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ORIGINAL ARTICLE

Comparison of Range of Motion of Knee and Hip in Athletes With and Without Patellofemoral Pain Syndrome

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Abstract: The aim of this study was to compare the range of motion of knee and hip in athletes with and without patellofemoral pain syndrome (PFPS). Twenty three healthy athletes (7 women, 16 men) and 15 athletes with PFPS (3 women, 12 men) ranging in age from 20 to 30 years took part in the current study. A bi-armed goniometer was used to measure range of motion of knee flexion and extension, and hip flexion, extension, abduction, adduction, internal and external rotation in the groups. No significant differences were demonstrated in range of motion of knee and hip between the patients with PFPS and control group (P>0.05). It may be assumed that athletes with PFPS had no restricted ROM of knee and hip joints in comparison to the control group.

Keywords: Patellofemoral Pain, Range of Motion, Lower Extremity, Goniometer.

Introduction

Patellofemoral pain syndrome (PFPS) is a common knee injury in athletes and in the general population. It accounts for 25% to 40% of all knee problems seen in sports medicine clinics (Roush & Wilson, 2000). Typical clinical presentation includes the complaint of anterior or retropatellar pain or pain along the medial and lateral borders of the patella. Symptoms are intensified by prolonged sitting, theoalong with activities requiring high levels of quadriceps activity, including running, squatting, and ascending and descending stairs (Wilk et al., 1998). Symptoms and pathology of PFPS are thought to be related to increased stress (pressure) at the patellofemoral articulation. The joint stress increases when either the joint force increases or the contact area between the patella and femur decreases. Although there is an increase in patellofemoral contact area as the knee flexes in weight-bearing activities (Lee & Csintalanl, 2003), the joint stress increases as a result of the greater relative increase in quadriceps force (Lee et al., 2003; Heino Brechter, 2002). Thus persons with PFPS frequently have pain with activities such as stair ascent and stair descent, which has been estimated to produce patellofemoral forces 3 to 7 times greater than the force measured during level walking (Lee & Csintalanl, 2003; Heino Brechter, 2002).

Because knee joint forces during lower limb activities are similar in persons with and without PFPS (Willson, 2008), a reduction in patellofemoral contact area is believed to be the major contributor to patellofemoral joint stress in persons with PFPS (Lee & Csintalanl, 2003). The position of the knee and the position of the hip are thought to have an effect on the orientation and position of the patella, and thus the stress on the patellofemoral joint (Lee & Csintalanl, 2003; Powers, 2010). Researchers have theorized that weakness or delayed onset of hip abductor and/or hip external rotator muscles in individuals with PFPS may contribute to excessive hip adduction and internal rotation during weight bearing activities. This hip position would in turn affect the position of the tibiofemoral and patellofemoral joints and increase the stress on the latter. Muscle weakness (Bolgla et al., 2008; Heiderscheit, 2010; Ireland et al., 2003; Mizner & hmielewski, 2008; Robinson, 2007; Souza, 2009) and delayedonset of abductors3 have been reported in individuals with PFPS compared to controls. However, corresponding differences in hip or knee joint angles have not always been found (Bolgla et al., 2008, Ireland et al., 2003; Robinson, 2007; Brindle

& McCrory, 2003). Furthermore, the coordination of knee and hip motion has not been investigated. The major complaint of patients with PFPS is retropatellar pain during activities such as running, squatting, going up and down stairs, prolonged sitting, cycling, and jumping (Witvrouw & Bellemans, 2001). A combination of factors, such as abnormal lower limb biomechanics and abnormal lateral tracking of the patella may result in increased cartilage and subchondral bone stress, subsequent PFPS and subtle patellar malalignment or more overt patellar maltracking (Fredericson, 2006; Miller & Croce, 1997; Souza, 1991).

