JRSR 1 (2017) 15-19

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Comparing Knee Joint Position Sense in Patellofemoral Pain and Healthy Futsal Women

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ARTICLE INFO

Article History:
Received: 03/07/2017
Revised: 25/10/2017
Accepted: 05/11/2017

Keywords:
Athlete
Anterior knee pain
Position sense
Electrogoniometer

ABSTRACT

Background: Proprioception, or joint position sense, probably plays an important role in joint function. A number of studies have shown that proper joint position sense can decrease the risk of injuries in sports. It is not very clear how patellofemoral pain syndrome (PFPS) can affect athletes joint position sense (JPS). Regarding the importance of proper joint position sense for movement performance and injury prevention in athletes, the aim of this study was to evaluate knee JPS in athletes with PFPS and compare it with asymptomatic individuals under non-weight bearing (sitting) conditions.
Methods: The study design was comparative in which 15 patients and 15 healthy athletes participated. JPS was evaluated by active and passive replication of knee angles for 30, 45 and 60° of knee flexion target angle while visual cues were eliminated. Each test was repeated three times. By subtracting the test angle from the replicated angle, the absolute error was calculated as a dependent variable. T-statistical test was used to compare data between two groups and P value of 0.05 was considered as the level of statistical significance.
Results: No significant difference ($P<0.05$) in active (A) and passive (P) knee JPS was found between two groups for three (30°, p-value (A =0.79, P=0.68), 45°, P value (A=0.12, P=0.54) and 60°, P value (A=0.74, P=0.71)) target angles.
Conclusion: According to results, both groups had the same JPS ability, it seems PFPS does not affect the knee JPS at least in athlete cases. It would be possible that deficiency of JPS compensated for the physical activity or on the other hand, maybe pain intensity was not high enough to interfere with JPS accuracy. According to our results, PFPS doesn't reduce IPS but further investigation is needed to disclose if other factors such as skill level, intensity of pain or joint pathology are effective on JPS accuracy or not.

Introduction

Patellofemoral pain syndrome (PFPS) is the most common overuse syndrome in athletes. It is one of the causes of anterior knee pain in athletic population who refer to the sports medicine clinic [1]. PFPS is a common painful musculoskeletal problem, particularly among young people who are physically active, especially between the ages of 15 and 30 years [2, 3]. PFPS prevalence has been reported from 12% to about 25% and is 2.2 times more in female athletes than in male [3], the pathophysiology of PFPS is multifactorial. These factors include both extrinsic risk factors, such as changes in training frequency or intensity, training surfaces and inappropriate shoe wear, and intrinsic risk factors, such as lower extremity malalignment and muscle and soft tissue imbalances, larger

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q-angle, muscle strength deficits, muscle tightness, joint and patella laxity, less hip abduction and knee extension strength. A combination of biomechanical factors and tissue imbalances causes improper tracking of the patella in the trochlea of the femur, leading to increased stress at the patellofemoral joint [4-6].

Proprioception, is considered as an ability to percept position of the different parts of the body which is considered as a specialized function for controlling movements [7]. Proprioception encompasses several different components like joint position sense (JPS), velocity, movement detection and force [8]. JPS is the awareness of the location of the joint in space and is a static phenomenon [9].

Proprioception information is provided from function of different sensory receptors, including touch and pressure receptors, mechanoreceptors of synovial membrane, muscle spindle and Golgi tendon organs [10]. It seems muscle spindles are mostly responsible for joint position perception in the middle of the joint range of motion, while joint mechanoreceptors such as Ruffini endings and Pacinian corpuscles, have roles at the two ends of joint range of motion most especially diagnosing stretch in ligament and joint capsule [10].

Any deficit of proprioception plays an important role in musculoskeletal sport injuries in athletes [11]. Proprioception is a necessary factor in motor control, balance and movement cooperation in sport activity. Abnormal proprioception or joint position sense can facilitate musculoskeletal injuries via the change of motor control and increase abnormal pressure to tissues [2]. For instance, sensorimotor dysfunction in osteoarthritis can cause more impact force during heel strike and cause damage to the joint surface or abnormal proprioceptive feedback from the knee joint position can also predispose knee joint to PFPS [7]. In this context, some studies showed the relationship between proprioception deficit and knee injury [12-15] but not in athletes.

