

## Original Research Article

# Correlation of rearfoot angle to Q-angle in patellofemoral pain syndrome: a prospective study

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### ABSTRACT

**Background:** Objective of the study was to evaluate the correlation between rearfoot posture to Q-angle in patients with patellofemoral pain syndrome.

**Methods:** This is a two-year prospective observational study in which all patients with patellofemoral pain syndrome in the age group of 20-30 years were included in the study. The static Q-angle and the rearfoot angles of these subjects were measured and analyzed statistically for their correlation.

**Results:** There were sixty patients who fulfilled the inclusion criteria of the study. Pearson product moment correlation showed 27% subjects having rearfoot valgus and 73% having rearfoot varus angle. T test showed statistically significant Q-angle for rearfoot varus compared to rearfoot valgus.

**Conclusions:** Rearfoot varus is more commonly associated with patellofemoral pain syndrome. The Q-angle increases in both rearfoot varus and valgus but is significantly more in patients with rearfoot varus.

**Keywords:** Rearfoot varus, Q-angle, Patellofemoral pain

### INTRODUCTION

Anterior knee pain is a common complaint encountered by health professionals.<sup>1</sup> Young and physically active adult women are affected more than twice as compared to men.<sup>2</sup> Patellofemoral pain syndrome (PFPS) is a common cause for anterior knee pain and predominantly affect young females without significantly increased Q-angle or articular cartilage pathologies.<sup>1,3</sup> The etiology of PFPS is multifactorial with involvement of various functional disorders of the lower leg and foot malalignment.<sup>4</sup> There are no gold standard tests or clinical methods to diagnose PFPS but a set of clinical measurements confirm the diagnosis of this dysfunction.<sup>5</sup> Besides being costly, quantitative dynamic evaluations of lower extremity

alignment are not readily available in clinical practice. Hence static clinical measurements of lower limb misalignments are commonly used in PFPS examination.<sup>5</sup> Rearfoot alignments and static Q-angle measurements are commonly evaluated in individuals with PFPS.<sup>5</sup> Abnormalities of bones of the rearfoot cause compensatory motion at the subtalar joint to attain normal function of the lower leg and foot during gait cycle. Excessive pronation of the subtalar joint leads to patellofemoral disorders.<sup>6</sup> Excessive subtalar joint pronation inhibits supination of foot and leads to abnormal internal rotation of tibia and hence maltracking of patella.<sup>7</sup>

There is controversy regarding the rearfoot posture and its contribution to PFPS.<sup>5</sup> Some studies demonstrate no significant correlation of foot type and PFPS while others show rearfoot varus posture in PFPS subjects.

Therefore the current study was aimed to evaluate clinically the correlation between clinical static rearfoot angles to Q-angle in subjects with PFPS.

**METHODS**

In this study, 60 young female patients in the age group of 20-30 years presenting to the Laxmi Memorial Physiotherapy Outpatient Clinic from June 2008 to May 2010 with symptoms of patellofemoral pain were included. Informed consent was obtained followed by demographic data from each subject. An ethical clearance was obtained from the institution. Patients with retropatellar pain atleast for a period of one month, pain atleast 3 or more out of 10 on a visual analog score and pain on patellar grinding test were included in the study. Patients with knee osteoarthritis, dislocation or subluxation of patella, generalized ligamentous laxity and previous history of surgery on the same knee were excluded from the study.

A marker pen, a goniometer and a ruler were used in the measurement of Q angle and rearfoot angle.

The Q-angle was measured with the patient in supine position and quadriceps relaxed. The anterior superior iliac spine, the center of patella and the tibial tuberosity were marked. A line was drawn from center of patella to the tibial tuberosity; this was the first line. Another line was drawn from the center of patella to the anterior superior iliac spine; this was the second line. The first line was extended proximally over the distal thigh and the angle was measured between the first and the second line using a universal goniometer.

The rearfoot angle was measured with the patient in prone position with the ankle and foot overhanging the edge of the table. The neutral position of the subtalar joint was identified. The posterior surface of the calcaneum was noted to be parallel to the floor. The navicular tuberosity which is 1 inch below and 1 inch distal to the medial malleolus was located. The thumb was placed just proximal to the navicular tuberosity. The 4<sup>th</sup> and 5<sup>th</sup> metatarsal heads were grasped and the foot was pronated and supinated. During pronation the head of the talus should contact the thumb, while during supination it should disappear. During pronation the sulcus was noted on the lateral aspect that anatomically represents the sinus tarsi and the location of the talar head during supination. The index finger was placed over this region, which is lateral and generally more anterior than the region of thumb. The foot was supinated and pronated again and the head of talus was palpated with the thumb and index finger in place. With a fine skin marker, the middle of the posterior calcaneus was marked. The distal one third of

the lower extremity just proximal to the malleoli was bisected. Extension of this line superiorly should bisect the knee joint within the popliteal space.