In addition, some studies indicated that muscle weakness, dynamic malalignment decreased quadriceps flexibility and shortened reflex time of the vastus medialis oblique muscle may be risk factors for PFPS (Witvrouw & Bellemans, 2001; El-Metwally et al., 2006; Mikkelson et al., 2006; Milgrom et al., 1991; Thomee & Karlsson, 1999). Since the shortness of muscles often correlates with sport injuries, decreased flexibility of the muscles around the knee and hip may be present during knee pain. Inflexibility of the quadriceps, hamstrings, or Iliotibial band (ITB) may restrict range of motion around the knee and are likely to increase the forces on the knee (Asplund, 2004). McConnel (2002) suggested that a decrease in the flexibility of the soft-tissue structures that surround the patella, such as lateral retinaculum, tensor facia lata (TFL), hamstring, gastrocnemius and rectus femoris, is a significant contributing factor in the etiology of PFPS, as it adversely affects the tracking of the patella (McConnell, 2002).

Several studies showed that there is a relationship between thigh muscles inflexibility and knee pain (Fredericson, 2006; Smith & Mcqueen, 1991; Piva & Childs, 2005; Puniello, 1993.). Fredericson et al (2006) in a review article stated that literatures supports the concept that tight quadriceps muscles create high patellofemoral stress during sports or the activities of daily living, thus potentiating PFPS. In addition, some researchers presented that subjects with PFPS did not differ in lower extremity range of motion (ROM) (Messier & Curl, 1991; Thomee & Karlson, 1995). However Willson (2008) showed that women with PFPS demonstrated increased hip adduction angle, hip flexion angle, hip abduction angular impulse, and decreased hip internal rotation angles throughout the exertion protocol. Both groups demonstrated decreased jump height, hip flexion and internal rotation, knee flexion, and hip extension impulse at the end of the protocol.

The purpose of this investigation was to compare the range of motion of knee and hip in athletes with and without patellofemoral pain syndrome. The specific factors examined were range of motion of knee (flexion and extension) and range of motion of hip (flexion, extension, abduction, adduction, internal rotation and external rotation).

Materials and Methods

Subjects

Subjects volunteered to participate in this study and were placed in an experimental group and a control group based on the presence of PFPS symptoms with no evidence of any other specific pathologic condition. All group members were athletes who were active in sports such as running, football, basketball, and handball, for more than 10 years. The control group was composed of 7 women and 16 men with a mean age of 25.1 ± 3.2 years. They were healthy and athletic, and reported no history of knee injury. The experimental group consisted of 3 women and 12 men with a mean age of 25.0 ± 4.3 years, who had history of PFPS with duration of symptoms was more than 6 months and intensity sufficient to limit function or cause the individual to seek intervention. These symptoms consisted of retropatellar pain during physical activities such as jumping, running, squatting, and going up or down stairs.

Clinical criteria include pain on 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. Participants were excluded if they had signs or symptoms of meniscal injury, pre-patellar bursitis, ligament laxity or tenderness, tenderness over the patellar tendon, illiotibial band syndrome, or pesanserinus tendonitis, patellar apprehension sign, patellar dislocation and previous knee surgery. The subjects did not have pain at rest, and did not have pain during a submaximal isometric contraction of knee flexion. The study received ethics committee approval from the Ruhr-Universität Bochum Ethics commission of Germany. Before beginning the study, every subject signed an informed consent document.

Instrumentation and procedures

A bi-armed goniometer was used to measure knee and hip ROM. According to Miller measuring ROM of joints by using a goiniometer is a valid method compared to X- ray measurements (Hoppenfeld, 1976). Active ROM of knee and hip was measured with the subject in three different positions and compared with normal range (Thomas, 1876).

Knee

Knee flexion was performed in the supine position. The fulcrum was aligned with the lateral epicondyle of the femur. The stationary arm was in line with the greater trochanter and midline of the femur, the moving arm with the lateral malleolus and midline of the fibula. Subject flexed the hip and knee, with the foot on the table. The opposite leg was kept extended on the table. Knee flexion ROM was measured and compared with normal range (120°-150°). Knee extension was completed in the same position when knee and hip joints were straightened. The goniometer positioning for knee extension was the same as it is for knee flexion. Extension ROM was measured and compared with normal range (5°-10°).