Abnormal knee JPS is seen in osteoarthritis and ACL injury [10]. According to the results of some studies, it seems PFPS patients experience some reduction of knee JPS accuracy in comparison with normal cases [2, 11, 16]. Nevertheless, it is unknown, if incidence of PFPS causes decrease JPS accuracy or loss of knee JPS accuracy in the beginning causes PFPS. However, results of some other studies, showed no difference in proprioceptive accuracy in healthy and PFPS patients [17]. Also in another study, no differences were seen between experimental and control group, and anterior knee pain was created by injecting saline into infrapatellar fat pad [7], so the question is, can PFPS interfere with knee JPS of high level athletes or not. We hypothesized that PFPS group may have some JPS deficiency compare to healthy group.

Nowadays, many studies has been carried out on assessing knee joint proprioception in a variety of musculoskeletal problems, including ACL injuries and osteoarthritis, but study of PFPS, especially in athletes, are less and controversial. Regarding this conflict and lack of clear data in athletes and the importance of knee joint position sense in control of body motions, movement coordination and prevention of injury, this study aimed to assess and compare active and passive knee joint position sense as a contributing factor of proprioception, in two groups of futsal women with and without PFPS under non-weight bearing (sitting) conditions.

Methods

Thirty female subjects participated which included 15 patients with PFPS with a mean age of 21.73±1.83 and 15 healthy subjects with mean age of 21.46±2.77. Pain level of PFPS group was measured by visual analog scale (VAS). Having PFPS was confirmed by a physiotherapist through clinical examination. The two groups were similar in anthropometrical characteristics. Details of the samples are shown in Table 1.

Patients should have 3 of the 5 following criteria: 1-Pain behind or around patella during physical activity, knee-locking, or clicking sound caused by impaction associated with pain or without pain, pain during climbing up and down stairs, pain during squat, joint pain and stiffness in long sitting with knees bent. The patients had positive Clark diagnostic test results [2].

Inclusion Criteria

The age range was between 18 to 30 years old, subjects with PFPS having vague and non-localized pain at anterior of knee for at least three months to two years, and have also not received any other treatment at the same time.

Exclusion Criteria

Lower extremity injuries in the past six months or any diagnosis of osteoarthritis, patella tendinitis, inflammation of bursa or fat pad, and a history of patellar fracture or dislocation, knee surgery or arthroscopy, ligament or meniscus injury, recurrent pain from low back or hip.

Measurement of knee angle was done by a digital electrogoniometer with 0.1 degree precision (it was custom made by ZANIDJ Industrial R&D Co. Ltd in Tarbiat Modares University, reliability coefficients for intra-tester was 0.76). Electrogoniometer had one fixed and one movable arm with an axis that connects two arms. Angle of knee motion is shown digitally on a display device (Figure 1).

Table 1: Mean±SD of anthropometrical and pain characteristics and statistical differences between two groups

Measurement	PFPS (Mean±SD)	Healthy (Mean±SD)	Sig.
Age (year)	21.73±1.83	21.46±2.77	0.75
Weight (kg)	63.73±12.73	56.80±8.53	0.14
Height (cm)	163.49±5.59	162.53±4.20	0.49
Pain level (VAS)	5.03±1.82	_	_
Pain duration (months)	11.26±7.65	_	_

