Biofeedback Training for Treating Patellofemoral Pain

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ABSTRACT

Introduction: *Patellofemoral pain syndrome (PFPS) describes anterior or retropatellar knee pain in the absence of other pathology. It is generally agreed that the patellofemoral pain syndrome should be managed initially by conservative rather than surgical means.* ***Purpose:*** *the purpose of this study was to clarify the importance of addition of biofeedback to vastus medialis obliquus strengthening exercises in the treatment of patellofemoral pain syndrome.* ***Methods:*** *a comparison was held between two groups of patients (A&B). Group (A) received a traditional physical therapy program with biofeedback and group (B) received a traditional physical therapy program only. Treatment outcome was determined from: 1) Visual analogue scale (VAS) to assess patellofemoral pain severity and Cincinnati Rating System to assess knee function.* ***Results:*** *The results showed a statistically significant decrease in (VAS) and a statistically significant increase in Cincinnati rating system for both groups (P<0.05). There was no statistical difference between groups in (VAS) (P<0.5). Also there was no statistical difference between groups in Cincinnati rating system (P<0.8).* ***Conclusion:*** *Combining biofeedback training to the traditional physical therapy rehabilitation program for treating patellofemoral pain syndrome was equally effective as traditional physical therapy rehabilitation program only. This may be limited to the use of a Tr20C biofeedback device.*

Keywords: *Patellofemoral pain syndrome, Biofeedback, Visual analogue scale and Cincinnati Rating system.*

INTRODUCTION

Patellofemoral pain is a common aliment within both the running and general populations. Many of the structures of the anterior knee that comprise the patellofemoral joint can be the source of chronic pain and inflammation that is associated with this condition. In general, patellofemoral pain can affect about 25% of the population[1].

Patellofemoral pain syndrome (PFPS) describes anterior or retropatellar knee pain in the absence of other pathology. Clinically, the condition presents as diffuse anterior or retropatellar knee pain exacerbated by activities such as stair climbing, prolonged sitting, squatting, and kneeling. PFPS is a common complaint in the sporting and general populations especially in which repetitive lower limb loading is involved. Patellar crepitus, a popping or grinding sensation, is often described by PFPS patients as well as incidences of swelling, buckling of the knee, or locking of the patella[2].

Factors that predispose to patellofemoral syndrome may include abnormal biomechanics, soft tissue tightness, muscle dysfunction or training[3]. Although the development of PFPS is a multifactorial, abnormal maltracking of the patella has been proposed as a contributing factor: this may increase patellofemoral contact pressure and precipitate pathology in the patellofemoral articular cartilage[4].

One proposed mechanism for abnormal patellar tracking is an imbalance in the activity of vastus medialis obliquus (VMO) relative to

vastus lateralis (VL). This could be caused be caused either by a reduction in the force-producing capabilities of the VMO or altered temporal control of VMO and VL activity in PFPS sufferers. Altered onset of the VMO may be of particular importance because in the symptomatic population it has been hypothesized that VMO must be activated earlier than VL to optimally track the patella due to VMO'S smaller cross-sectional area and VL's predominantly laterally directed force[4].

It is genally agreed that the patellofemoral pain syndrome should be managed initially by conservative rather than surgical means. Not only this but also, it is generally managed successfully with physiotherapy[3]. Conservative treatments include patient education, physical therapy, exercise, bracing, activity modification and medications[5].

The main aims of the treatment for patellofemoral pain are twofolds. First, the therapist should unload abnormally stressed soft tissue around the patellofemoral joint by optimizing the patella position. Second, the therapist should aim to improve the lower-limb mechanics, which, if well executed, will significantly decrease the patient's symptoms. The physiotherapist can achieve this by appropriate stretching and muscle training. This means that the primary goal in treating PFPS is to condition the quadriceps muscle while maintaining moderate load in the joint[3].

Biofeedback is a therapeutic procedure that used electronic or electromechanical instruments to measure, process, and feedback to patients, in the form of auditive and/or visual feedback signals, information about their normal and /or abnormal neuromuscular and autonomic activity. Biofeedback treatment is used to help patients develop greater awareness of and an increase in voluntary control over their physicologic processes that are otherwise involuntary and unfelt[5].

The treatment of PFPS provides an example of using EMG biofeedback in an exercise progression. Failure to establish volition control in the open chain before beginning closed chain exercise often reinforces substitute motor pattern. Thus, it is important to assess and train volitional control in an open chain before progressing to more functional, closed chain movement[6]. Few studies supported the use of biofeedback training in the rehabilitation of patients with PFPS[7]. So the purpose of this study was to investigate the effect of addition of biofeedback – controlled exercise program in PFPS management.

