0.001$). But, between the group comparison of control and case on the left side did not show significance ($P = 1.0$). Within group comparison of right and left side of the control did not show significance ($P = 0.434$). But within group comparison of right and left side of the case showed statistical significance ($P < 0.001$) (Figure 4). This shows that the right-side pelvic angle is low in case compared to the control as well as the left side.

The mean and standard error of genu recurvatum of control and case (osteoarthritis and quadriceps tendinitis) are given in Table 4. The mean of genu recurvatum of control and case right side, and control and case left side are 29.24, 29.30, 29.17 and 29.31 degrees, respectively. It was not found to be statistically significant ($P = 0.938$). Between the group comparison of control and case on the right side, as well as on the left side did not show statistical significance ($P = 1.0$ and 1,0, respectively). Within the group comparison of the right and left side of the control as well as the case did not show significance ($P = 1.0$ and 1.0, respectively) (Figure 5). This shows that the genu recurvatum is not affected by osteoarthritis, and quadriceps tendinitis.

The mean and standard error of medial rotation of the hip of control and case (osteoarthritis and quadriceps tendinitis) are given in Table 4. The mean of medial rotation of the hip of control and case right side, and control and case left side are 61.55, 62.56, 61.86 and 62.03 degrees, respectively. It was not found to be statistically significant ($P = 0.846$). Between the group comparison of control and case on the right side, as well as on the left side did not show statistical significance ($P = 1.0$ and 1,0, respectively). Within the group comparison of the right and left side of the control as well as the case did not show significance ($P = 1.0$ and

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1.0, respectively) (Figure 6). This shows that the medial rotation of the hip is not affected by osteoarthritis, and quadriceps tendinitis.

The mean and standard error of lateral rotation of hip of control and case (osteoarthritis and quadriceps tendinitis) are given in Table 4. The mean of lateral rotation of hip of control and case right side, and control and case left side are 62.51, 60.98, 62.02 and 62.28 degrees, respectively. It was not found to be statistically significant (P = 0.561). Between the group comparison of control and case on the right side, as well as on the left side did not show statistical significance (P = 1.0 and 1,0, respectively). Within group comparison of right and left side of the control as well as the case did not show significance (P = 1.0 and 1.0, respectively) (Figure 7). This shows that the lateral rotation of hip is not affected by osteoarthritis, and quadriceps tendinitis.

Table 1: Demographic details of the participants in the control and case (osteoarthritis and quadriceps tendinitis)

Demographic details	**Control**	**Case (osteoarthritis and quadriceps tendinitis)**
Age (years)	51.42 ± 0.51	51.84±0.51
Gender- Male/Female	67/83	66/84
Hight (cm)	166.71±0.64	164.15±0.77
Weight (kg)	64.27±0.90	65.56±0.88
Body mass index	23.55±0.32	24.91±0.33
All the data were represented as Mean ± SE. (n=150)		

Table 2: Social history of the participants in the control and case (osteoarthritis and quadriceps tendinitis)

Social details	**Control (%)**		**Case (%) (osteoarthritis and quadriceps tendinitis)**	
	Male	Female	Male	Female
Teaching profession	20.4	22.3	22.4	24.2
Medical profession	26.0	28.5	24.0	20.8
Farmer profession	20.8	8.0	21.2	11.3
Housewives	0.0	20.0	0.0	18.2
IT Profession	20.2	19.7	19.2	22.5
Driving profession	12.6	1.5	13.2	3.0
All the data were represented as percentages (n=150)				

Table 3: Medication history of the participants in the control and case (osteoarthritis and quadriceps tendinitis)

Medication details	**Control (%)**		**Case (%) (osteoarthritis and quadriceps tendinitis)**	
	Male	Female	Male	Female

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On physiotherapy -Ultrasound therapy -Interferential therapy -Moist heat therapy	0.0	0.0	67.4	52.3
On calcium tablets	2.6	5.3	16.8	28.5
On anti-inflammatory and analgesic tablets	0.0	0.0	15.8	19.2
All the data were represented as percentage (n=150)				

Table 4: Relationship of lower extremity alignment parameters in control and case (osteoarthritis and quadriceps tendinitis)

Dependent variable	Control Right	Case Right	Control left	Case left
Pelvic angle (degrees)	7.97±0.19	6.63±0.12*	7.53±0.17	7.72±0.18#
Genu recurvatum, (degrees)	29.24±0.17	29.30±0.18	29.17±0.16	29.31±0.18
Medial rotation of hip	61.55±0.87	62.56±0.75	61.86±0.86	62.03±0.76
Lateral rotation of hip	62.51±0.91	60.98±0.76	62.02±0.88	62.28±0.74

All the data were represented as Mean ± SE. (n=150)

* Significantly different from the respective control (between group comparison).

