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Relationship Between Functional Tests and Knee Muscular Isokinetic Parameters in Patients with Patellofemoral Pain Syndrome

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To measure quadriceps and hamstring muscle strength with Isokinetic dynamometer in patients with patellofemoral pain syndrome (PFPS) and also to examine the relationship between muscle strength and functional test scores and subjective assessment. In this case-control study a total of 30 subjects (15 healthy and 15 patients with diagnosed PFPS) completed Kujala questionnaire concerning subjective functional knee assessment. Then muscle strength was measured with Isokinetic dynamometer in sitting position during 10 to 90 degree of knee flexion in 60 and 120 degree per sec speeds. Finally two kinds of functional tests (step down and semi-squat) were performed by each subject. There was no relationship between functional test scores and Isokinetic strength assessment. There was a poor relationship between functional test scores and Kujala questionnaire score (r = 0.47 for semi squat test and 0.37 for step down test). The overall mean scores of quadriceps Isokinetic parameter in 60 degree per sec speed, functional test scores and Kujala subjective knee assessment scores was less in patients with PFPS. This study showed that both Isokinetic dynamometry and functional tests must be done individually in patients with PFPS.

Key words: Functional tests, Isokinetic dynamometry, Patellofemoral pain syndrome

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INTRODUCTION

PFPS is the most common knee injuries in patients referred to orthopedic and sport clinics (Loudon *et al*., 2002; Alaca *et al*., 2002; Fredericson *et al*., 1995).

The traditional treatment method for these patients was quadriceps muscle isometric or isotonic exercise in open and closed chains (Pincivero *et al*., 1997; Alaca *et al*., 2002; Keays *et al*., 2003). Recently, Isokinetic dynamometry and functional tests was performed to determine the extent of knee muscles weakness before treatment (Negrete and Brophy, 2000; Petschenig *et al*., 1998; Andrerson *et al*., 2003).

The most important parameter in Isokinetic test is Hamstring/Quadriceps ratio (H/Q), which is about 1 (Aaggard *et al*., 1995; Ostenberg and Raos, 1998). In PFPS this ratio will be less than 1 means that there is a neuro-muscular deficit in agonist-antagonist contraction (Alaca *et al*., 2002; Loudon *et al*., 2002). As Tsiokanos *et al*. (2002) described, there is a significant relationship between knee extensor Isokinetic strength and functional tests.

Keays *et al*. (2003), Petschenig *et al*. (1998), Mattacola *et al*. (2002) and Juris *et al*. (1997) in their researches with Biodex system noticed that there is a positive relationship between quadriceps muscle strength (in different speeds) and functional tests after ACL reconstruction.

The aim of this study was to determine the Quadriceps/Hamstring, Isokinetic strength and its relationship with functional tests and Kujala subjective assessment in patients with PFPS.

MATERIALS AND METHODS

This case-control study was performed in 2005-2006 at Department of Biomechanics, Iran rehabilitation school. 30 non-athletic subjects (15 healthy and 15 patients with PFPS) aged between 20-30 years old participated. As we selected patients according to inclusion criteria and because Isokinetic tests was very difficult and aggravating pain, thus only 15 patients was selected among 43 who referred to clinic.

Inclusion criteria: Positive Clark test (Magee, 2005), periodic giving way, patella creptation, patellar medial and lateral border tenderness, retro patellar pain (especially after exercise), quadriceps muscle atrophy and patellofemoral joint pain within previous 6 weeks.

Exclusion criteria: Any inter-articular derangement, malunion after lower limb fracture, acute joint pain, treatment for major knee problems within the previous 6 month such as ligament reconstruction or meniscal tearing.

Patient selection: The patients diagnosed with PFPS, who met the inclusion criteria were given more information about the purpose of the study and were asked to participate. The personal consent was also taken for those who enrolled.