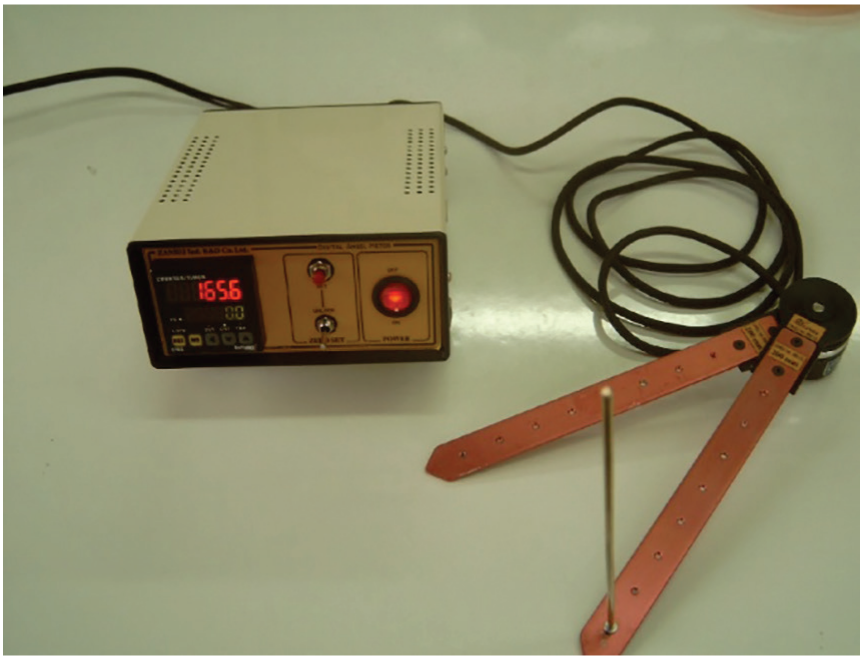

Figure 1: Electrogoniometer

After subject was seated on a testing table, fixed arm of goniometer was attached to a fiber glass plate (while the plate was fixed to the side of a chair on the lateral side of femur) instead of skin, to avoid change in fixed arm position which caused testing error during knee movement. Fixed arm was set in the line of femur. Two-side tape was used to fix the fixed arm. Movable arm was aligned with tibia. Goniometer axis of rotation was matched to mechanical knee axis that is along the line connecting medial and lateral epicondyle. Movable arm had a hole such that a 30 cm bar was placed in it with a horizontally crossed leg, so moving the leg caused the movable arm to move, then changes in knee angle were registered. Real time knee joint angle was displayed digitally. Also, a pad was placed under the thigh to place it on horizontal level parallel to fixed arm during testing (Figure 2).

After evaluation by the investigator and ensuring that the participants met the inclusive criteria, research stage was explained for them. Subjects were made to seat on a chair whose back was set on 80° for comfort [18], while eyes were closed. The knee was 90° at starting position and electrogoniometer showed zero degree. The individual was asked to actively position the testing knee to the considered angles (30, 45 and 60°) and hold for 5 s with controlled angular velocity by examiner. Individuals were asked to keep in mind the target knee angle, then back to start position. After 5 s interval, individual replicated the target angle with their eyes still closed [19]. Replication was done three times [20], with five seconds rest between each trial. Testing for each of three target angles was repeated with 30-s rest interval [19]. For passive testing, all process was same to active angular replication just that examiner moved and stop the leg according to the individual commands instead of themselves. Testing leg for healthy group was done according to each individual preferences.

Knee JPS accuracy was calculated using absolute angle replication error in 30, 45 and 60° of knee flexion [18]. Absolute error was considered as deviation rate from the

Figure 2: The setting of testing table

target angle in each replication trial without considering the direction of deviation (+ or -). Absolute error was recorded by first calculating average of three times replication test and then subtracting from the target angle for each of 3 target angles separately.

Independent t-test was used for statistical analysis of absolute angular error between the two groups. The normality of data was checked by Kolmogorov Smirnov (KS) test. Statistical analysis was done by SPSS software version 16 with significant levels of 0.5.

Results

All data distribution were normal (P>0.05). Mean and Standard deviation (SD) of absolute angle replication error in three target angles (30, 45, and 60° of knee flexion) are shown in Table 2. Statistical analysis showed no significant difference in the absolute error for 30, 45 and 60° between two groups. Results of comparing absolute angular error between two groups of healthy and patients, are shown in Table 2 and Figure 3.

Discussion

The aim of this study was to assess the knee joint position sense in female futsal athletes with and without PFPS. Regarding the results of some research studies which indicate that knee injuries can contribute to reducing joint position sense [21], it was hypothesized that group with PFPS had less position sense precision due to the experience of knee pain. However, our results showed no differences in active and passive joint position sense for all three angles 30, 45 and 60° of knee flexion between two groups. Our finding is similar to the findings of some other researchers that found no differences in joint position sense accuracy between PFPS and control groups [17, 22, 23]. Contrary to our findings, the findings of Prymka et al (1998), Jerosch et al (1997) and Baker et al (2002) showed significant differences in joint position sense accuracy between two groups [2, 24, 25]. However, subjects used in the research were not athlete or active cases.

Overall, proprioceptive sensation is derived from mechanoreceptors in the muscle, joint capsule, tendon, ligaments and skin. Motion stimulates mechanoreceptors giving a proprioceptive sensation that is required for undertaking normal activities of daily living and more physically demanding tasks [14]. Nevertheless, trauma and pathological processes can damage this feedback system, which may make the limb more susceptible to injury with reduced motor control. When any musculoskeletal injury occurs, joint position sense decreases, and different mechanisms are attributed to it including stimulation of nociceptive sensor and muscle inhibition around the joint [9]. So we expected to see some decrease in JPS accuracy of the knee in PFPS group.