Significantly different from the respective right side (within group comparison).

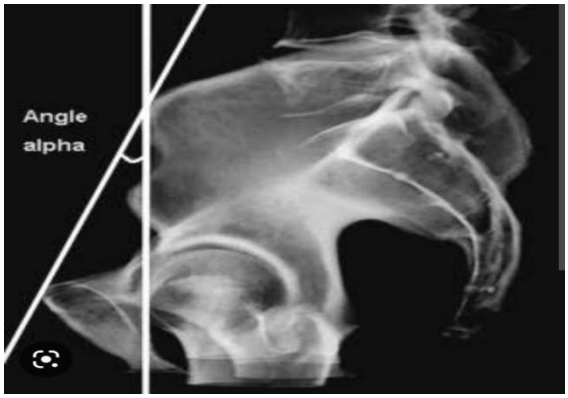

Figure 1: Measurement of pelvic angle

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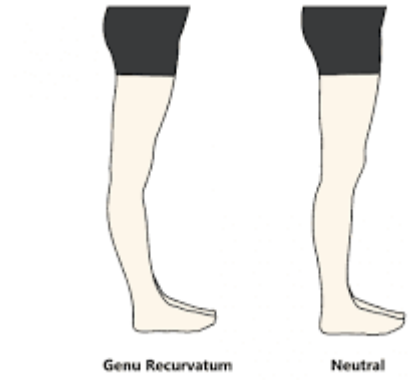

Figure 2: Measurement of genu recurvatum

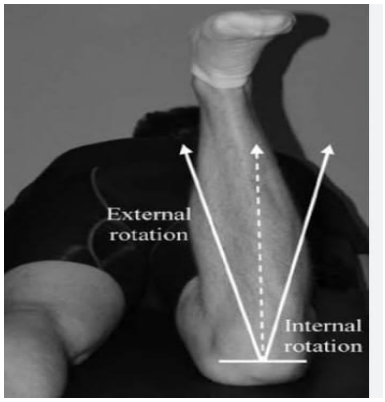

Figure 3: Measurement of lateral (external) rotation and medial (internal) rotation

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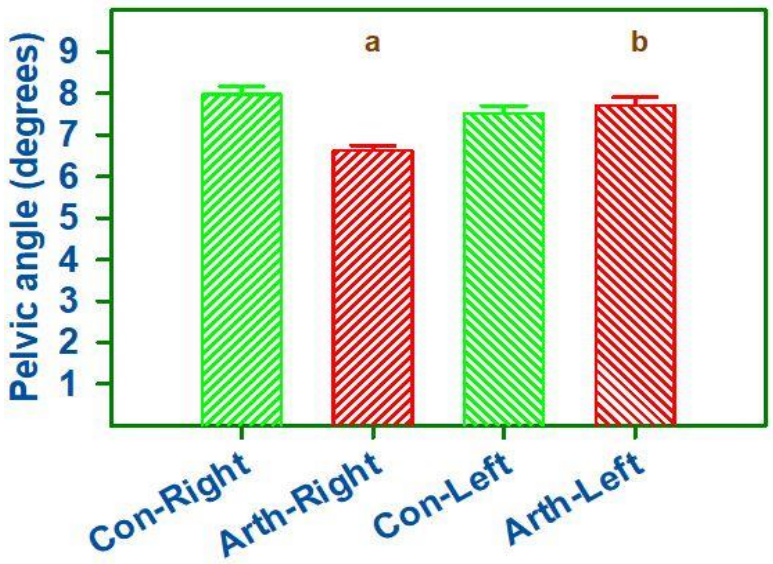

Figure 4: Comparison of right and left side of pelvic angle in control and cases (osteoarthritis and quadriceps tendinitis).
Values are mean + SE (n = 150 each). The data was analysed by one-way RM ANOVA with Bonferroni 't' test for multiple comparison.
[a] Significantly different from the respective control (between group comparison).
[b] Significantly different from the respective right side (within group comparison).