Data collection

Phase 1: Warm-up phase; This phase contained, 5 min stationary bicycling and muscle stretching (Quadriceps, Hamstring, Gastrocnemious and Iliotibial band), each muscle 3 times and each time 10 sec.

Phase 2: In this phase functional tests were performed. The sequence of tests was also altered to avoid fatigue induced by muscle activity. These tests were as follow:

A: **Step down test:** This test was done on 20.5 cm step for 30 sec. The number of up-down steps was counted and recorded.

B: **Bilateral squat:** In this test, each patient flex the knee up to 90 degree and return to starting position (upright standing). The number of performance was recorded for 30 sec.

Phase 3: In this phase, Isokinetic strength of knee muscles was assessed by Biodex dynamometer system in sitting position, during 10 to 90 degree of knee flexion (Pincivero *et al*., 1997; Mattacola *et al*., 2002; Petschenig *et al*., 1998; Keays *et al*., 2003) within two different speeds; 60 and 120 degree per sec (Petschenig, 1998; Keays *et al*., 2003). Three maximum eccentric and concentric contractions were given from quadriceps and hamstring muscles in both speeds randomly.

Phase 4: Each subject performed 5 min stationary bicycling as cool down phase.

Finally Kujala questionnaire scale was completed by patients as subjective knee assessment.

RESULTS

The most previous researches was done on small sample groups (n = 12 or 15), so we compared present results with the same other valuable researches.

Table 1 showed mean and standard deviation of physical characteristics of subjects.

Table 1: Physical properties of normal subjects and patients with PFPS

Variables	Normal	Patient
Age	23.00±1.98	23.46±2.35
Height	170.43±8.09	169.43±6.15
Weight	63.00±6.04	62.26±7.77
Lower limb length	81.00±4.79	82.56±3.69
BMI	21.89±2.08	21.74±2.7
Bilateral squat test (count during 30 sec)	19.40±2.87	14.06±2.28
Step test (count during 30 sec)	18.93±1.7	14.06±1.9

Table 2: Quadriceps/Hamstring ratio in two different speeds (60 and 120 degree per sec)

Variables	Normal	Patient
H/Q ratio during extension (60 degree per sec)	0.79±0.17	1.10±0.29
H/Q ratio during extension (120 degree per sec)	0.98±0.17	1.05±0.18
H/Q ratio during flexion (60 degree per sec)	0.51±9.1	0.84±0.19
H/Q ratio during flexion (120 degree per sec)	0.52±0.16	0.77±0.19
Hamstring isometric maximum peak torque	84.23±27.37	75.00±22.17
Quadriceps isometric maximum peak torque	157.46±45.07	111.84±34.8

H = Hamstring muscle, Q = Quadriceps muscle

According to importance of knee muscle strength and coordination in patients with PFPS, Quadriceps/Hamstring ratio was measured as an important key in these patients (Table 2).

Peak torque of muscle activation in both concentric and eccentric contractions and in 60 and 120 degree per sec speeds was measured and shown in Table 3.

Kujala questionnaire score as a subjective functional assessment of knee is between 0 and 105. In this study, Kujala score was 103±1.79 in normal subjects and 78.26±4.43 in patient group. Table 4 showed pain intensity measured according to VAS scale.

This study showed that there was no relationship between maximum peak torque of quadriceps and hamstring muscles in 60 and 120 degree per sec speeds and functional test scores (p>0/05). Also there was no relationship between maximum peak toque per body weight (concentric and eccentric)of quadriceps and hamstring muscles with functional test scores in 60 and 120 degree per sec speeds ($p>0.05$), but there was a significant relationship between Kujala subjective questionnaire score and functional test scores ($p = 0.032$ and $r = 0.47$ for squat test, $p = 0.052$ and $r = 0.37$ for step down test) and a significant relationship between Kujala subjective questionnaire score and hamstring/quadriceps ratio during knee flexion with 60 degree per sec speed ($p = 0.047$ and $r = 0.56$). A reverse relationship was seen between Kujala subjective questionnaire score and knee pain according to VAS score ($p = 0.022$ and $r = 0.585$). In patients group, squat and step down functional test scores was less than normal group.