Hip

Hip flexion was performed in the supine position. The fulcrum was aligned with the greater trochanter of the femur. The stationary arm was positioned along the lateral midline of the abdomen, using the pelvis for reference, the moving arm along the lateral midline of the femur. Subject flexed knee on the measured side and extended the opposite leg and rested on the examining table. The hip joint being examined was bended while pelvis was stabilized to prevent rotation or posterior tilting. Flexion ROM was measured and compared with normal range (130°-140°).

Hip extension was done with the subjects in lateral position and the knee on the measured side extended (figure 1). Subjects fixed the opposite hip joint in maximal flexion. The leg being examined was then extended under the examiner's guidance while the pelvis was stabilized to prevent rotation or anterior tilting. Goniometer positioning was the same as for hip flexion. Hip extension ROM of each subject was compared with normal range (10°-30°)

Figure 1. Measurement of hip extension.

Hip abduction was performed in the supine position. Fulcrum was placed in line with the ASIS. The moving arm of the goniometer was aligned with the midline of the patella, the stationary arm with the ASIS of the opposite side. The knee on the measured side was kept straight, and the examiner supported the weight of the leg as the subject moved it out to the side. Hip abduction was measured and compared with normal range (30°-50°). Hip adduction was done in the same position with abduction (figure 2). The goniometer positioning was the same as for abduction, fulcrum at the ASIS, moving arm aligned with the midline of the patella, and the stationary arm with the ASIS of the opposite side.

Figure 2. Measurement of hip adduction.

When measuring adduction, the opposite hip joint must be slightly flexed. Subject moved his leg being examined to inside. Adduction ROM was measured and compared with normal range (20°-30°). Hip internal rotation was measured in a prone position, with the knee flexed to 90 degree (figure 3). The fulcrum was aligned with the patella and both arms of the goniometer with the midline of the tibia. The lower leg was used as a pointer. During internal rotation, the axis of the lower leg pointed outward. Hip internal rotation was measured and compared with normal range (30°-40°).

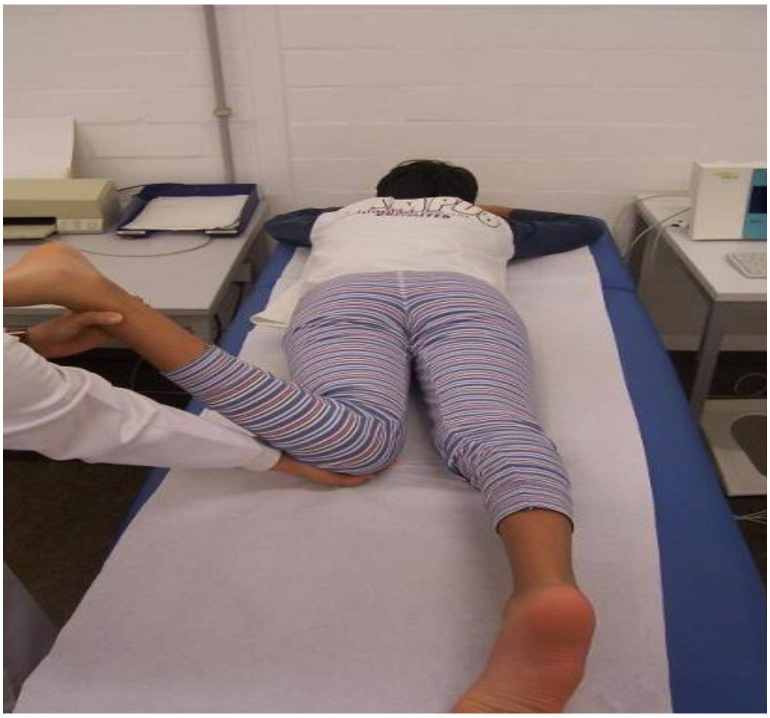

Figure 3. Measurement of hip internal rotation.