MATERIAL AND METHODS

Thirty male patients diagnosed as patellofemeoral pain syndrome were incorporated in this sutyd. They were divided into two experimental groups. Their age ranged from f17-32 years, with a mean of 26 ± 2.32. first experimental group (group A) included fifteen patients who received biofeedback controlled Vastus medialis obliquus strengthening exercises, patellar taping and stretching exercises. While Second control group (group B) included also, fifteen patients who received traditional physical therapy program (Vastus medialis obliquus strengthening exercises, patellar taping and stretching exercises).

Inclusion Criteria

Patients had to meet all the following criteria in order to participate in the study:

- Referred from an orthopedist with a diagnosis of unilateral patellofemoral pain syndrome.

- Age of patients ranges form 17-35 years (mean = 26 ± 2.32).
- All patients are athletic persons.

Exclusion criteria

Patients were excluded form the study for any of the following reasons:

- Patients with history of any previous surgeries, knee trauma, intra-articular injection therapy, current medication or other physicotherapy modalities.
- Patients with any other knee pathology.

Evaluation of pain

The patients were instructed that a continues lo-cm line represents the degree of pain with no pain at the extreme left side and the maximum at the extreme right side, every patients had to put a dash on that line. The patient had to put a dash on one line to represent his pain during rest and a dash on other line to represent his pain during his game performance[5].

Evaluation of knee functional capacity

Cincinnati Rating System has been used to evaluate the patient knee functional performance, it is a self report questionnaire that elicits information about the functional capacity of the knee assessing (1) pain, (2) swelling, (3) giving way, (4) other symptoms (unscored), (5) overall activity level, (6) walking, (7) stairs, (8) running activity (9) jumping or twisting activity. The point (4) (other symptoms [unscored]) was not included in that study as it is beyond our concern (appendix).

The biofeedback machine (TR-20C)

It is a dual channel machine (channel A and B) used for treatment for variousdisorders (figure1). It has back panel (at which there is a 9 Volt battery compartment), the bottom panel (at which the amplifier cable is connected in channel A and B, the surfaces electrodes will be connected to that amplifier cable) and the front panel which contains:

- A rotatory thumb wheel, which turns the machine on and off and controls audio volume.
- Two led bar graphs to display microvolt level, goal type and goal level.
- Four led indicators to provide status information (light indicators).
- Up and down arrow keys to change the goal.
- A and B goal keys to define A and B goal type and direction.

Treatment procedures

The traditional physical therapy program consists of patellar taping, strengthening and stretching exercises.

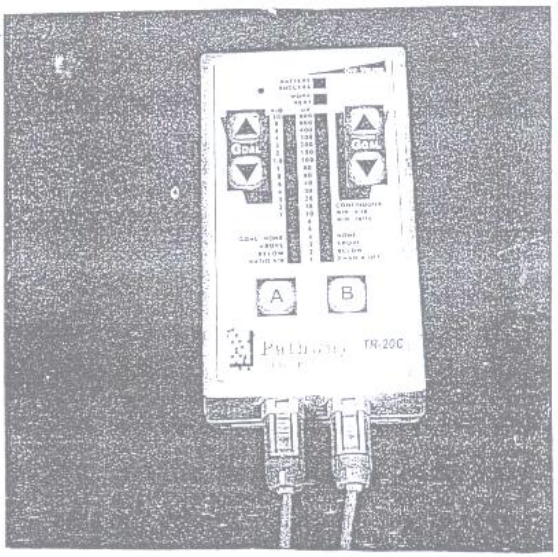

Fig. (1): Biofeedback (TR 20C) maehine.

Both groups received the traditional physical therapy program (Vatus medialis obliquus strengthening, stretching exercises and patellar taping) but in group (A) biofeedback have been used when performing quadriceps strengthening exercises. Biofeedback machine electrodes positionsing for group (A) described as follows:

The electrode for VMO (channel A) was placed over the vatus medialis obliquus belly 4cm superior to and 3cm medical to the superomedial patella borders and oriented 55 degree to the vertical. The electrode for VL (channel B) was placed 10 cm superior and 6-8 cm lateral to the superior border of the patella and oriented 15 degree to the vertical.

The machine prepared to fit its benefit for PFPS strengthening exercises which was to give feedback to the patient when VMO (cnannel A) work was over VL (channel B) so, the patients heard auditory and saw visual feedback only when channel A: channel B is more than 1:1.

