Influence of Proprioceptive Training on Knee Function in Patients with Knee Osteoarthritis

Mohamed Elgendy*, Fatma Amin*, Hasan Baraka and Osama Khaled*.**
* Department of Basic Science, Faculty of Physical Therapy, Cairo University
** Department of Orthopedic surgery, Faculty of Medicine, Azhar University.

ABSTRACT

Background: *There is a prominent loss in proprioceptive sensation in patients with knee osteoarthritis compared with control subjects of the same age and gender.* ***Purposes:*** *To investigate the influence of proprioceptive training on knee function in patients with knee osteoarthritis.* ***Study Design:*** *A pre test post test control group design.* ***Materials and methods:*** *Thirty patients with knee osteoarthritis from both sexes were involved, aged between 40-60 years. They were divided into two equal groups, fifteen patients each. Patients in the first group received a traditional exercise program in the form of stretching and strengthening exercises. Patients in the second group received a proprioceptive training program in addition to stretching and strengthening exercises. Training was done 3 times a week for 8 weeks. Pain level, functional performance and proprioceptive accuracy were measured before and after treatment.* ***Results:*** *there were significant differences between the two groups in pain (p=0.007) and (p=0.009) for the right and left knees respectively, functional performance (p=0.008) and proprioceptive accuracy (p=0.037) and (p=0.014) for the right and left knees respectively.* ***Conclusion:*** *Proprioceptive training proved to be beneficial in improving functional performance, perceived knee pain and proprioceptive accuracy in patients with knee osteoarthritis as compared with traditional exercise program.*
Key words: *osteoarthritis, knee function proprioceptive training, proprioception.*

INTRODUCTION

Osteoarthritis (OA) is considered to be a chronic degenerative and progressive condition affecting synovial joints which mainly causes degeneration of hyaline cartilage, its symptoms occur most often in the weight bearing joints in the lower extremities. OA is wide spread slowly developing disease with age and the most common large joints involved in this disease are the knee joints[5,13,17].

The cardinal symptoms of knee osteoarthritis are pain, decreased range of movement, stiffness, muscle weakness and fatigue; all these symptoms collectively lead to impaired functional performance[12].

Many physical therapy strategies were used in management of knee osteoarthritis, such as hot packs, infra red, LASER, ultrasound, transcutaneous electrical nerve stimulation, electrical acupuncture, electrical stimulation and exercise[15].

Exercise is considered as an essential part of any treatment program designed for management of knee osteoarthritis as it reported to decrease pain, improve muscle strength and improve functional performance[10].

Proprioception allow the body to maintain stability and orientation during both static and dynamic activities and also it is the process by which the body can vary muscle contraction in immediate response to incoming information regarding external force[7]. It is also

key component of active joint stability, because afferent input indirectly produces and modulates the efferent response that allow the neuromuscular system to maintain a balance of stability and mobility. In essence, active joint stability is the "product" of the proprioceptive system[9,14].

Knee Proprioception found to be affected in subjects with knee OA[2,18,20]; this may be as a result of mechanoreceptor damage due to dysfunction in capsule, ligament, Cartilage and surrounding muscles[18].

The purposes of the study were to investigate the influence of proprioceptive training on pain level, functional performance and knee proprioception accuracy in patients with chronic knee OA.

SUBJECTS AND METHODS

Design of the study

A pre test post test control group design was used to investigate the influence of proprioceptive training on knee function in patients with chronic knee OA.

Subjects

Thirty patients with chronic bilateral knee OA of both sexes with age of 40-60 years were randomly assigned into two groups, each group consisted of fifteen patients, and there were no significant differences between the two groups in age, weight and height. The first group received a traditional exercise program and the second group received a proprioceptive training program plus traditional exercise program. All patients were fulfilling the criteria of the American college of rheumatology which include knee pain, stiffness less than 30 minutes, crepitus and presence of osteophytes[1], patients were excluded if they had neurological disease, such as Parkinson's disease and CVA, metabolic or vascular disease with a neurological component such as diabetes or atherosclerosis, previous knee operation and recent significant injury of the knee, femur or tibia[2].

