BioBacta
Journal of Bioscience and Applied Research
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The Association of Anterior Pelvic Tilt Angle and Clinical Knee Outcomes among Patients with Patellofemoral Pain: A Cross-Sectional Study.

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DOI:10.21608/jbaar.2024.389599

Abstract

Background: Patellofemoral Pain (PFP) is a frequent musculoskeletal disorder that affects young active subjects and the public. A significant contributing component to the etiology of PFP is an alteration of the lower limb kinetic chain. **Purpose:** The study was conducted to determine if anterior pelvic tilt angle is correlated to pain intensity, functional impairment, and knee extensor muscle strength in patients with PFP. **Methods:** Forty patients were diagnosed with unilateral PFP (29 females and 11 males) with age between 18 and 35 years. Each patient was assessed for pain severity using the visual Analogue scale (VAS), functional disability using the Arabic version of the anterior knee pain scale (AKPS), knee extensor muscle strength with a hand-held dynamometer and pelvic tilting angle with Palpation Meter (PALM). Spearman's rank correlation coefficient test was conducted to evaluate the relationship between these clinical measures. **Results:** There was a statistically significant moderate positive correlation between anterior pelvic tilt angle and pain (r= 0.409; p= 0.009). However, there was no statistically significant relationship seen between the anterior pelvic tilt angle and knee extensor strength (r= -0.068; p= 0.677) and function (r= -0.088; p= 0.588).

Conclusions: Anterior pelvic tilt angle affects the pain intensity in patients with PFP while has no impact on knee function or strength of knee extensors. Anterior pelvic tilt angle may be one of the risk factors that makes PFP more common.

Keywords: Anterior knee pain, Patellofemoral pain, Pelvic tilt, Quadriceps strength.

Introduction

Patellofemoral pain (PFP) is an overuse musculoskeletal disorder defined by a persistent, excruciating pain around the patella that gets worse when a person bends his/her knees for an extended period, squats, or climbs stairs. Patellofemoral pain has a complicated etiology [1], which makes it difficult to identify the cause or factors that can be addressed by rehabilitation [2].

Patellofemoral pain is believed to impact the general population, particularly young active people [3]. Nonetheless, an estimated two to three times higher occurrence of females than males. This prevalence rate has been linked to gender variations in anatomy

Received: July 27, 2024. Accepted: October 3, 2024. Published: October 29, 2024

and biomechanics, which increases the risk of PFP in women [4].

Previous research indicated that the etiology of PFP is multifactorial when there is no direct trauma. It has also been suggested that proximal factors, such as weak hip muscles and hip, pelvis, and trunk alignment and mobility, and factors distal to the knee, such as over pronation of foot, ankle, and foot mobility and intrinsic foot muscles, as well as tibialis posterior weakness in addition to those directly related to the patellofemoral joint, may contribute to patellofemoral improper alignment and the development of PFP [5].

The pelvis acts as a regulator and compensatory mechanism between the spine and the lower extremities, as well as contributing to the development of PFP [6]. Anterior pelvic tilt and increased lumbar lordosis alter the lower extremity's kinetic chain by allowing for increased femoral internal rotation. Changes in the orientation of hip abductor muscle fibers to the femoral head cause them to serve as a strong internal rotator of the hip during functional tasks. The higher the femoral internal rotation, the more PFP development [7–9].

Patellofemoral pain is attributed to soft tissue tightness, weak quadriceps muscles, incongruity between patella and femoral groove, weak vastus medialis oblique, imbalance ratio of vastus medialis/vastus lateralis, and poor joint alignment [10,11]. Besides that lower extremity, structural and biomechanical alterations, movement quality, and psychological difficulties all affect patients' functional capacity and the development of PFP [12]. Patients with PFP experience pain and function restrictions, leading to higher stress and fear-avoidance thoughts about jobs and outdoor pursuits, particularly in those with greater physical function restrictions [13].

It has been revealed that quadriceps strength significantly predicts the subjective function of PFP individuals. It was additionally discovered that individuals with PFP who had stronger quadriceps also reported having greater subjective functions [14]. Patients with unilateral PFP have decreased torque, total volume, and cross-sectional area of the quadriceps muscle compared to the asymptomatic side [15]. Traditional rehabilitation programs for muscle weakness, like PFP, are challenging due to poor results [14]. Recent research suggests isokinetic muscle strengthening to increase knee extensor strength and flexibility and improve joint mobility, pain sensitivity, and worth of life [16].

In the current research, a desire is made to ascertain how anterior pelvic tilt angle is related to pain, patient function, and knee extensor strength in patients with PFP. To the best of the author's knowledge, until now, no study has thoroughly assessed these clinical knee measures together. Thus, it is anticipated that the anterior pelvic tilt angle would not correlate with knee pain, functional outcomes, or knee extensor strength.