Vastus medialis obliquus strengthening exercises

Wall squats

The patient is ordered to stand with the back to the wall and the foot out in front. He squatted by bending at the hips and knees. He is informed that knees should remain over the ankles so that the lower leg doesn't go beyond a perpendicular line to the floor, knees should not flexed more than 90^{o} and he should hold this position in an isometric for several seconds or move up and down without pausing in the low position[8].

Plie

The patient is ordered to stand with the feet in a wide stance with the hips and feet turned outward about 45^{o}. The patient is informed that he should slowly bend the knees, keeping them in line with second toe and his back should remain straight as he flexes knees and hips[8].

Lunge

The patient is ordered to stand with the involved extremity I nfront of him. He flexed

the front knee. He is informed to shift weight on the front knee[8].

Stepping down

The patient was asked to descend form 10cm chair by his sound knee[8].

Isometric exercises

1- Medial rotation / extension exercise

The patient was in supine position with the involved knee in 70^{o} flexion with the tibia laterally rotated 30^{o}. The therapist was in stride standing behind the affected limb fixing the patient thigh with one hand and the other hand hold the lower part of tibia. The patient was told to medially rotate the tibia simultanceously with knee extension in isometric contraction for 6 seconds[2].

2- Extension exercise

The patient was in sitting position on the plinth with the affected knee extended and the therapist behind him with one hand rested at patient thigh and the other was giving resistance below affected knee. The patient is informed to hold an extension isometric contraction for 6second[2].

3- Leg press exercise

The patient was in supine position with his thigh flexed in 60^{o} and knee is in last 30^{o} knee extension, the therapist supported thigh with one hand and the other hand holds the foot. The patient extended the knee with the therapist lower hand resisted this movement[2].

All strengthening exercises were applied according to patient's pain tolerance, beginning with isometrics exercises then other exercises which mentioned before. The patient was asked to hold contraction for 6 to 10 seconds. Strengthening exercises training session were applied for 15 minutes (after patellar taping application).

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Stretching exercises

Hamstring, Quadriceps, Tensor fasciae , Gastrocnemius and Soleus stretching exercise[9].

In all stretching exercises the therapist applied a stretch force for 30 seconds for 5 repetitions.

Patellar taping

The taping was applied while the patient was in supine position, the therapist applied the tap from the lateral knee side to the medial side while forcing the patella to move medially.

The total duration of the whole treatment was 30 minutes. The treatment was applied daily for 12 sessions. Patients were asked to perform his sport training and not to rest from it throughout the whole treatment duration (because by rest pain might be decreased).

RESULTS

The obtained results revealed that biofeedback group was a highly statistically significant decrease in pain acuity of pain and increase in knee functions (P=0.01 for all) (Table and Figure 2) and control group was a highly statistically significant decrease in pain acuity of pain and increase in knee functions (P=0.01 for all) (Table 2 and Figure 3).

Comparing the results of both groups:

On comparing the results of both groups, there was no statistically significant difference between both groups regarding pain acuity and knee function both before treatment and after treatment (table 3, 4 and figure 4,5).

Table (1): Comparison between before and after treatment for biofeedback group (group A).

Variable	Bio-feedback Group (group A)		t-value	P-value
	Before treatment	After the treatment		
VAS	5.19 (± 0.77)	2.37 (± 0.67)	21.318	0.01(S)
CRS	77.00 (± 3.85)	83.00 (± 2.85)	-10.869	0.01(S)

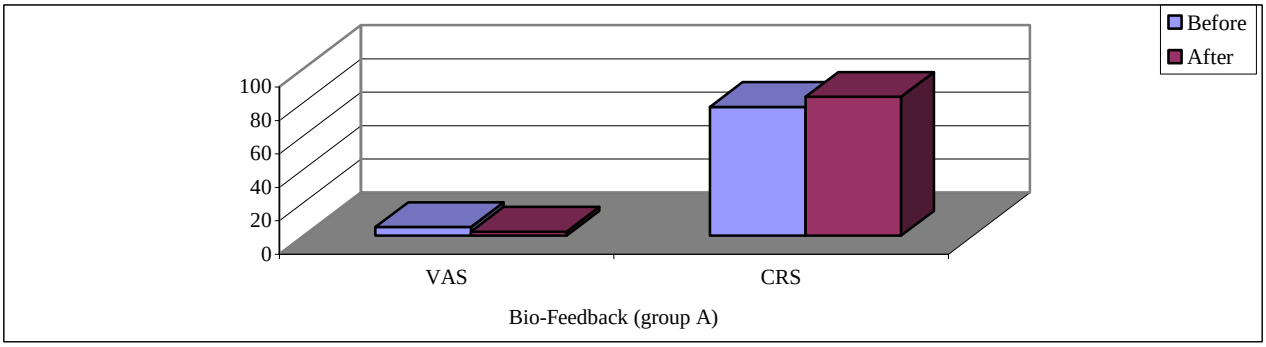

Fig. (2): Comparison between before and after treatment for biofeedback group (group A).