Hip external rotation was measured in the same position and goniometer positioning of internal rotation. During external rotation, the axis of the lower leg pointed inward. Hip external rotation was measured and compared with normal range (40°-50°). The t-test for independent variables was used to compare the knee and hip ROM between the patients and control group. Statistical analysis was performed with SPSS Version 17.0, and a value of 0.05 was accepted as reflecting significance.

Results

No significance differences were found in ROM of knee flexion and extension between the subjects with and without PFPS groups (P≠0.05 (Figure 4). The mean values and standard deviations of ROM of knee flexion and extension in the groups have been reported in Table 1.

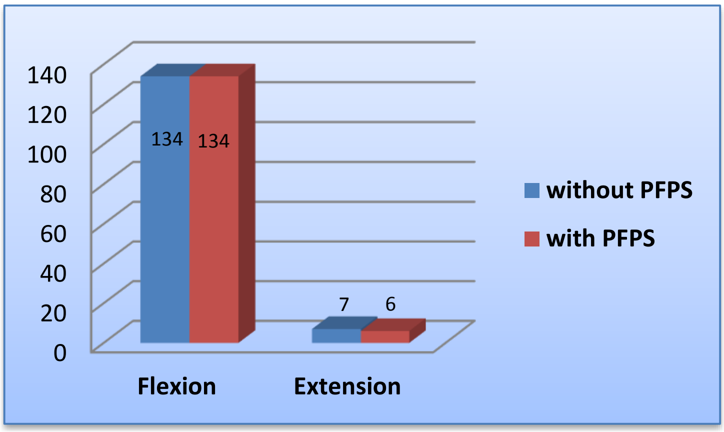

Figure 4. Comparison of range of motion (ROM) of knee in the subjects with and without PFPS.

Table 1. The mean values and standard deviations of ROM of knee flexion and extension in the subjects with and without PFPS.

Group (n)	Without PFPS (23)	With PFPS (15)
Knee flexion	134°± 9°	134°± 7°
knee extension	7°± 4°	6°± 4.5°

In addition, no significant differences were demonstrated in hip flexion, extension, abduction, adduction, internal rotation and external rotation between the patients and control group (Figure 5). The mean values and standard deviations of ROM of hip in the subjects with and without PFPS group have been reported in Table 2.

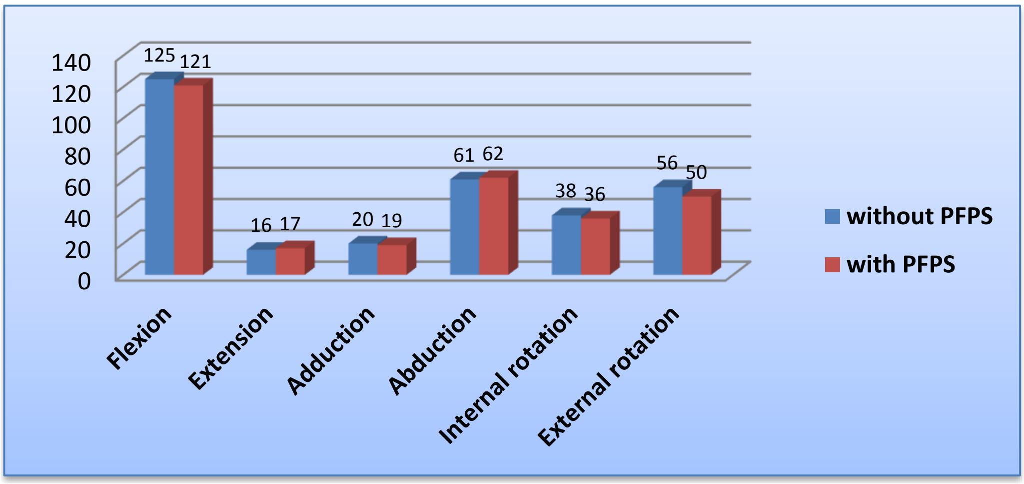

Figure 5. Comparison of ROM of hip in the subjects with and without PFPS.

