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Proprioception of the knee joint in patellofemoral pain syndrome

Patellofemoral ağrı sendromunda diz ekleminin propriyosepsiyonu

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Amaç: Spor yaralanmalarının ya da eklem hastalıklarının etyoloji, tanı ve tedavilerinde propriyosepsiyon kavramı gittikçe daha fazla önem kazanmaktadır. Bu çalışmada patellofemoral ağrı sendromu (PFAS) olan hastalarda diz propriyosepsiyonu değerlendirildi.

Çalışma planı: Çalışmaya, klinik olarak tek taraflı PFAS tanısı konan 28 hasta (18 kadın, 10 erkek; ort. yaş 28; dağılım 16-48) ve kontrol grubu olarak, herhangi bir diz yakınması olmayan 27 normal gönüllü (13 kadın, 14 erkek; ort. yaş 26; dağılım 19-32) alındı. Hastaların ortalama yakınma süresi 35.8 hafta (dağılım 2 hafta-3 yıl) idi. Hasta ve kontrol grubunun diz propriyosepsiyonları, dört farklı hedef açı için (15°, 30°, 45°, 60°) aktif eklem pozisyon duyusu yöntemi kullanılarak dijital gonyometre ile ölçüldü ve sonuçlar karşılaştırıldı.

Sonuçlar: Patolojik dizlerde, karşı dizlere ve kontrol grubunun sağ ve sol dizlerine göre tüm hedef açılarda yanılma daha fazla idi. Patolojik dizlerle karşı dizler arasında dört hedef açının üçünde (15°, 30°, 60°), 1.01±0.25° ile 1.65±0.43° arasında değişen farklar saptandı ($p<0.05$). Patolojik dizlerle kontrol grubunun sağ ve sol dizleri arasında ise tüm hedef açılarda 2.48±0.92° ile 3.87±2.46° arasında değişen farklılıklar vardı ($p<0.001$). Hastaların normal dizlerinde de, kontrol grubunun sağ ve sol dizlerine oranla daha fazla yanıldıkları gözlendi ($p<0.001$). Aradaki fark bazı hedef açılarda 2.7 dereceyi geçmekteydi.

Çıkarımlar: Sonuçlarımız PFAS bulunan hastalarda diz eklemi propriyosepsiyonunun azaldığını, sorundan normal dizin propriyosepsiyonun da benzer şekilde etkilendiğini göstermektedir. Bu çalışmanın bulguları ışığında, PFAS bulunan olguların tedavisinde propriyoseptif egzersizlerin de dikkate alınması önerilebilir.

Anahtar sözcükler: Diz eklemi/patoloji; ağrı/etyoloji; patellofemoral ağrı sendromu/fizyopatoloji; propriyosepsiyon/fizyoloji; sendrom.

Objectives: The importance of proprioception in the etiology, treatment, and prevention of sports injuries and joint diseases has become increasingly clear. The purpose of this study was to investigate knee proprioception in patients with patellofemoral pain syndrome (PFPS).

Methods: The study included 28 patients (18 females, 10 males; mean age 28 years; range 16 to 48 years) with a clinical diagnosis of unilateral PFPS and 27 normal volunteers (13 females, 14 males; mean age 26 years; range 19 to 32 years) without any complaint related to the knee. The mean duration of complaints was 35.8 weeks (range 2 weeks to 3 years). In both patient and control groups, proprioception of the knee was measured by means of active joint position sense at four different target angles (15°, 30°, 45°, 60°) with the use of a digital goniometer and the results were compared.

Results: Proprioceptive errors were greater at all target angles in the affected knees compared to those measured in the contralateral knees and both knees of the controls. Differences between affected knees and contralateral knees ranged from 1.01±0.25° to 1.65±0.43° and were significant at three target angles (15°, 30°, 60°; $p<0.05$). Comparisons between the affected knees and both knees of the controls also showed significant differences at all target angles ranging from 2.48±0.92° to 3.87±2.46° ($p<0.001$). Errors obtained in the normal knees of the patients were also significantly greater compared to those seen in both knees of the controls, exceeding 2.7° at some target angles ($p<0.001$).

Conclusion: Our results show that patients with PFPS have impaired proprioception in the affected knee accompanied by significant losses in the proprioception of the contralateral normal knee. Based on these findings, proprioceptive rehabilitation techniques should be incorporated into the treatment of PFPS.

Key words: Knee joint/pathology; pain/etiology; patellofemoral pain syndrome/physiopathology; proprioception/physiology; syndrome.