Instrumentation

1- Biodex system 3 Pro Multijoint system isokinetic dynamometer (Biodex Medical Inc., Shirley, NY) was used to measure the proprioceptive accuracy of the knee joint; the measurement was done before treatment and after completion of all treatment sessions.
2- Visual analogue scale: 10 cm visual analogue scale (VAS, 0 = no pain; 10 = unbearable pain), which assesses the severity of pain in general, at night, after inactivity, and during ADL.

Evaluative procedures

1- Knee Proprioception level:

Knee proprioception level as represented by repositioning accuracy was assessed by the Biodex system 3 Pro Multijoint system isokinetic dynamometer (Biodex Medical Inc., Shirley, NY) through active repositioning test. Each patient was asked to sit on the chair of the Biodex system with his tested knee positioned in 90° flexion (starting position), the patients were stabilized in the test position by straps around the trunk, pelvis and thigh, and the patients were blind folded[4,8].

Initially the anatomical reference angle was set at 30° then the patient leg was returned to the starting position then the patient was asked to move his limb to the target angle (30°) actively, when the patient felt that he reached the target angle actively he told the examiner to stop the apparatus using the Hold/Release button[3]. Three trials were done with rest period of 3 minutes between the trials and the mean angular differences of the 3 trials, between the target angle position and the patient perceived

end range position will be recorded in degrees as the deficit in repositioning accuracy and will be used in the statistical analysis[19].

2- Pain level:

The patient level of pain was assessed by using 10 cm visual analogue scale (VAS, 0 = no pain; 10 = unbearable pain).

3- The functional performance:

The functional performance of the patients was assessed by the Meenan functional assessment scale[11], which assesses the functional performance in five areas including pain, walking distance, walking aids, standing and climbing stairs.

Treatment procedures

The patients were divided into two groups of equal number (15 patients for each), the first group received traditional exercise program in the form of stretching of the hamstring muscle, stretching of the calf muscles straight leg raise exercise and isometric strengthening of the quadriceps muscle. The second group received the same exercise program in addition to a proprioceptive training program which includes 5 steps; foot fits, anteroposterior rolling movement, sliding rolling movement, multidirectional rolling movement from sitting and multidirectional rolling movement from standing. Progression to a new step was provided by the ability of the patient to do the previous step with minimal difficulty. The two groups were trained 3 times a week for a period of 8 weeks.

Data collection and statistical analysis

Data collected were analyzed using descriptive statistics (mean and standard deviation) and t-test to test the difference within and between the two groups.

RESULTS

1- Pain level

Control group

The average pain level before treatment for the right knee was 7 and the standard deviation was ±1.25, after treatment the average was 4.7 and the standard deviation was ±1.29. The average pain level before treatment for the left knee was 6.2 and the standard deviation was ±1.47, after treatment the average was 4.3 and the standard deviation was ±1.29 as shown in figure (1). The paired t-test revealed that there were significant differences in pain in the control group before and after treatment.

Experimental group

The average pain level before treatment for the right knee was 6.9 and the standard deviation was ±0.9, after treatment the average was 3.4 and the standard deviation was ±0.9. The average pain level before treatment for the left knee was 6.4 and the standard deviation was ±1.3, after treatment the average was 3.2 and the standard deviation was ±0.9 as shown in figure (1).The paired t-test revealed that there were significant differences in pain in the experimental group before and after treatment.