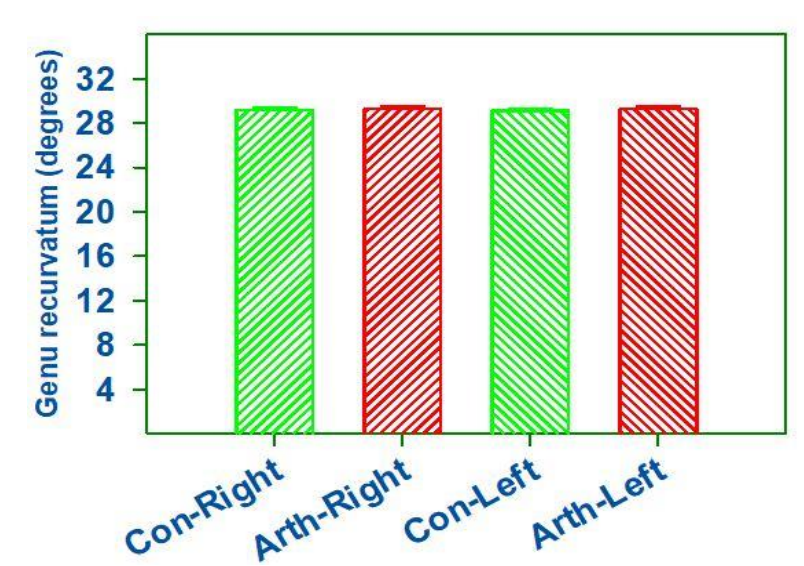

Figure 5: Comparison of right and left side of genu recurvatum in control and cases (osteoarthritis and quadriceps tendinitis).
Values are mean + SE (n = 150 each). The data was analysed by one-way RM ANOVA with Bonferroni 't' test for multiple comparison.

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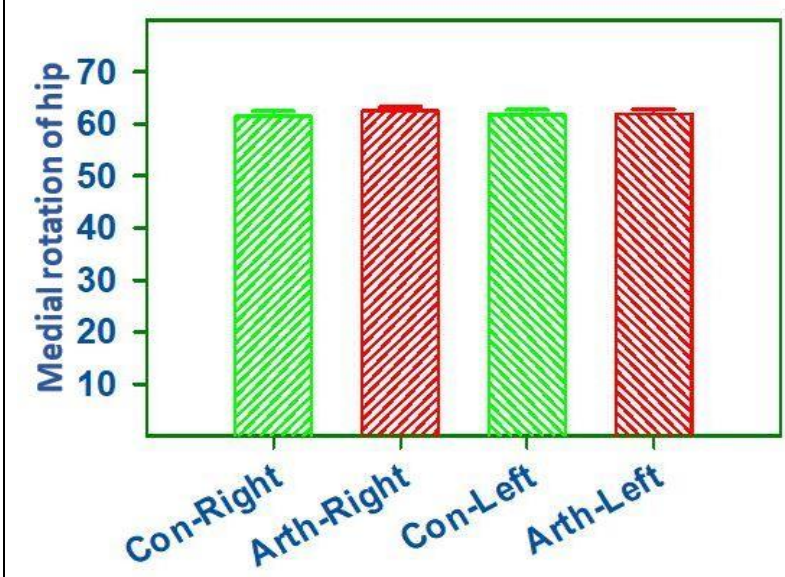

Figure 6: Comparison of right and left side of medial rotation of hip in control and cases (osteoarthritis and quadriceps tendinitis).
Values are mean + SE (n = 150 each). The data was analysed by one-way RM ANOVA with Bonferroni 't' test for multiple comparison.