Materials and Methods

Study design

This was a single-blinded cross-sectional study enrolling forty individuals aged from 18 to 35 years who were diagnosed with PFP and referred by an orthopedic surgeon.

Subjects

Forty patients (29 females and 11 males) suffered from PFP associated with anterior pelvic tilt. Informed consent was obtained in writing from each patient before they were enrolled in the study, and they were also given a rundown of all study procedures. The study was carried out from September 2023 to April 2024 at the Faculty of Physical Therapy, Cairo University, Egypt, in the Outpatient Orthopedic Physical Therapy Clinic. It has adhered to the ethical guidelines outlined in the Declaration of Helsinki for human research and has been approved by the institutional review board of the Faculty of Physical Therapy (P.T.REC/012/003947).

The following inclusion criteria were used to choose the patients: age from 18 to 35 years [17], Anterior or retro-patellar knee pain remaining for a minimum of six weeks [18], pain induced from at least 2 of the following activities: Prolonged sitting; stair climbing; squat-ting; running; kneeling; and hopping/jumping [19], and anterior pelvic tilt angle more of than 8 degrees [20]. Patients with a BMI ≥ 30 and a history of osteoarthritis in the knee, ankle, and hip joints, meniscal or other intra-articular pathologic diseases, involvement of the cruciate or collateral ligaments, a history of severe patellar subluxation or dislocation, or prior surgery in these joints were excluded [19].

Assessment Procedures of the Knee Clinical Measures

The researcher met patients and explained the specifics of the study and its significance. After confirming the diagnosis of PFP, demographic data were taken age, gender, predominant lower limb, affected lower limb, weight, and height to measure body mass index, using the equation [weight (kg)/height (m2)]. The following measurements were employed by a blind assessor who was unaware of the study's purpose:

1. Assessment of pelvic tilt angle from the sagittal plane using a Palpation meter (PALM)

Two caliper arms and an inclinometer make up the PALM. The bubble inclinometer is a semicircular arc on either side of the midline, with one-degree gradations ranging from 0 to 30. After being instructed to march in place ten times, each patient stood with their arms crossed over their chests. The researcher instructed patients to assume an erect posture, placing their feet on a platform that was 30 centimeters wide, and to look straight ahead to check for postural sway. The examiner then palpated the anterior and posterior iliac spines, placing the ends of the PALM's arms on them to determine the angle of pelvic tilting in the sagittal plane [21]. Following the collection of three readings, the mean value was presented as the final score. (Fig.3).

The interclass correlation coefficient suggests that intra-rater reliability was high for sagittal plane measurements (0.98), on the other hand, the inter-rater reliability was also high for sagittal plane measurements (0.89) [22,23].

Fig.1: Assessment of pelvic tilt angle from the sagittal plane using PALM.

2. Assessment of pain using Visual Analogue Scale (VAS)

The validity, responsiveness, and reliability of the 10-cm VAS have been assessed for evaluations of "usual" and "worst" pain [24,25]. The patient's discomfort during the past week was assessed using a 10-cm VAS, where zero represents no pain and 10 represents the greatest suffering possible. It has been demonstrated that this assessment technique is valid and dependable for determining pain [25,26]. The patients marked their amount of discomfort on the line, and a ruler was used to convert their marks into a number for additional analysis. According to evaluations of the lowest clinically significant difference for the VAS, improvement has to be seen at a change of 1.5 to 2.0 cm (15%–20%) [27].

3. Assessment of knee function by the Arabic version of the Anterior Knee Pain Scale (AKPS).

The Anterior Knee Pain Scale is a self-reporting instrument that has 13 questions that are unique to the knee [28]. Patients' responses to six functional activities: walking, jogging, leaping, running, ascending stairs, squatting, and prolonged sitting were recorded. Additionally, it gathered comparable signs that are connected to a range of clinical and functional results linked to anterior knee pain. The questionnaire was given to the patient, and the responses were scored on a range of zero to 100, with pain and disability receiving the lowest score. The Arabic AKPS is a trustworthy and legitimate patient-reported outcome indicator for those who speak Arabic with anterior knee pain and PFP, making it the initial knee outcome metric to be approved [29].

4. Assessment of knee extensor muscle strength by Handheld Dynamometer.

The hand-held dynamometer is a dependable and accurate tool used in the evaluation of muscle strength [30]. To measure knee extensor strength, the patient sat with his or her hips and knees flexed to a 90-degree angle and a belt around his or her thigh to fix it. Then, near the ankle joint, on the front of the distal part of the leg, was where the dynamometer was placed. After that, the patient was instructed to contract the knee extensors as much as possible isometrically [30]. Each patient completed two submaximal trials to acquaint themselves with the procedures; following that, they completed three maximum isometric effort trials. 30-second intervals separated the trials after the 5-second contraction [31]. (Fig.2).