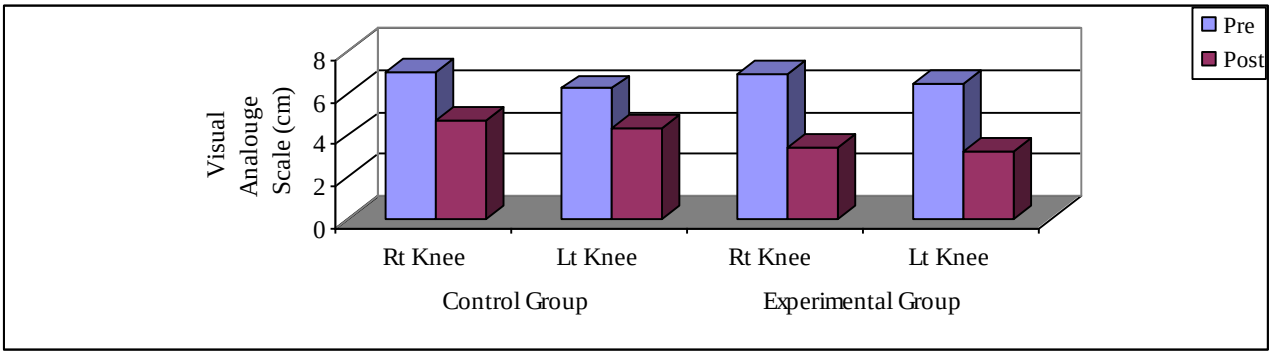

Fig. (1): Mean and standard deviation of pain for control and experimental groups.

1- Functional performance:

Control group

The average functional performance before treatment was 14.9 and the standard deviation was ±2.26, after treatment the average functional performance was 11.1 and the standard deviation was ±2 as shown in figure (2). The paired t-test revealed that there were significant differences in the functional performance in the control group before and after treatment.

Experimental group

The average functional performance before treatment was 13.6 and the standard deviation was ±1.5, after treatment the average functional performance was 9.4 and the standard deviation was ±1.2 as shown in figure (2). The paired t-test revealed that there were significant differences in the functional performance in the experimental group before and after treatment.

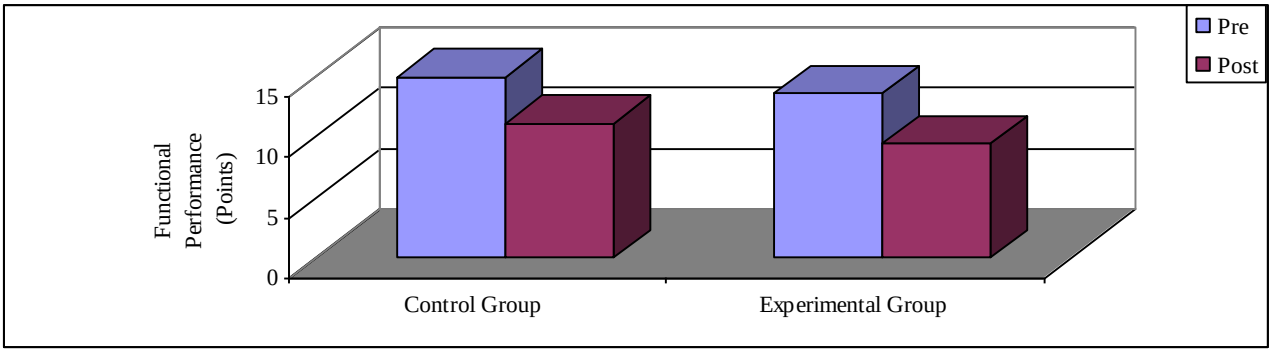

Fig. (2): Mean and standard deviation of functional performance for control and experimental groups.

Proprioception accuracy

Control group

The average repositioning absolute error before treatment for the right knee was 6.4 and the standard deviation was ±2.31, after treatment the average was 5.4 and the standard deviation was ±2.1. The average repositioning absolute error before treatment for the left knee was 6.8 and the standard deviation was ±2.9, after treatment the average was 6 and the standard deviation was ±2.5 as shown in figure (3). The paired t-test revealed that there were significant differences in repositioning absolute error in the control group before and after treatment.