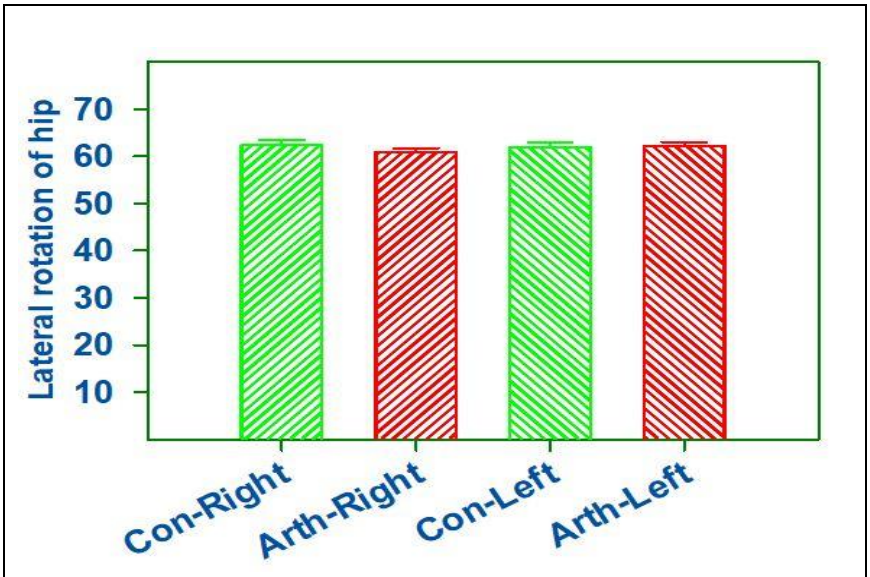

Figure 7: Comparison of right and left side of lateral rotation of hip in control and cases (osteoarthritis and quadriceps tendinitis).
Values are mean + SE (n = 150 each). The data was analysed by one-way RM ANOVA with Bonferroni 't' test for multiple comparison.

4. Discussion

The purpose of this study was to establish the relationship between lower extremity alignment-pelvic angle, genu recurvatum, lateral and medial rotation of the hip in osteoarthritis, and

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quadriceps tendinitis. The pelvic angle denotes the special orientation of the pelvis which varies according to the position. The pelvic angle is important in reducing back pain. They can usually be corrected with exercise and changes in sitting and sleep habits [18]. In the current study, the right-side pelvic angle is low in the case compared to the control as well as the left side. The osteoarthritis and quadriceps tendinitis conditions significantly affected the pelvic angle. This indicates that there was a direct relationship between osteoarthritis, quadriceps tendinitis and pelvic angle.

Genu recurvatum is hyperextension of the knee and is difficult to treat with prominent symptoms like pain, weakness, instability, leg length discrepancy and limited range of movement. Patellofemoral arthritis is the one cause where hyperextended knee gait due to pain and muscle weakness was seen. This development of genu recurvatum leads to knee osteoarthritis [19]. In the current study, genu recurvatum between the groups and within the groups of the case (osteoarthritis, quadriceps tendinitis) and control, showed no significant difference. Hence genu recurvatum was not affected by the osteoarthritis, quadriceps tendinitis conditions.

Medial and lateral rotation of the hip is very important in maintaining a good posture for long-term health. Medial rotation involves bringing the anatomical structure closer to the median plane, while lateral rotation involves moving it further away. When the femur rotates within the hip towards the midline of the body is called the medial rotation of the hip. When the femur rotates within the hip away from the midline of the body is called the lateral rotation of the hip. Medial and lateral rotation of the hip is important for walking, running and sports person [20]. In the current study, medial and lateral rotation of the hip between the groups and within the groups of the case (osteoarthritis and quadriceps tendinitis) and control, showed no significant difference. Hence medial and lateral rotation of the hip was not affected by the osteoarthritis, quadriceps tendinitis conditions.

5. Conclusion

The conclusion of the study was the lower extremity alignment-pelvic angle was significantly affected by the osteoarthritis and quadriceps tendinitis conditions which indicates there was a direct relationship between them. Lower extremity alignment- genu recurvatum, medial and lateral rotation of the hip was not affected by the osteoarthritis and quadriceps tendinitis conditions which showed there was no direct relationship between them.

Conflicts of interest

The author declares that there were no conflicts of interest.

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