Fig.2: Assessment of knee extensors muscle strength.

Statistical analysis

The sample size was determined based on the presumption that there is a substantial positive link between anterior pelvic angle and pain (VAS) in the studied group, with $\alpha = 0.05$, one-sided, power of 80%, and correlation coefficient equal to 0.415. Thus, a sample size would need to be expanded from thirty-four to forty patients to account for a 15% dropout rate (G Power 301). (http: www.psycho.uni-duesseldorf.de).

Findings were reported as minimum, maximum, mean ± standard deviation, or number (%). The test of normality, the Kolmogorov-Smirnov test, was employed to measure the data's distribution. Data were not normally distributed, so the correlation between pelvic tilt angle and different studied parameters was performed using Spearman's rank correlation coefficient test. Statistical analysis was performed using the SPSS computer program (version 19 Windows). P value ≤ 0.05 was considered significant.

Results:

The age of the studied group ranged from 19 to 30 years, with a mean value (± SD) equal to 21.98 ± 1.83 years. Of them, 11 (27.5%) were men and twenty-nine (72.5%) were women. Their BMI ranged from 19 to 27 kg/m2, with a mean value (± SD) equal to 23.34 ± 2.31 kg/m^2. All of them were right dominance [40 (100%)]. Left and right affected sides were [16 (40%)] and [24 (60%)], respectively. Their pain varied from 5 to 9, with a mean value (± SD) equal to 5.98 ± 1.12. Their function (AKPS) ranged from 50 to 87, with a mean value (± SD) equal to 75.68 ± 8.52. Their knee extensor strength varied from 13.1 to 18.44, with a mean value (± SD) equal to 15.38 ± 1.44. Their anterior pelvic angle ranged from 10.0 to 13.87, with a mean value (± SD) equal to 12.32 ± 1.04 (Table. 1).

The anterior pelvic angle and pain (VAS) showed a statistically significant, moderately favorable association (r= 0.409; p= 0.009). There was no statistically significant correlation between anterior pelvic angle and both function (AKPS) (r= -0.088; p= 0.588) and knee extensor strength (r= -0.068; p= 0.677) (Table 2; Fig.3).

Table 1: Demographic and clinical findings of the studied group.

	Cases (n= 40)
Age (years)	
Min.-max.	19-30
Mean ± SD	21.98 ± 1.83
Gender	
Female	29 (72.5%)
Male	11 (27.5%
BMI (kg/m^2)	
Min.-max.	19 – 27
Mean ± SD	23.34 ± 2.31
Dominant (Rt.)	40 (100%)
Affected side	
Left	16 (40.0%)
Right	24 (60.0%)
Pain (VAS)	
Min.-max.	5-9
Mean ± SD	5.98 ± 1.12
Function (AKPS)	
Min.-max.	50-87
Mean ± SD	75.68 ± 8.52
Knee extensor strength	
Min.-max.	13.1-18.44
Mean ± SD	15.38 ± 1.44
Anterior pelvic angle	
Min.-max.	10.0 -13.87
Mean ± SD	12.32 ± 1.04

Data are expressed as minimum, maximum, mean ± SD or number (%), BMI: body mass index, VAS: visual Analogue scale, AKPS: anterior knee pain scale.

Table 2: Correlation between pain anterior pelvic tilt angle and different studied clinical knee measures in the studied group.

	Anterior pelvic tilt angle	
	Correlation coefficient (r)	***p-value***
Pain (VAS)	0.409	0.009*
Function (AKPS)	-0.088	0.588
Knee extensor strength	-0.068	0.677

r= Spearman's rank correlation coefficient. p> 0.05= not significant; p≤ 0.05= significant, VAS: visual Analogue scale, AKPS: anterior knee pain scale.