Experimental group

The average repositioning absolute error before treatment for the right knee was 6.8 and the standard deviation was ±1.5, after treatment the average was 4.2 and the standard deviation was ±0.9. The average repositioning absolute error before treatment for the left knee was 6.7 and the standard deviation was ±1.3, after treatment the average was4.2 and the standard deviation was ±0.9 as shown in figure (3). The paired t-test revealed that there were significant differences in repositioning absolute error in the experimental group before and after treatment.

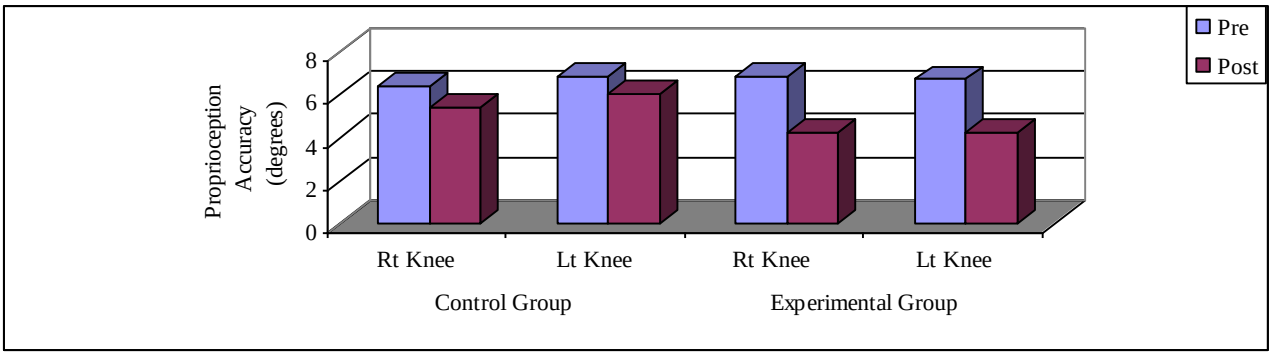

Fig. (3): Mean and standard deviation of proprioception accuracy for control and experimental groups.

Differences in pain, functional performance and proprioception accuracy before treatment for both group:

Unpaired t-test between the two groups before treatment revealed that there were no significant differences in pain where the t value was 0.33, while P was 0.74 for the right knee, and the t value was 0.39while P was 0.7for the left knee, there were no significant differences in the functional performance between both groups where the t value was 1.8, while P was 0.08and there were no significant differences in repositioning absolute error where the t value was 0.55, while P was0.58for the right knee, and the t value was 0.09while P was 0.93for the left knee as shown in table (1).

Table (1): Results of unpaired t-test between control-experimental groups before treatment.

	VAS		Functional Performance	Proprioception Accuracy	
	Rt Side	Lt Side		Rt Side	Lt Side
T	0.33	0.39	1.8	0.55	0.09
P	0.74	0.7	0.08	0.58	0.93
Sig	NS	NS	NS	NS	NS

Differences in pain, functional performance and proprioception accuracy after treatment for both group:

Unpaired t-test between the two groups after treatment revealed that there were significant differences in pain after treatment where the t value was 2.937, while P was 0.0007for the right knee, and the t value was 2.828 while P was 0.0009 for the left knee, there were significant differences in the functional performance after treatment where the t value was 2.856, while P was 0.0008 and there were significant differences in repositioning absolute error after treatment

where the t value was 2.196, while P was 0.037for the right knee, and the t value was 2.626 while P was 0.014 for the left knee as shown in table (2).

Table (2): Results of unpaired t-test between control-experimental groups after treatment.

	VAS		Functional Performance	Proprioception Accuracy	
	Rt Side	Lt Side		Rt Side	Lt Side
T	2.937	2.828	2.856	2.196	2.626
P	0.007	0.009	0.008	0.037	0.014
Sig	S	S	S	S	S

DISCUSSION

Within the limitations of this study, significant positive changes were detected in the proprioceptive training group compared with the traditional exercise group in pain level (P was 0.0007) for the right knee while (P was 0.0009) for the left knee, functional performance (P was 0.0008), and proprioception accuracy (P was 0.037) for the right knee while (P was 0.014) for the left knee.