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The role of the proprioception has become increasingly clear in the etiology, prevention and the treatment of sports injuries and joint diseases. It has been shown that proprioceptive deficiency facilitates the injury, proprioceptive rehabilitation decreases the incidence of injury or improves the results of treatment.[1, 2] Recently, there has been significant amount of research on the importance of proprioception. Usually, the knee joint is studied in these researches. Most of the studies about knee proprioception has focused on anterior cruciate ligament (ACL) injuries.

Anterior knee pain syndrome has been cited as one of the most common disorders of the knee joint. [3] It has also been notified as the most common cause of chronic knee pain among young adults.[4] However, no agreement exists about the etiology of the problem. Some investigators believed that the grade of the cartilage degeneration is not concordant to the clinical complaints [3, 5] ; others showed the absence of inflamatory agents at peripatellar soft tissue.[6, 7] Thus, treatment of the disorder is still contoversial. Although many conservative and surgical treatment modalities have been proposed for the problem, a standardized treatment has not been described. Relationship of proprioception and patellofemoral pain syndrome seems to be important. Prevention and treatment of the patellofemoral pain syndrome(PFPS) with proprioceptive rehabilitation may come to order if a prorioceptive deficit is found in those patients.

Proprioception has been shown to be deteroirated following injury in the ankle, shoulder and knee joints.[8-11] Thus, proprioceptive deficiency has been shown to cause abnormal stress accumulation in the surrounding tissue by obstructing the movements and consequently contributes to the occurence of further problems in the joint.[12] It is not clear if proprioceptive deficiency causes the injury or if the injury causes the proprioceptive deficiency.

Limited studies exist investigating the proprioception in patellofemoral disorders. Edin [3] thought that alteration of the tensil forces in the surrounding tissue might cause abnormal joint position sense. Jensen et al [14] showed the decreased thresholds for tactile and cold senses in patients with PFPS. Maker et al [12] and Hazneci et al [15] found deteriorated proprioception in patients with PFPS, however Kramer et al [16] found no change in proprioceptive level.

This study was planned to determine the proprioceptive status in patients with a clinical diagnosis of PFPS.

Patients and methods

28 patients (18 female, 10 male) with a clinical diagnosis of unilateral PFPS were included in the study. All the patients had the signs and symptoms of anterior knee pain, cinema sign, increased pain during step down of stairs, and on physical examination patellar crepitation, positive patellar friction and compression tests. Previously treated patiens (consevatively or surgically) or patients with accompanying lesions diagnosed on physical examination and radiography were excluded from the study.

There were 27 normal volunteers (14 male, 13 female; mean age 26, range 19-32) who had no knee problem or complaints, history of previous knee surgery, systemic disorder, hip and ankle problem, degenerative spine diseases, use of analgesics. The dominant foot was right side in all the volunteers.

Time between the onset of symptoms and admittance was 35.8 months (range, 2 weeks and 3 years). Pain was the main symptom in all patients. Thus, cinema sign was positive in 23 of patients, first step pain in 19, and diffuculty in squatting in 23. Standard AP and Lateral X-rays and skyline view of the patella were obtained in all patients. Patients who had tibiofemoral or patellofemoral arthrosis were excluded from the study. Mean Lysholm score was found as 67.1 (range, 28-90).

Proprioception testing protocol which will be described below was applied to the patients and controls. All the canditates were informed about the procedure before testing. The testing method was the active joint position testing which accuracy is proven previously.[16, 17] Selected measurement method and the goniometer were used in another study of the authors [18], and the interobserver reliability was tested. Thus, interobserver reliability was not tested in the present study and all the measurements were done by the same author (DA).

Proprioception test protocol

Active joint position sense (JPS) testing was measured by using a digital goniometer sensitive for 1° (Lafayette, IN, USA) (figure 1). Subjects were tested in supine position and both lower extremities were undressed, and eyes closed. The rotation center of the go-

