

## Effect of Neuromuscular Training with Rigid Tape Versus Strength Training on Functional Performance of Knee Osteoarthritis

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### Abstract

**Background:** Osteoarthritis of the knee involving predominantly the medial tibiofemoral compartment is common in older people, giving rise to pain and loss of function. Neuromuscular exercises are typically performed in functional weight-bearing positions emphasizing quality and efficiency of movement, as well as Rigid taping (RT) is an efficient way of treatment of pain relief.

**Purpose:** This study was conducted to detect the effect of neuromuscular training with Rigid taping versus strength training on functional mobility in medial compartment knee osteoarthritis.

**Methods:** This study was conducted on thirty patients both gender with mild to moderate OA of medial compartment knee OA. Their age ranged from 45-55 years old. All patients were referred by orthopedic surgeons who are responsible for diagnosis based on clinical and radiological examination. They were randomly assigned into two groups Group (A) received strength training exercises and Group (B) received neuromuscular exercises with rigid tape for three sessions per week for one month. The study was conducted from September 2016 to May 2017 at the department of physical therapy at Abo Keir Hospital, Alexandria, at the out clinic at pharous university and a Private hospital at Alexandria.

**Methods of Evaluation:** Thirty seconds chair stand test (30-CST) test for the assessment of functional performance,

**Results:** Showed that both strength training (group A) and neuromuscular exercises with rigid tape (group B) were effective in improvement of functional performance, but strength training (Group A) were less effective than neuromuscular exercises with rigid tape.

**Conclusion:** It can be concluded that both strength training and neuromuscular exercises with rigid tape are effective treatment for medial compartment knee OA in terms of functional performance.

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**Key Words:** Strength training – Neuromuscular exercises – Rigid tape and medial compartment knee osteoarthritis – Functional performance.

### Introduction

**OSTEOARTHRITIS** of the knee involving predominantly the medial tibiofemoral compartment is common in older people, giving rise to pain and loss of function [1] OA is seen radiographically in 33% of the population older than 60 years of age [2].

In the absence of a cure, current treatment of osteoarthritis (OA) aims to improve pain and function and enhance quality of life, Slowing structural disease progression is also important to help reducing the rate of costly joint replacement surgeries for advanced disease [3].

Strength training programs usually consist of non-weight-bearing exercises involving isolated muscle training and weight-bearing exercises involving multiple joints. The level of training and progression is guided by the patient's one-repetition maximum [4]. The interest of having muscular strengthening as a part of the therapeutic program for the medical treatment of knee OA is now well established [5].

On the other hand Neuromuscular training with an individualized approach and gradual progression showed promise for improving patient-reported outcomes and physical function even in older patients with severe primary OA of the knee [6]. It is a relatively broad class of exercise programs incorporating programs known by terms such as functional exercise, proprioceptive, agility, or perturbation training [1].

Rigid taping (RT) is an easy, cost effective and an efficient way of treatment of pain relief. It can, therefore, be a handy tool in clinical practice for the immediate symptomatic relief of OA by reducing the pain and improving the gait parameters. [7].

The addition of rigid tape to neuromuscular exercises could help the elimination of pain during neuromuscular training and thus improve the performance of the patient as Warden et al., [8]. Faqih et al., [7] proved that knee taping has a great effect on chronic knee pain.

### Subjects and Methods

This study is a randomized controlled study that was conducted from september 2016 to may 2017. It included Thirty patients (males and females) with mild to moderate medial compartment knee OA, their age ranged from 45-55 years, the participants were selected from the department of physical therapy at Abo Keir Hospital, Alexandria at the out clinic at pharous university and a Private hospital at Alexandria. Patients were enrolled to the study and informed a consent form; All had mild to moderate medial compartment knee OA grade II-III Kellgren and Lawrence. They had no any other knee problems in past or present. Patients were excluded if they had ages more than 55 years or less than 45 years.

They were divided randomly using sealed envelopes into two equal groups (A,B). Group A included 15 patients who received strength training exercises. Group B included 15 patients who received neuromuscular exercise with rigid tape.

Thirty seconds Chair Stand Test (30 CST) is suited to assess the physical function of those with lower limb arthritis, it assessed the number of times a person can stand then sit in a chair in 30 seconds, thirty seconds was measured with a hand held stopwatch, the same chair was used for all assessments [11].

#### Assessment procedures:

All patients after had been included, the following procedures were done for all of them.

#### Assessment of functional performance:

All patients were asked to stand up and sit down during thirty seconds and the number of times the patient could stand and sit in a chair in 30 seconds were measured with a hand held stopwatch by the clinician (Fig. 1).



Fig. (1): 30 seconds chair stand test.

#### Treatment procedure:

*Group A (control group):* Patients were assigned to the group (strength training) received 12 sessions for 4 weeks consecutively, 3 sessions per week. The strengthening program consisted mainly of strengthening exercises of the lower-extremity muscles, with emphasis on the quadriceps femoris, hamstring, gluteus medius, and gastrocnemius muscles [9].

*All 15 patients were asked to perform the following strengthening exercises (10) Appendix (I):*

- Exercise 1 : Isometric quadriceps.
- Exercise 2: Four way straight leg raises.
- Exercise 3: Seated knee extension.
- Exercise 4: Calf raises.
- Exercise 5: Elastic-bands leg-press exercise.

*Group B (study group):* Patients was assigned to group II (neuromuscular exercises with rigid tape) for a total of 12 treatment sessions in a month (three sessions per week).

*Rigid tape application before exercises then neuromuscular training exercises Appendix (II):*

- Exercise 1 : Forward and backward sliding or stepping.
- Exercise 2: Sideways exercises.
- Exercise 3: Functional hip muscle strengthening.
- Exercise 4: Functional knee muscle strengthening.
- Exercise 5: Step-ups and down.
- Exercise 6: Balance.