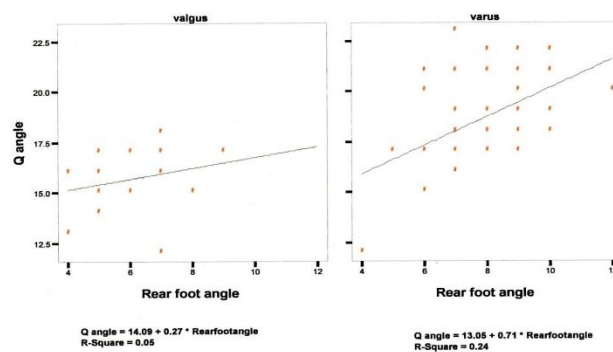
The subtalar joint neutral was maintained in neutral and the angle formed by the longitudinal midline of the posterior calcaneus and the line drawn on the posterior lower leg was measured and noted for rearfoot neutral, varus and valgus angles. p value <0.05 was considered as statistically significant.

**RESULTS**

A total of 60 subjects with patellofemoral pain were selected for the study and the Q angle and rear foot angles were measured. The age of the patients ranged from 20 to 30 years (mean age 25.7 years). All the subjects selected were males. The Q-angle and rearfoot angles were correlated. Rearfoot varus angle was noted in 44 patients and rearfoot valgus angle in 16 patients. Mean Q-angle for rearfoot valgus was 15.69° (SD 1.62°) whereas that for rearfoot varus was 18.8° (SD 2.4°). Q-angle was significantly less for rearfoot valgus than rearfoot varus (Figure 1). The mean rearfoot valgus angle for Q-angle was 6° (SD 1.4°) and the mean rearfoot varus angle for Q-angle was 8.07° (SD 1.6°). Hence rearfoot varus angle was significantly more for Q-angle (Figure 2).

**Table 1: Demographic data of patients involved.**

<b>Number of subjects involved</b>	60
<b>Mean age of subjects</b>	25.7 years
<b>Rearfoot varus</b>	44 subjects (73.33%)
<b>Rearfoot valgus</b>	16 subjects (26.67%)
<b>Mean Q-angle for rearfoot varus subjects</b>	18.8° (SD 2.4°)
<b>Mean Q-angle for rearfoot valgus subjects</b>	15.69° (SD 1.62°)
<b>Mean rearfoot varus angle for Q-angle</b>	8.07° (SD 1.6°)
<b>Mean rearfoot valgus angle for Q-angle</b>	6° (SD 1.4°)



**Figure 1: Correlation of Q-angle to rearfoot angle (in foot valgus and varus).**

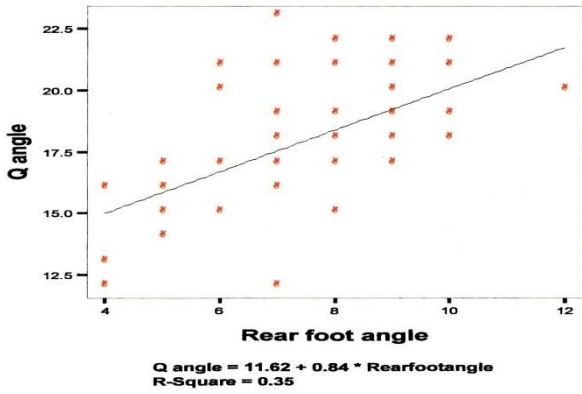


Figure 2: Rearfoot angle correlation in Q-angle.

Table 2: Correlation of Q-angle to rearfoot varus and valgus angle.

	R value	p	
Q-angle to rearfoot Valgus angle	0.233	0.046	Sig
Q-angle to rearfoot Varus angle	0.486	0.001	HS

Table 3: Rearfoot angle correlation in Q-angle.

	R value	p	
Rearfoot angle to Q-angle	0.590	0.000	HS

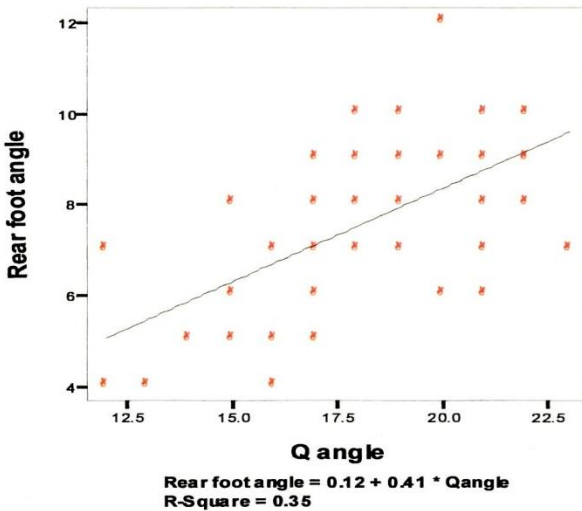


Figure 3: Q-angle correlation in rearfoot angle.