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Table 2. The mean values and standard deviations of ROM of hip in the subjects with and without PFPS.

Hip movement	without PFPS (23)	with PFPS
Flexion	125°± 8°	121°± 9°
Extension	16°± 5°	17°± 8°
Adduction	20°± 4°	19°± 5°
Abduction	61°±10°	62°± 12°
Internal rotation	38°± 9°	36°± 10°
External rotation	56°± 8°	50°± 13°

Discussion and Conclusion

In the current study, knee ROM (includes: flexion and extension) and hip ROM (includes: flexion, extension, abduction, adduction, internal and external rotation) were investigated in the subjects with and without PFPS. The results showed that no significant differences in knee and hip ROM between the two groups. This finding is in accordance with the findings of other researchers. Messier et al. (1991) found runners with PFPS had no differences in knee ROM with control group (Messier & Curl, 1991). Also, Thomee et al (1995) stated that subjects with PFPS did not differ in lower-extremity alignment and lower-extremity ROM measurements in comparison to control group (Thomee & Karlson, 1995). Dixit et al (2007) stated that patients with PFPS usually demonstrate a full ROM of the knee (Dixit, 2007).

Bolgla et al (2008) reported no difference in hip adduction or internal rotation between females with and without PFPS while descending stairs (Bolgla et al., 2008). The finding of Van Mechelen et al (1992) was in disagreement with our finding. They investigated a group of runners with lower extremity injuries and compared them with controls with respect to ROM of the hip and ankle joints (Van Mechelen & Zijlstra, 1992). They found that the injured group had more restricted ROM at the hip joint, but ROM at the ankle joint showed no statistically significant differences (Van Mechelen & Zijlstra, 1992). Although PFPS is one of the lower extremity injuries, Van Mechelen and Zijlstra (1992) hadn't indicated which injuries were considered and whether PFPS also was one of the considered injuries. This reason may explain the difference found between their and our study.

In the other study, Willson (2008) showed that women with PFPS demonstrated increased hip adduction angle, hip flexion angle, hip abduction angular impulse, and decreased hip internal rotation angles throughout the exertion protocol. Although these findings are in disagreement with our findings, there were differences between their studies and ours. Their subjects were women with and without PFPS who did functional lower-extremity exertion protocol of repetitive single-legged jumps and they measured the knee and hip angles during and after protocol by VICON 3-D motion analysis system. However, our subjects were men and women with and without PFPS that we evaluated the knee and hip angles by goniometer. Boling stated that if people who ultimately develop PFPS also have lateral patellar malalignment due to the increased femoral internal rotation, the patellofemoral contact stress may be even more increased at the smaller knee flexion angles because of the decreased contact area at these decreased knee flexion angles (Bolling & Marshall, 2009). In addition, decreased knee flexion angles during dynamic tasks leads to increased vertical ground-reaction forces (Schmitz et al., 2007; Yu & Garrett, 2006).

Recently, Boling et al (2009) published a prospective study of biomechanical risk factors for PFPS that reported increased hip internal rotation as a predictor of knee symptoms in subjects; however, hip adduction was not a factor in the predictive model (Bolling & Marshall, 2009). However, Boling et al. considered only a patient group and they compared the hip ROM between the patients and control group. In the current study, the knee and hip ROM compared between experimental and control groups. From the results of this study it can be concluded that athletes with PFPS had no restricted ROM of knee and hip joints in comparison to the control group. It may be suggested that PFPS has no effect on knee and hip ROM.

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