Improvement in functional performance of the proprioceptive training group might be the result of the improvement of dynamic stabilization by the synergistic and synchronous working of the muscle group and increased coordination between muscle groups and the response to the sensorial information. Similarly, repetitive movements that are used in the daily life exercises might have contributed to this improvement[6].

Exercise regimens that include repetitive movements increase the ability of the person's control over joint movements in all positions; dynamic stability may help to control abnormal joint translation that occurs during daily movements and may provide increased motor control through a reflex route, also reduction of pain might be contributed into improvement of the functional performance[6].

The improvement of the proprioceptive accuracy in the proprioceptive training group compared with the traditional exercise group might be attributed to sufficient stimulation of proprioceptors and activation of the proprioceptive system[6].

It was suggested that general exercise programs are less effective than programs that target a specific system (e.g. visual, vestibular, and somatosensory) that functions to maintain balance. In the current study, the proprioceptive training group received a training program that was targeting the sensorimotor system; in turn improvement of proprioceptive function as represented by joint position sense may be explained on the light of this principle.

Previous studies stated that pain reduction after exercise regimens may be attributed to gaining muscle strength[10,16]. Also it was mentioned that proprioceptive deficits in OA may have effect on pain, thus improving the proprioceptive function may be associated with pain reduction[16]. The improvement of the proprioceptive accuracy in the proprioceptive training group compared with the traditional exercise group might be attributed to sufficient stimulation of proprioceptors and activation of the proprioceptive system[6].

Conclusions

Proprioceptive training proved to be beneficial in improving functional performance, perceived knee pain and proprioceptive accuracy as represented by repositioning accuracy in patients with knee

osteoarthritis as compared with traditional exercise program.

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الملخص العربي

تأثير تدريب المستقبلات الحسية العميقة على وظيفة مفصل الركبة فى مرضى خشونة الركبة

أجريت هذة الدراسة في كلية العلاج الطبيعي خلال المدة من مايو إلى سبتمبر 2005 لدراسة تاثير تدريب المستقبلات الحسية العميقة على وظيفة الركبة فى مرضى خشونة الركبة . شارك فى هذة الدراسة ثلاثون مريضا من مرضى خشونة الركبة من كلاُ الجنسين تراوحت أعمارهم من 40 إلى 60 سنة، تم تقسيمهم الى مجموعتين متساويتين 15 مريضا فى كل مجموعة . اعطيت المجموعة الاولى (المجموعة الضابطة) برنامج تمارين تقليدى فى شكل تمارين اطالة للعضلة الخلفية و عضلة السمانة، وتمارين تقوية للعضلة ذات الأربعة رؤوس وتم التدريب ثلاث مرات اسبوعيا لمدة 8 اسابيع . أعطيت المجموعة الثانية (المجموعة التجريبية) برنامج تدريب للمستقبلات الحسية العميقة بجانب برنامج تمارين تقليدى، وتم التدريب ثلاث مرات اسبوعيا لمدة 8 اسابيع . تم قياس مستوى الالم . الاداء الوظيفى ودقة المستقبلات الحسية العميقة قبل و بعد العلاج . تم تحليل المعلومات المجموعة احصائيا من خلال الأحصاء الوصفية والتحليلية لمعرفة الاختلافات داخل كل مجموعة وبين المجموعتين . وقد أظهرت النتائج وجود أختلافات ذات دلالة إحصائية بين الأشخاص فى المجموعة الضابطة قبل وبعد العلاج ، وجود أختلافات ذات دلالة إحصائية بين الأشخاص فى المجموعة التجريبية قبل و بعد العلاج . ووجود أختلافات ذات دلالة إحصائية بين المجموعتين بعد العلاج . وبذلك وجد أن برنامج تدريب المستقبلات الحسية العميقة أعطى تأثير أفضل من برنامج التمارين التقليدى على مستوى الألم للأداء الوظيفى ودقة المستقبلات الحسية العميقة فى مرضى خشونة الركبة .