Table (2): Comparison between before and after treatment for control group (group A).

Variable	Bio-feedback Group (group A)		t-value	P-value
	Before treatment	After the treatment		
VAS	5.11 (± 0.98)	1.90 (± 0.65)	21.459	0.01(S)
CRS	76.67 (± 3.89)	82.80 (± 2.88)	-11.133	0.01(S)

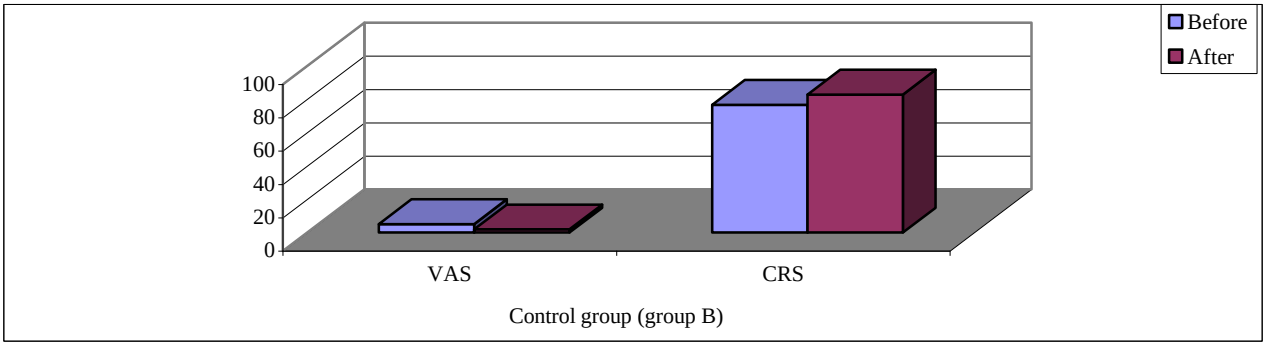

Fig. (3): Comparison between before and after treatment for control (group B).

Table (3): Comparison between groups before treatment.

Variable	Bio-feedback Group (group A)		t-value	P-value
	Before treatment	After the treatment		
VAS (Before)	5.19 (± 0.77)	5.11 (± 0.98)	0.549	0.80 (N.S)
CRS (Before)	77.00 (± 3.85)	76.67 (± 3.89)	0.236	0.81 (N.S)

(N.S): not significant

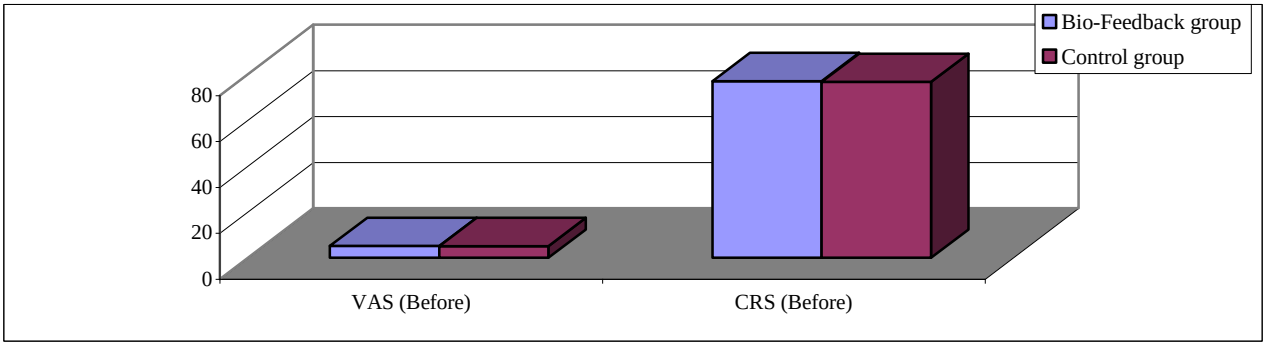

Fig. (4): Comparison between groups before treatment.