To justify the finding of this study, we can state that this finding may be attributed to the subject characteristics, because all participants of this study were genius athletes. It seems individuals who participate in different fields of sport such as futsal, have a high level of neuromuscular control as a result of their high level of movement demands. So it appears that high neuromuscular ability in PFPS group could compensate for PFPS deficient effect on accuracy of knee JPS. Thereupon, knee joint position sense accuracy in PFPS group got closed to asymptomatic control group.

However, Yosmaoglu et al (2013) showed that patellofemoral pain among subjects with PFPS was not related to JPS [23], one reason that could be attributed to this finding is the pain level of PFPS group at the time of testing. Given that the mean pain level in VAS was almost in the medium scale (about grade 5) at the time of testing, it is possible that the level of pain in PFPS

Table 2: Mean±SD of absolute angle replication error for 30, 45 and 60° of knee flexion and comparing results of active and passive knee replication for 30, 45 and 60° of knee flexion.

Target angle	Group	Passive Mean (degree) ±SD	t	Sig.	Active Mean (degree) ±SD	t	Sig.
30°	Healthy	5.79±4.09	-0.41	0.68	5.92±4.00	0.26	0.79
	PFPS	6.64±5.09			5.55±3.79		
45°	Healthy	4.26±2.12	0.36	0.54	5.19±3.84		0.12
	PFPS	3.64±3.35			3.39±2.09		
60°	Healthy	3.84±4.04	0.6	0.71	4.75±3.11	1.59	
	PFPS	3.37±3.21			5.08±2.34		

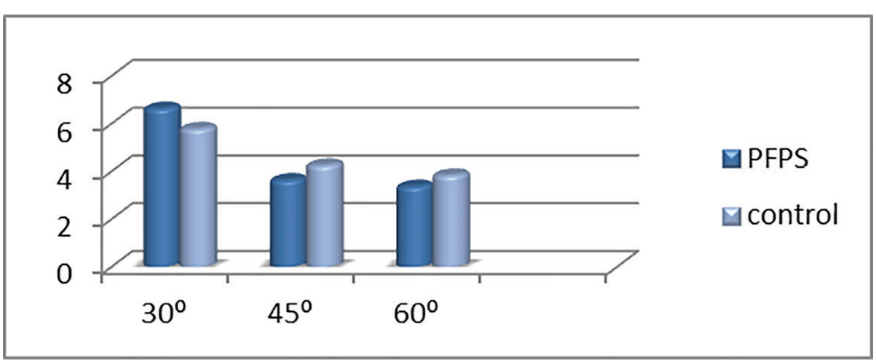

Figure 3: Comparing knee position sense accuracy between two groups

group was not high enough to interfere with the neural analysis of joint position sense input, so no differences were observed in joint position sense between two groups. The third cause maybe the testing position, as testing position in this study was non weight bearing or sitting, in which knee joint acts in open chain movement. In non-weight bearing compare to weight bearing position, some proprioceptive receptors around the joint decrease their activity or in other words, proprioceptive receptors are stimulated less in non-weight bearing, it is also possible if we test joint position sense in weight bearing instead of non-weight bearing, our results showed significant differences between two groups.

In non-weight bearing position, proprioceptive and motor control requirement is less than weight bearing, so PFPS deficiency could not affect the joint position sense accuracy. Limitations of this study include sample size, not matching testing leg between two groups. Testing position is another limitation because if we had tested in weight bearing position, the results might have changed.

Conclusion

Despite our expectation that any pain and neuromuscular injury might interfere with sensory input and cause decrease in joint position sense accuracy, these findings have shown no change in joint position sense accuracy in PFPS subjects compare to healthy cases. It seems regular physical activity and involvement in sports activities with high level of movement demands, may compensate for proprioception's deficit derived from PFPS. To clarify this, it is proposed that JPS should be compared in non-active cases with and without PFPS coincident with athletes cases and considering different pain level for future research.

Acknowledgment

The authors are grateful for the help of Tarbiat Modares University and Tehran University for their cooperation in this study.

Conflict of interest: None declared.

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