Table 3: Average of quadriceps and hamstring muscles peak torque in different contractions and speeds in normal and patient groups

Variables	Normal	Patient
Quadriceps concentric maximum peak torque (120 degree per sec)	123.68±30.14	108.58±30.79
Quadriceps eccentric maximum peak torque (120 degree per sec)	200.00±51.88	151.94±36.39
Quadriceps concentric maximum peak torque (60 degree per sec)	147.44±35.66	114.27±40.06
Quadriceps eccentric maximum peak torque (60 degree per sec)	195.65±51.53	140.30±38.48
Hamstring concentric maximum peak torque (120 degree per sec)	102.72±30.99	116.58±28.73
Hamstring eccentric maximum peak torque (120 degree per sec)	120.24±27.20	120.56±29.61
Hamstring concentric maximum peak torque (60 degree per sec)	98.98±33.32	113.06±30.6
Hamstring eccentric maximum peak torque (60 degree per sec)	115.70±31.32	116.36±28.49

Table 4: Pain intensity measured by VAS scale

Pain	Normal	Patient
During step up-down	0	4.16±2.09
During sitting with knee flexion	0	5.96±1.45
During isometric contraction	0	1.63±1.99
Average	0	3.90±0.81

DISCUSSION

Isokinetic exercises could increase strength and power of muscles, but because these exercises are not functional, there is no relationship between power improvement and functional capacity. Present result was the same as other researchers (Alaca *et al*., 2002; Anderson *et al*., 1991; Ostenberg and Raos, 1998; Swarup *et al*., 1992; Barber *et al*., 1990).

We noticed that there was no relationship between functional test results and Isokinetic parameters of quadriceps and hamstring muscle in both 60 and 120 degree per sec. Because the speed of Isokinetic exercises was changed during the task, this result was obtained (Juris *et al*., 1997; Destaso *et al*., 1997; Anderson *et al*., 1991; Wilk *et al*., 1994; Tsiokanos *et al*., 2002). Another result of this study was no relationship between subjective assessment of knee function (Kujala questionnaire) and functional tests. This result was the same as Borsa *et al*. (1998) and Wilk *et al*. (1994). Also we noticed that there was a weak relationship between Kujala questionnaire score and functional test performance (Squat and Step-down). This result was the same as the findings of Noyes *et al*. (1991), Wilk *et al*. (1994), Borsa *et al*. (1998) and Sernert *et al*. (1999).

Present results about the presence of a reversed relationship between subjective assessment of knee function and pain scale was the same as other researches (Alaca *et al*., 2002; Hohner *et al*., 1995; Dvir, 2004).

It means that functional activity capacity will increase as patellofemoral pain decreased. Result of comparison between Isokinetic parameters of knee muscles in healthy subjects and patients with patellofemoral pain syndrome, showed that in patients group all Isokinetic parameters (peak torque, peak torque/body weight and muscle power) of quadriceps muscle, both concentrically and/or eccentrically in 60 and 120 degree per sec was significantly less than healthy subject group. This result was the same as Alaca *et al.* (2002), Anderson *et al.* (2003), Dvir (2004) and Wilk *et al.* (1994).

The main causes of these results are as followed:

- In low speeds, patellofemoral joint exposed to high external load and high stress for a longer period that lead to quadriceps muscle inhibition.
- Quadriceps muscle inhibited due to low activation of muscle reflex arc because of joint over loading and pain.

We noticed that eccentric/concentric activity ratio of quadriceps muscle in patients group decreased at both 60 and 120 degree per sec.

Malone (1992) and Dvir (2004) maintained that this decrease is related to selective quadriceps muscle inhibition due to pain, because of high eccentric torque and high stress in patellofemoral joint. This study was a basic one and now we continue the same research on sport injured athletes before and after functional and neuro-muscular training exercises.

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