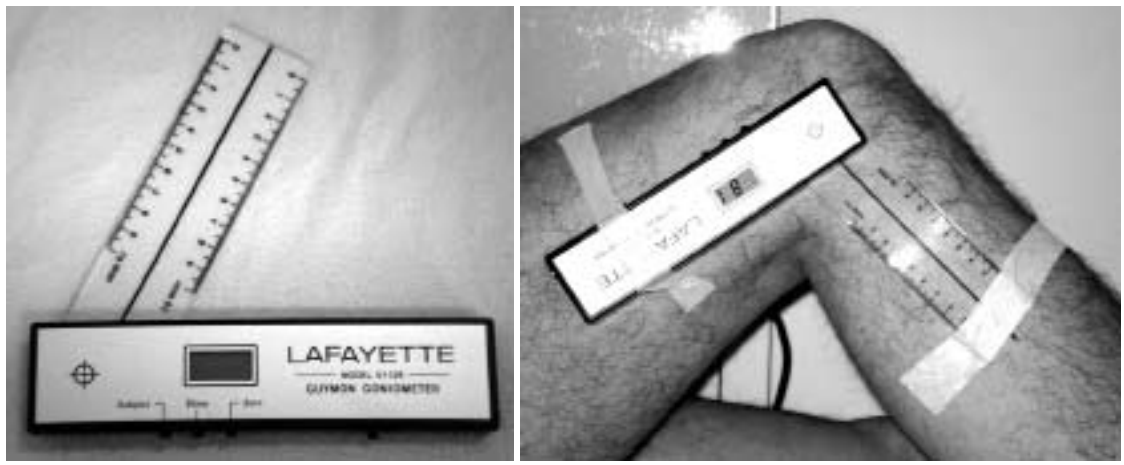

Figure 1. The digital goniometer used for tests, and application on the patient.

niometer was fitted to the rotation center of the knee. In full extension, the goniometer was set to 0 and thus, the initial position was set to be 0°. The target angles were determined as 15°, 30°, 45° and 60°. The angle of concern was was instructed to the subjects twice be fore the measurement. Then, the subjects were instructed to find the correct angle, with six time repetitions. First measurements were done on pathologic side of patients and then after on normal side. The deviations of the average of the six measurements from the target angle were recorded for all angles. The same test protocol was also applied to both knees of normal volunteers.

Statistical analysis

Statistical analysis of the study were done at the Department of Public Health of the Celal Bayar University. Data were evaluated with the SPSS 11.0 package program (2001, SPSS Inc). T-Test was used for the comparisons of sex and left and right sides of the normal volunteers. Mann-Whitney-U was used for the comparisons of pathologic and normal sides of the patient group. The correlations between the repeated measurements of same observer were evaluated with Pearson Correlation test.

Results

No significant differences were found between the left and right knees of volunteers and between males and females. Intraobserver variations exhibited a high positive correlation ($p<0,01$)

There were significant differences between the pathologic knees of the patients and both left and right knees of the volunteers (Table 1 and 2). Increased reproduction errors were obtained in pathologic knees in all the target angles ($p<0.001$) The difference was as high as 3.8° in some of the target angles (Table 2).

When the pathologic knees were compared to the normal knees of the patients, it was observed that greater reproduction errors were obtained in pathologic side in all targets (Table 1). However, the differences were statistically significant in three of four target angles (15°, 30° and 60°, $p<0.05$). The difference between the pathological knees and the contralateral knees were lower than the difference between the pathologic knees and the left and right knees of the volunteers. The top level of the difference was limited

Table 1. Reproduction errors at four target angles of pathologic and normal knees of the patients and left and right knees of volunteers.

	Patient group		Control group	
	PK	CK	VLK	VRK
15°	3.41±1.87	1.97±1.47	0.41±0.31	0.60±1.02
30°	3.44±1.98	2.43±1.73	0.94±1.35	0.96±1.06
45°	4.17±2.24	3.69±3.13	0.96±0.71	1.41±1.08
60°	5.03±3.58	3.38±3.15	1.39±1.27	1.39±1.12

(PK= pathologic knee, CK= contralateral knee, VLK= volunteers left knee, VRK= volunteers right knee).

Table 2. Differences between the comparisons and p values

	PK-CK	PK-VLK	PK-VRK	CK-VLN	CK-VRK	VLK-VRK
15°	1.44±0.11	3.00±1.56	2.81±0.71	1.56±1.16	1.37±1.45	0.19±0.71
	$p<0.05$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	$p>0.05$
30°	1.01±0.25	2.50±0.63	2.48±0.92	1.49±0.38	1.47±2.05	0.02±0.29
	$p<0.05$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	$p>0.05$
45°	0.48±0.99	3.21±1.53	2.76±1.16	2.73±2.42	2.28±2.05	0.45±0.37
	$p>0.05$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	$p>0.05$
60°	1.65±0.43	3.64±2.31	3.87±2.46	1.99±1.88	1.99±2.03	0.00±0.15
	$p<0.05$	$p<0.001$	$p<0.001$	$p<0.001$	$p<0.001$	$p>0.05$

(PK= pathologic knee, CK= contralateral knee, VLK= volunteers left knee, VRK= Volunteers right knee).

to 1.65° between the pathologic-contralateral comparison; but the highest difference was 3.5° between the pathologic knees and the normal knees of the volunteers (Table 2).

When normal knees of volunteers and nonpathologic knees of patients were compared, there were significantly increased reproduction errors in normal knees of the patients ($p<0.001$, Table 1). The difference was exceeded to 2.7° in some targets.