According to Pearson product moment correlation (R value), in rearfoot valgus, Q-angle and rearfoot angle significantly correlated with R=0.233. Hence regression equation was obtained as Q angle =14.09+0.27×rearfoot angle (Table 2). In rearfoot varus, Q angle and rearfoot angle was significantly correlated with R=0.486. Hence regression equation was obtained as Q angle =13.05+0.71×rearfoot angle (Table 2). In Q angle, rearfoot angle is significantly correlated with R =0.590.

Hence regression equation was obtained as Q angle =11.62+0.84×rearfoot angle (Table 3). In rearfoot angle, Q-angle is significantly correlated with r =0.590. Hence regression equation was obtained as rearfoot angle =0.12+0.41×Q-angle (Figure 3).

**DISCUSSION**

Patellofemoral pain syndrome is a common cause of anterior knee pain specially in young females.<sup>2</sup> The pathogenesis of PFPS is multifactorial with the involvement of functional disorders of lower extremity.<sup>8</sup> Maltracking of patella plays a key role in the emergence of PFPS.<sup>8</sup> Delayed activation of vastus medial muscle was also correlated to maltracking of patella. Increased Q-angle is associated with PFPS.<sup>10,11</sup> Abnormalities of bones of the rearfoot cause compensatory motion at the subtalar joint to attain normal function of the lower leg and foot during gait cycle. Excessive pronation of the subtalar joint leads to patellofemoral disorders.<sup>6</sup> Delayed timing of peak rearfoot eversion, increased rearfoot eversion at heel strike and reduced rearfoot eversion angle have been shown to be present in PFPS patients.<sup>8</sup> According to Mc Poil et al rear foot varus is the most common osseus deformity of the foot.<sup>12</sup> This suggests that a higher incidence of rear foot varus deformity may exist in patellofemoral pain population compared with normal subjects. Our study also showed a higher incidence of rearfoot varus in PFPS patients. Previous studies shows that there will be changes in the Q angle according to the alterations in foot positions.<sup>12</sup> The rearfoot varus is the most common osseous deformity seen in foot. Rearfoot varus can also be described as rear foot supination. An active calcaneal inversion and the leg external rotation always indicate supination in this height of the medial longitudinal arch is increased. So in rearfoot varus the tibia rotates externally. External tibial rotation has been associated with a variety of patellofemoral dysfunctions. During external tibial rotation, when the tibial tuberosity moves laterally, the patellar tendon functions to pull on the distal pole of the patella laterally, thus rotating the superior aspect of the patella medially about the center of the patella, thus increasing the Q-angle. Our study also showed a statistically significant rearfoot varus angle for Q-angle in PFPS patients. Also, this study demonstrated higher Q-angle in patients with rearfoot varus. Rearfoot valgus is a less common osseous deformity. Root suggested that the “ideal foot ”should be when the subtalar joint neutral position is aligned or parallel with the bisection line of the distal lower leg.<sup>12</sup> However, some investigators reported varus position of the calcaneus with values of 2°-8° to be normal, and therefore do not conform to the theoretical concept of the “ideal foot”. According to Root's clinical observation, in rear foot valgus there will be an active calcaneal eversion which indicates ongoing pronation; this causes internal rotation of the leg.<sup>13</sup> Subotnick suggested, based on the anatomical congruency between the talus and tibia, increased tibial internal rotation will accompany the increased rearfoot

eversion.<sup>14</sup> This internal rotation of tibia moves the tibial tuberosity medially thus reduces the Q-angle. According to Tiberio D, excessive internal rotation of the tibia transmits abnormal forces upward in the kinetic chain and produces medial knee stresses, force vector changes of the quadriceps mechanism, and lateral tracking of the patella.<sup>15</sup> This increases the Q-angle but this may depend on the amount of internal rotation of the tibia. The statistical analysis of this study shows an increased Q-angle for rear foot valgus also but the Q-angle is relatively less than that of rearfoot valgus.

## CONCLUSION

Rearfoot varus is more commonly associated with patellofemoral pain syndrome. The Q-angle increases in both rearfoot varus and valgus but is significantly more in patients with rearfoot varus.

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