Table (4): Comparison between group after treatment.

Variable	Bio-feedback Group (group A)		t-value	P-value
	Before treatment	After the treatment		
VAS (after)	2.37 (± 0.67)	1.90 (± 0.65)	1.965	0.059(N.S)
CRS (after)	83.00 (± 2.85)	82.80 (± 2.88)	0.191	0.85(N.S)

(N.S): not significant

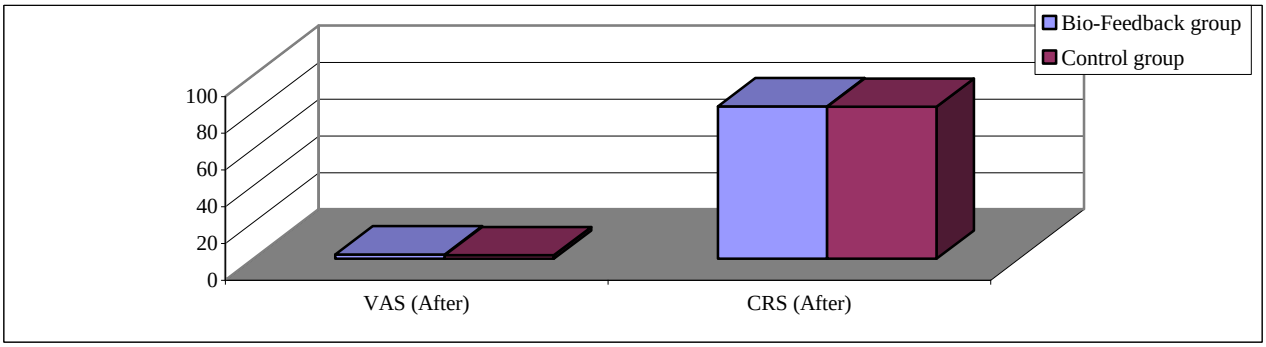

Fig. (5): Comparison between before group after treatment.

DISCUSSION

The results of this study revealed that both biofeedback-controlled exercises and exercises only without biofeedback were effective in reducing pain and increasing knee functional activity. There was no significant difference between biofeedback-controlled exercises and exercises only without biofeedback.

Dursun et al. (2001) had reported a similar result. There were a sixty patients (female and male) received the training sessions for 5 days a week for 4 weeks and a 3 days a week thereafter and they evaluated the patients by the beginning of the study and then at monthly interval for 3 monthes. Their study was high in that they applied the treatment program for 5 weeks and followed up the patients for 3 months .In our current study we applied the treatment program daily for 12 days while, Dursun et al. (2001) have used a more sophisticated EMG biofeedback device (Myomed 932) which has a clear and full-

screen display of the electromyographic signal. In our current study we used the TR20C biofeedback device without EMG biofeedback. Although it was easy to use but it contained some errors such as false auditory and visional feedback while patient were in rest period. In our current study we didn't assess vastus medialis obliquus and vastus larteralis contraction values while, Dursun et al. (2001) assessed their contraction value but they stated that testing the patients by functional tests would seem to be particular appropriate more than assessing VMO and VL muscle contraction values which is not reliable when measured repeatedly over long time frames.

In our current study we used Cincinnati rating system for assessing knee function while, Dursun et al used Functional index questionnaire. Cincinnati rating system is more commonly used, assessing more knee functions and its items contain more choices.

Crossley et al. (2002) showed significant difference in pain severity and knee disability between two groups of patellofemoral pain syndrome; one group received traditional physical therapy with biofeedback and the other group received placebo treatment (sham ultrasound and placebo taping). This study hasn't been designed to show the effect of biofeedback addition to traditional physical therapy but it considered biofeedback as a part of the traditional program instead, it has been designed to establish the efficacy of physical therapy program to patellofemoral pain syndrome. This study has used a MR-20 biofeedback machine which was a new version of Tr20c biofeedback machine that we used in our study.

El Nahass (1996) showed significant difference between pre-treatment and post-treatment values of Q-angle, sulcus angle and patellofemoral congruence angle after 4 weeks of EMG Biofeedback-controlled exercises for Patellofemoral pain syndrome patients. He stated that by the end of the fourth week of training, the vastus medialis showed great increase in the activity level and difference between the VL and VM activity level was 6.11 percent. This study was a more appreciative than Ingersoll and Knight (1991) study as the author studied a patellofemoral pain syndrome patients (not normal subjects as Ingersoll and Knight (1991)[12] did but Elnahass (1996) study included only one group of patients so we can't conclude from this study that biofeedback was more useful than exercises only.

