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Studying the Relationship between Leg Deformities and Patellafemoral Pain Syndrome in Athletes

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Abstract

We examined leg length difference (LLD), varus and valgus knee and foot deformities in athletes with and without patellofemoral pain syndrome (PFPS). Twenty three healthy participants (seven women and 16 men) and 15 participants (three women and 12 men) with PFPS aged 20-30 participated in the study. Leg length difference, genu varum, genu valgum, foot pronation and flat foot were measured and the groups were compared. No significant differences were found in LLD, genu varum, genu valgum, foot pronation and flat foot between the two groups. Our findings suggest that abnormal biomechanics of lower limb do not increase the risk of PFPS.

Keywords: Patellofemoral pain syndrome; leg length difference; lower leg malalignment; knee deformities.

Introduction

Disorders of the patellofemoral joint continue to be some of the most perplexing pathologic conditions in orthopedic and sports medicine [1]. Patellofemoral pain syndrome (PFPS) appears as diffuse anterior or retropatellar knee pain in the absence of other pathology exacerbated by activities such as stair climbing, prolonged sitting, squatting and kneeling [2]. Generally, one out of four persons will likely experience PFPS at some time [3, 4]. Although PFPS presents the most common knee problem, the etiology of this pain syndrome remains vague and controversial [5, 6, 7]. A commonly accepted assumption concerning the etiology of PFPS is related to increased patellofemoral joint stress and subsequent articular cartilage wear [8]. Eng stated that abnormal patellofemoral mechanics and anatomical variations throughout the entire lower extremities cause malalignment of the patellofemoral joint [9]. Some abnormal biomechanics and anatomic risk factors may be associated with overuse injuries [10, 11]. Common abnormalities include leg length discrepancies, excessive rearfoot pronation, poor flexibility, inadequate pelvic control, genu varum, genu valgum, excessive quadriceps angle, and genu recurvatum [1, 8].

Leg length discrepancy (LLD) is defined as a condition in which paired legs are noticeably unequal [12]. Several authors have found that LLD created significant changes in gait such as increased ground reaction forces, increased energy consumption and increased lower extremity kinetic energy [13, 14]. LLD is thought to contribute to the occurrence of many clinical syndromes such as low back pain, scoliosis and a variety of running injuries [15].

Excessive foot pronation is a risk factor contributing to alterations in lower-extremity kinematics and musculoskeletal injury [16]. Excessive foot pronation during the stance phase can alter the normal rotation of the tibia in the frontal and transverse planes as a result of anatomical incongruence of the talus within the ankle mortise. In turn, aberrant tibial rotation can disrupt the normal patellofemoral relationship [9].

The purpose of this investigation was to determine whether LLD, genu varum, genu valgum, foot pronation, flat foot and high arch foot are the risk factors of PFPS.

Methods

Participants

Participation in the study was voluntarily. Participants were placed in an experimental group (N=15) or a control group (N=23) based on the presence or absence of symptoms of PFPS (in one or both knees), respectively. All participants must

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show no evidence of any other specific pathological conditions. The control group comprised both genders with a mean age of 25.2 ± 3.2 years, height of 1.77± 0.08 meters, and weight of 71.87± 11.98 kg. They were healthy and athletic, reporting no history of knee injury.

The experimental group comprised women and men with a mean age of 25 ± 4.3 years, height of 1.79± 0.12 meters, and weight of 78.13± 14.42 kg who had symptoms of PFPS . These symptoms comprised retropatellar pain during physical activities such as jumping, running, squatting, and going up or down stairs. Clinical criteria included pain upon direct compression of the patella against the femoral condyles with the knee in full extension, tenderness of the posterior surface of the patella on palpation, pain on resisted knee extension and pain with isometric quadriceps muscle contraction against suprapatellar resistance with the knee in 15° of flexion. The participants with signs or symptoms of meniscal, bursae, ligament laxity or tenderness, tenderness over the patellar tendon, illiotibial band, or pes anserinus tendons, patellar apprehension sign, patellar dislocation or previous knee surgery were excluded. Before beginning the study all participants read and signed an informed consent form.

Experimental procedure

Supine-long sitting test was used for measuring LLD. The standard procedure for the test is as follows. The patient lies supine while the therapist places his or her thumbs on the inferior borders of the medial malleoli to outline the position of the malleoli. The two malleoli are approximated to facilitate comparisons of their positions. The patient then sits up; he or she can use his or her hands if necessary but must push evenly with each hand to avoid shifting the pelvis. The therapist notes any change in the relationship of the malleoli. One leg appearing to lengthen in relationship to the other when the patient moves from supine to sitting, indicates posterior innominate rotation on that side. Conversely, one leg appearing to shorten in relationship to the other indicates an anterior innominate rotation on that side. One leg remaining consistently shorter or longer in relationship to the other indicates an anatomical leg-length difference [17].