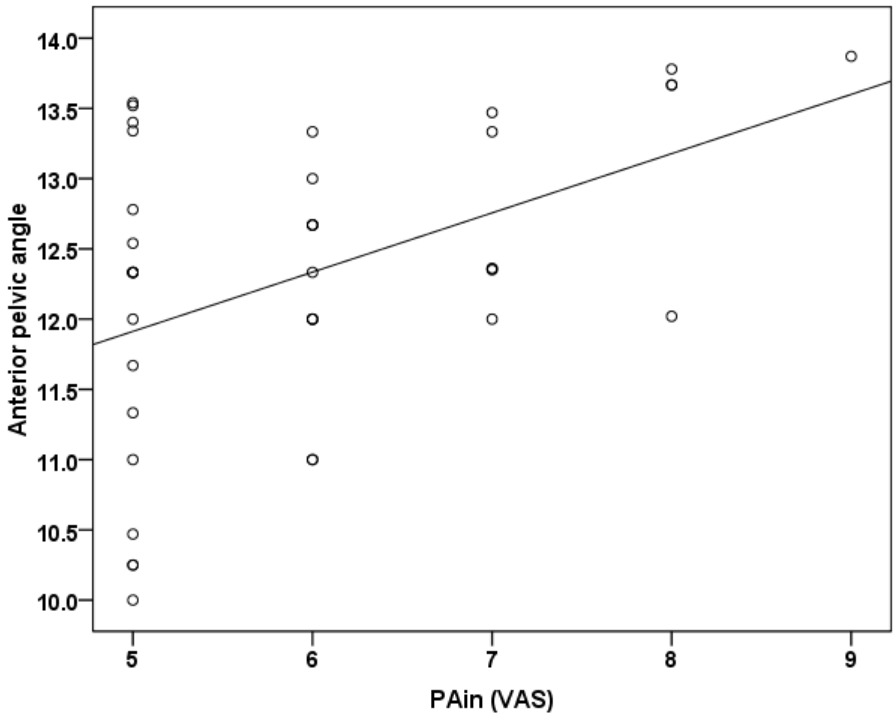

Fig.3: Correlation between anterior pelvic angle and pain (VAS) in the studied group (r= 0409; p= 0.009).

Discussion

The aim of this research was to examine the relationship between anterior pelvic tilt angle and pain levels, functional capacity, and knee extensor strength in patients with PFP. The findings of the current study revealed that there is a moderate positive correlation between anterior pelvic angle and pain; however, there is no relationship between anterior pelvic tilt angle with functional level or knee extensor strength.

Pain

Our findings concur with prior research that reported a moderate correlation between pelvic tilt and pain intensity in women with PFP [32]. However, researchers studied the relationship between spine alignment mainly, lumbar spine, and knee pain and mechanics and called it knee-spine syndrome; they reported that reduced lumbar lordosis, sacral inclination, and sagittal pelvic tilt at the spine's level compensates for increased knee discomfort brought on by degenerative changes that impair knee function in old age patients [33]. This contradiction may be due to the degenerative changes with aging; thus, it is challenging to extrapolate these findings to all age groups. Moreover, previous literature examined the relationship between anterior knee discomfort and morphological alterations in the hip bones and found that changes in the lateral inclination of the pelvis affect the pain level in patients with PFP, possibly, because of iliotibial tract and tensor fasciae latae tightness and gluteal muscles weakness [34].

Function

A prior study investigated the relationship between lower limb static alignment and PFP and found that there was no correlation between pelvic angle and PFP patients' functional abilities [19], This finding supports the current research. In contrast, a previous study determined whether spinopelvic characteristics and functional impairment are correlated in female PFP patients and found a weak inverse correlation of pelvic tilt angle with functional level scores [32]. The functional level contradiction could be explained by the reason that the prior study only contained one gender in its sample.

Knee extensors strength

The relationship between anterior pelvic tilt angle and knee extensors strength, previous research supports our findings as it has demonstrated the influences of pelvic tilt angle changes (anterior, neutral, and posterior) on ultimate hip and knee muscle strength and antagonist/agonist strength ratios and found that the highest hip extensor torque was considerably higher in the anterior pelvic tilt angle while the hip flexor-to-extensor torque ratio reduced. On the other hand, changing pelvic tilt did not influence the results for the hip flexor, knee flexor, or knee extension [35].

A study showed that thoracic kyphosis negatively correlates with back muscle power and fractures of vertebrae, while knee extensor power positively correlates with pelvic tilt, contradicting the findings of this research [36]. This disagreement is most likely a result of reported decreased hamstring stiffness in their recruited patients.

Earlier research had emphasized the link between anterior pelvic tilt angle and hip muscle strength [37,38]; however, it had not addressed the indirect link between the anterior pelvic tilt angle and knee extensor strength; therefore, this was the current study's concern.

A large sample size from both genders is needed to generalize the results. This study was confined to the evaluation of pain, function, and knee extensor strength in patients with PFP who exhibit anterior pelvic tilt. Further future research is required to examine additional clinical symptoms and outcomes, such as hip muscle strength, proprioception, and knee ROM, besides different pelvic alignments.

Conclusion

There is a positive correlation between anterior pelvic tilt angle and pain severity in patients with PFP. Pelvic measures should be taken into consideration while evaluating individuals whose symptoms persist for a long period of time.

Author contributions

The above authors have all given their approval for the work to be published and have contributed significantly, directly, and intellectually.

Conflicts of interest

The authors have reported no potential conflicts of interest.

Funding

There was no external funding for this study.

List of abbreviations

PFP: Patellofemoral pain

ROM: range of motion

BMI: body mass index

AKPS: anterior knee pain scale

PALM: palpation meter

SD: standard deviation

VAS: visual Analogue scale

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