Ingersoll and Knight (1991) showed significant difference between progressive resistive exercise group and EMG biofeedback group in normal, college females. The major difference between our study and Ingersoll and Knight (1991) is that we treated a patellofemoral pain syndrome patients and that we assessed knee pain and functions while, Ingersoll and Knight (1991) trained normal, college females and they assessed patellofemoral congruence (PFC) angle, the patellar rotation (PR) angle, and the sulcus angle which were not our concern.

Croce (1986) showed a similar results to Ingersoll and Knight (1991) as he trained healthy volunteers on quadriceps muscle strengthening and he compared biofeedback group (leg extension exercises with biofeedback control) to non-biofeedback group (leg extension exercises without . biofeedback control) but he measured EMG values of quadriceps muscle. His study showed "significant difference of the quadriceps EMG values between biofeedback group and non-biofeedback group.

Davlin et al. (1999) showed that hip position either neutral, external or internal rotation didn't affect the EMG biofeedback

training of the VMO and VE in normal healthy colleges. They also, found a significant increase in VMO: VE ration in 5 days training regardless hip position. Their study was similar to Ingersoll and Knight (1991) and Croce (1986) in that they trained normal subjects but Davlin et al. (1999) didn't include a control group.

Lucca and Recchiuti (1983) showed that an isometric exercise for leg extensors combined with biofeedback training in normal female undergraduate students was better than isometric exercises only in peak torque of leg extensors. Krebs (1981) showed that the average electrical activity output in a biofeedback group was 10 times greater than non biofeedback group in a study for post meniscectomy patients. Kirnap et al. (2005) supported theses results in a very similar study.

Our current study showed significant difference between pre-treatment and post-treatment values of both groups, these results approved with Crossley et al. (2002) which showed that 6-week physical therapy regimen is efficacious for alleviation of patellofemoral pain. Our results also, supported the descriptive questionnaire study of Ghoussoub et al. (2003) who concluded that functional rehabilitation has confirmed its efficiency in the treatment of young patients suffering from patellofemoral syndrome. Our results supported the descriptive study of Post (2005) who concluded that most patients should go thorough non operative treatment before elective surgery for patellofemoral pain is prescribed.

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الملخص العربي

تدريبات التنبيه الرجعي الحسي لعلاج ألآم مفصل الرضفه مع أسفل الفخذ

تهدف هذه الدراسة إلي توضيح أهمية إضافة التغذية الرجعية الحسية إلي تمرينات التقوية في برنامج العلاج الطبيعي في حالات علاج ألام مفصل الرضفة مع أسفل الفخذ . وقد اشتملت هذه الدارسة علي مجموعتين من المرضي الذين تم تشخيصهم مسبقا ولقد تم علاج المجموعة الأولي بالعلاج الطبيعي التقليدي (تمارين تقوية للعضلة الأمامية للركبة وتمارين إطالة لمجموعة العضلات حول الركبة واستعمال الشريط اللاصق للركبة) مع استعمال التنبيه الرجعي الحسي أما المجموعة الثانية فتم علاجها بالعلاج التقليدي فقط . وقد تحددت نتائج العلاج من خلال نتائج مقياس الألم ونتائج مقياس الوظائف للركبة (نظام سنسيناتي لوظائف الركبة) . وقد أظهرت النتائج وجود فروق ذات دلالة إحصائية في نتائج مقياس ألام لمفصل الرضفة مع أسفل الفخذ في كلتا المجموعتين قبل وبعد العلاج . حيث انه كان هناك انخفاض في مستوي الألم في المجموعتين ولم يوجد فروق ذات دلالة إحصائية بين المجموعتين . كما أظهرت النتائج وجود فروق ذات دلالة إحصائية في نتائج مقياس الوظائف للركبة (نظام سنسيناتي الوظائف الركبة) في كلتا المجموعتين قبل وبعد العلاج. حيث انه كان هناك زيادة ذات دلالة إحصائية في كلتا المجموعتين قبل وبعد العلاج . ولم يوجد فرق ذات دلاله إحصائية بين المجموعتين . وبالتالي أظهرت نتائج هذا البحث أن استخدام جهاز التغذية الرجعية الحسية مع برنامج العلاج الطبيعي التقليدي لا يكون أكثر فاعلية في تحسين مستوي الألم في مفصل الرضفة مع أسفل الفخذ أو زيادة المدى الوظيفي للركبة .