The standing flexion test, prone knee flexion test and sitting PSIS test were also done. According to Cibulka et al. performing all these tests together has a high reliability [18]. The medial tibial intercondylar distance was measured as follows. The participant was instructed to stand naturally, with their legs together. Depending on the alignment of the knees, either the medial malleoli or the knees touched. For the participants in whom the malleoli touched (genu varum), the distance between the medial condyles of the tibias was measured to the nearest centimeter. If the knees touched (Genu valgum), the distance between the medial malleoli was measured to the nearest centimeter. If the distance between medial condyles of the tibias and the medial malleoli were both less than 1 cm, the knees were evaluated as normal [5, 19].

Rearfoot-to-leg orientation was used for evaluation of foot pronation. Participants were instructed to stand naturally, with the feet shoulder width apart. The angle between a longitude line bisecting the rearfoot (calcaneus) with the bisecting line of distal one-third of the lower leg was measured. The neutral posture was assumed 0°. A negative value of this angle represented pronation, whereas a positive value represented supination [20, 21].

The study of the plantar stance usually comprises the morphologic evaluation of the footprint. The footprint index is defined as the ratio of the non-contact to the contact areas of the toeless footprint. The non-contact area is the part between the medial borderline of the footprint and the medial footprint outline. The contact area is the area of the footprint without the toes [20]. A footprint can be defined as normal, when the print of the foot's isthmus, which is the middle part of the foot touching the ground along its lateral edge, is 1/3 of the forefoot's print. In a footprint of a flatfoot the isthmus is more than 1/3 of the forefoot's print, and in a footprint of a claw foot the isthmus is smaller than 1/3 of the forefoot's print [22].

Statistical analysis

A descriptive analysis was done. The two groups (i.e., experimental and control) were compared using Pearson's Chi-square Test. This test was performed using SPSS version 17.00 and statistical significant was set at 0.05.

Results

Leg length difference: Ten of the 15 participants in the experimental group with PFPS (67%) had LLD and the left leg was longer than the right leg in eight of the participants with LLD (53%). In the control group, 16 of 23 participants (70%) had LLD and the left leg was longer than the right leg in 7 of them (30%). No significant differences were identified in LLD between the participants with and without PFPS (p >0.05).

Varus and valgus knee deformity: Thirteen of the 15 participants in the experimental group (87%) demonstrated no knee deformities; only two participants (13%) had genu valgum and none of them showed genu varum. In the control group, 17 of the 23 participants (74%) had no knee deformities, three participants (13%) had genu valgum and three participants (13%) had genu varum. There were no differences in knee deformities between the participants with and without PFPS (p>0.05).

Foot pronation: Eight of the 15 participants (53%) and 15 of the 23 control participants (65%) had foot pronation and the rest of them had normal foot. No differences were demonstrated in foot pronation between the two groups (p >0.05).

Foot structure: Eight of the 15 participants with PFPS (53%) had flat foot and nine of the 23 healthy individuals (35%) were noted to have flat foot and the rest of participants and control group had a normal arch of foot. However, no differences were found between the two groups (p>0.05).

These results have been summarized in Table 1 and compared in Figure 1.

Table 1: The percentage of incidence of leg length discrepancy (LLD), varus and valgus knee deformity, excessive foot pronation and flat foot in the participants with and without PFPS.

Leg deformities	Patients	Control group
LLD	67%	70%
Genu valgum	13%	13%
Genu varum	0%	13%
Foot pronation	53%	65%
Flat foot	53%	35%

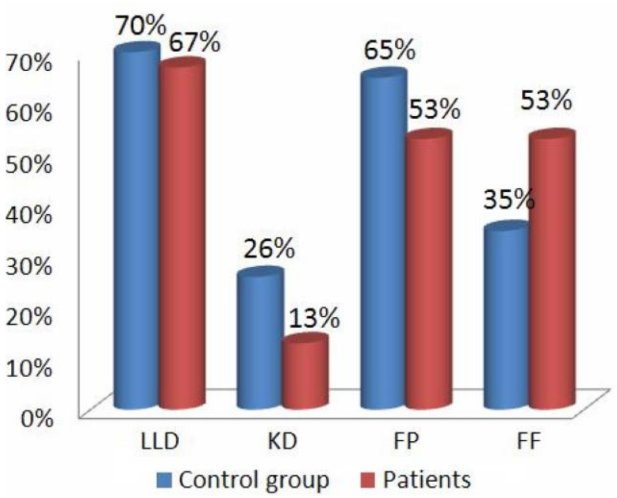

Figure 1: Comparison of indence of leg length discrepancy (LLD), Knee deformities (KD), foot pronation (FP) and flat foot (FF) in the patients with patellofemoral pain syndrome (PFPS) and control group.