Discussion

Results of this study showed that proprioceptive quality decreased in pathologic and normal knees of the patients with a clinical diagnosis of unilateral PFPS. This finding suggests that proprioceptive changes should also be considered in the etiology of the disorder besides the mechanical and biochemical factors. The presence of proprioceptive deficiency in PFPS may be due to several factors. Abnormal forces at the surrounding tissues which already go along with the disorder may deteroirate the proprioception by affecting the motor control. Pain and inflammation may also contribute to proprioceptive deficiency.

There are limited studies investigating the proprioceptive changes in patients with PFPS [12,15,16,19]. Jerosch et al [19], studied the proprioceptive status in 43 patients with unilateral PFPS and in 30 normal volunteers with the technique of detection of threshold of movement, and found deterioraiton in pathologic and normal knees. Although we used a different test method, our results seem to be paralel with Jerosch et al's.[19] Baker et al [12] and Hazneci et al [15] used different test techniques and found similiar results. In contrast to the above mentioned findings, Kramer et al [16] found no differences amoung the proprioceptive status of 24 patients with PFPS and normal controls. They believed that recreational experience of their patients all of whom were athletes, contributed to their results.[16] They used four different target angles during proprioceptive tests, but made only one measurement for each of them. We believe that one measurement at each target angle may influence the results negatively and may not reflect the real status.

The main difference between the present study and the above mentioned ones with similar results was that the proprioception was evaluated in four target angles in a more wide range of motion.[12,15,19] Thus, proprioception in extension and flexion of the knee were evaluated. Our results showed that proprioception deteriorated more in flexion position of the knee. As it is well known, symptoms and signs are pronounced with increased flexion of the knee in patients with PFPS. Increased pain or mechanical stress seems to be paralel with proprioceptive deterioration. Similar findings were observed in a study investigating the proprioception following allograft meniscal transplantation.[20] Authors believed that increased tension in the tissue with further flexion of the knee triggered the Golgi and Ruffini receptors, hence caused deterioration of proprioception.[20] Similarly, increased tissue tension at the peripatellar soft tissue with increased knee flexion may have caused further deterioration of proprioception at the present study.

Proprioceptive deficiency at the contralateral normal knee seems to be an interesting finding. Significant differences were obtained between the left and right knees of normal volunteers and nonpathologic normal knees of the patients at all target angles. Si-

milar differences were also obtained between pathological and contralateral normal knees at three of four target angles. These findings signify that severity of proprioceptive deterioration of the contralateral normal knees may be as high as the deterioration on pathological knees. Similar findings were also obtained in some previous proprioception researches about gonarthrosis [21], meniscus [18, 19] and anterior cruciate ligament.[22] Besides, deterioration of proprioception in nonpathologic contralateral normal knees were noticed in two above mentioned studies related to proprioception in patients with PFPS.[12, 19] Several possible explanations may be theorized for this finding. Spesifically, it should be remembered that PFPS usually exists in both knees. Contralateral normal knee may be asymptomatic but some biochemical and mechanical changes may exist subclinically. A second explanation may be the existence of cross connections in afferent or efferent neural pathways at the spinal cord or upper levels. These theorical possibilities are all evaluated in previous studies but the exact mechanisms have not been understood yet. [12, 18. 19,21,22] However, it should be kept in mind that proprioception of the contralateral normal knee in a patient with a unilateral knee disorder might be deteriorated, thus that normal knee may also be at high risk for an injury.

Proprioceptive deficiency may be the result of an injury or may also be the reason of injury. It is unknown whether proprioceptive deficiency is the reason or the result of an injury. To answer this question, proprioceptive level of the patients should be measured before the pathophysiological and clinical findings start. But it seems to be nonpractical to predict which individuals will suffer from PFPS, and to measure the proprioceptive level before the onset of the disorder.

Most usefull clinical result of the study is that proprioceptive rehabilitation techniques may be added to the Standard treatment protocols of the patients with PFPS. The results were positively influenced from this type of managements in patients with ligament injury. [1,2] Hazneci et al [15] showed that isokinetic exercise training increased the proprioceptive quality in patients with PFPS. Additionally other exercises which may be developed specifically for patellofemoral joint may further improve the proprioception in this group of patients, thus improve the clinical results. Thus, it may be possible to decrease the incidence of unsuccesful results in the treatment of PFPS.

As a result, proprioceptive quality of the patients with unilateral PFPS is decreased both in pathologic and non pathologic sides. This deterioration seems to be more pronounced in pathologic side and with further flexion of the knee. These findings give rise the thought that proprioceptive rehabilitation techniques may improve the results in the treatment of patients with PFPS.

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