Discussion

In the present study, LLD, genu varum, genu valgum, flat foot and foot pronation were investigated in participants with and without PFPS .We found that incidence of LLD in the experimental and control groups was almost the same; that is, 67% in the experimental and 70% in the control group. LLD is a risk factor for overuse injuries [23] and causes stress fracture, hip pain and low back pain [12, 24]. The civilian sports medicine literature suggests that the extremes of anatomic variation and malalignment of the lower extremities predispose runners and athletes to injury [25]. LLD may have several adverse effects on the lower extremity during running [26]. It may alter the pattern of mechanical stress within the joint and also affect muscle tension patterns around the joint [27]. Although there is a link between overuse injury and LLD, to our knowledge, no researcher has proved a positive correlation between LLD and PFPS. Only Kujala et al. indicated that LLD causes patellofemoral joint incongruency [28], although they did not illustrate directly the role of LLD on PFPS. Our finding is in agreement with the findings of several authors [5, 27, 29]. We also observed that incidence of LLD in the left leg of the experimental group was more than that in the control group; however no difference was observed between the two groups.

Genu varum and genu valgum are the other anatomic factors, which have been hypothesized to be associated with increased risk of injury among athletes. Lun et al. tested six patients with PFPS and they found that right knee genu varum is significantly different in injured and non-injured groups. However, they stated that the small number of cases and a lack of agreement between the injured side and significant side of alignment measurement make it difficult to determine which of the alignment measurements are clinically significant [30]. Tauton et al. demonstrated that among the patients with PFPS, 32% had genu varum and 29% had genu valgum [31]. Milgorm et al. revealed that the presence of genu varum had a significant correlation with the incidence of PFPS [32]. However, Douciette and Goble indicated that genu valgum is a factor which increases the tendency of the patella to displace laterally [33]. The results of the present study showed that among the participants who had knee deformities, the incidence of genu valgum was more than genu varum. However, there were no differences in genu varum or genu valgum between the experimental and the control groups.

Foot pronation has been recognized as a risk factor contributing to alterations in lower–extremity kinematics [16] and a cause for overuse running injuries [34]. There are a few studies that have examined the relation between foot pronation and PFPS. In the current study, no differences in pronation between the participants with and without PFPS were found. Messier et al. also found no differences in maximum pronation, maximum pronation velocity and total rearfoot movement in 36 evaluated runners (16 with PFPS and 20 controls) [29]. Powers and colleagues performed 3 dimensional motion analyses during self-selected free- and fast-walking velocities on 24 females with PFPS and 17 controls and found no group differences with respect to the magnitude and timing of peak foot pronation and tibia rotation [35]. Christopher suggested that according to the results of Powers and Messier, one cannot assume a cause-and-effect relationship between abnormal pronation and PFPS; however, it is entirely possible that certain individuals with PFPS may demonstrate abnormal foot pronation [36].

Although several studies suggested that excessive high or low arches of the foot are a factor of injury [23, 27], in the current study no differences was found in flat or high arch foot between the experimental and control groups. The incidence of flat foot in the experimental group was more than the control group; however, the difference was not significant. The result of our study is in agreement with the finding of Witvrow et al. who revealed no difference in the division of foot type between the students with and without PFPS [5]. In another research by Messier et al. with two groups (those with and without history of overuse injuries), it was shown that both groups had normal arched foot [29]. In contrast to our study, Duffey demonstrated that the anterior knee pain group had a higher arched foot relative to control group and that this position causes a more cavus and rigid foot that is less able to absorb shock [27].

Taken together, the results of the present study suggest that abnormal biomechanics of the lower limb may not cause PFPS; however, the individuals with PFPS may demonstrate one or more of the abnormal biomechanics. A few studies have been done about the relationship between abnormal biomechanics of lower limb and PFPS. The majority of studies have considered the relationship between overuse injuries and malalignment of the leg. Further research in this area may focus on PFPS.

Conclusion

This study provides no evidence that abnormal biomechanics of lower limb, such as LLD, genu varum, genu valgus, foot pronation, flat foot and high arched foot place individuals at risk of PSPS. Although this result is helpful for runners with abnormal biomechanics, further research is needed in order to clarify the actual consequences of these abnormalities.

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