The neuromuscular exercises were applied to the patients with progression according to pain response and patient tolerance. Progression was provided by increasing number repetitions, changing direction, and increasing velocity of the movements and the load. Safety was ensured by using hand support or having hand support within easy reach. This was used for balance support and for

maintaining quality of performance throughout the movements.

*Statistical analysis:*

Descriptive statistics were used to describe subject characteristics in form of mean and standard deviation of age, weight, height and body mass index (BMI) of both groups.

Manova test was used to test the mean difference within and between groups using SPSS for windows, version 22 (SPSS, Inc., Chicago, IL).

**Results**

*General characteristics:*

The current study was conducted on 30 patients (16 females and 14 males) suffering from mild to moderate medial compartment knee OA, they were assigned randomly into two equal studies groups As indicated by the independent *t*-test, there were no significant differences ( $p > 0.05$ ) in the mean values of age, body mass, and height between both tested groups (Table 1). Chi square revealed there was no significant differences between both groups in sex distribution ( $p > 0.05$ ).

Table (1): Physical characteristics of patients in both groups (A&B).

Items	Group A	Group B	Comparison	S
	Mean±SD	Mean±SD	<i>p</i> -value	
Age (years)	48.86±3.35	48.73±3.39	0.195	NS
Body mass (Kg)	71.43±10.06	74.06±10.96	0.499	NS
Height (cm)	166.53±10.28	169.33±10.40	0.465	NS
BMI (kg/m <sup>2</sup> )	25.63±1.99	25.69±2.30	0.94	NS
Sex distribution N (%)				
	Group A	Group B	<i>p</i> -value	NS
Female	8 (53.3%)	8 (53.3%)	1.00	NS
Male	7 (46.7%)	7 (46.7%)		

\*SD : Standard deviation,  
S : Significance,

P : Probability,  
NS: Non-significant.

Multiple pairwise comparison tests (Post hoc tests).

*Thirty sec chair stand test:*

1- *Within groups:*

As presented in Tables (1,2) and illustrated in Fig. (1), within group's comparison the mean ± SD values of 30 sec chair stand test in the "pre" and "post" tests were 10.93±1.90 and 12.46±2.44 respectively in the group (A). Multiple pairwise comparison tests (Post hoc tests) revealed that

there was significant increase of 30 sec chair stand test at post treatment in compare to pre treatment ( $p$ -value =0.0001\*). While, the mean ±SD values of 30 sec chair stand test in the "pre" and "post" tests were 11.2±1.78 and 13.73±2.63 respectively the group (B). Multiple pairwise comparison tests (Post hoc tests) revealed that there was significant increase of 30 sec chair stand test at post treatment in compare to pre treatment ( $p$ -value=0.0001\*).

2- *Between groups:*

Considering the effect of the tested group (first independent variable) on 30 sec chair stand test, Multiple pairwise comparison tests (Post hoc tests) revealed that the mean values of the "pre" test between both groups showed no significant differences with ( $p=0.899$ ). As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there was significant difference of the mean values of the "post" test between both groups with ( $p=0.017$ \*) and this significant increase in favor to group B.

Table (2): Mean ± SD and p values of 30 sec chair stand test pre and post test at both groups.

30 sec chair stand test	Pre test	Post test	MD	% of change	<i>p</i> -value
	Mean±SD	Mean±SD			
Group A	10.93±1.90	12.46±2.44	-1.53↑	13.9	0.0001*
Group B	11.2 ±1.78	13.73±2.63	-2.53↑	22.58	0.0001*
MD	-0.26	-1.26			
<i>p</i> -value	0.695	0.183			

\*Significant level is set at alpha level <0.05.  
SD :Standard deviation.  
MD : Mean difference.  
*p*-value: Probability value.

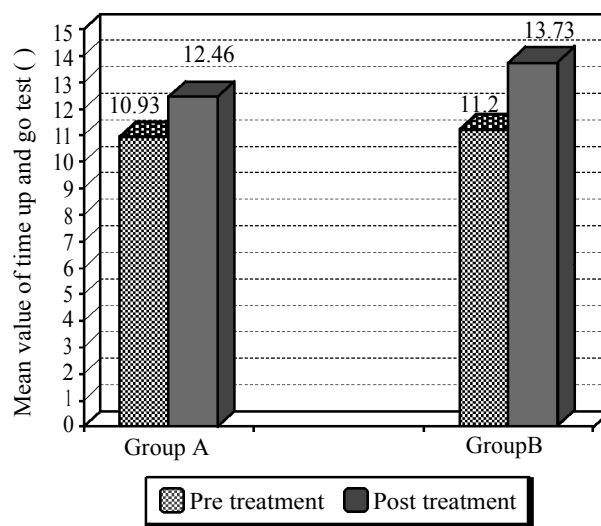


Fig. (1): Mean values of 30 sec chair stand test pre and post tests in both groups.

## Discussion

Knee OA is one of the most common disorders affecting elderly populations, and causes chronic pain and disability that has been researched in numerous publications over the last several decades [1].

There is a growing evidence that neuromuscular training with an individualized approach and gradual progression showed promise for improving patient-reported outcomes and physical function even in older patients with severe primary OA of the knee [3]. Related literature showed that rigid taping is an easy, cost effective and an efficient way of treatment of pain relief. The addition of rigid tape to neuromuscular training would eliminate the pain and improve the performance of neuromuscular exercises as knee taping was proved to decrease chronic knee pain and improve gait parameters [5].

*The effect of strength training on functional mobility in medial compartment knee OA:*

The statistical analysis reported significant improvement of functional mobility after strength training.

The results of the current study agreed with the randomized controlled trial by Topp et al., [12] who compared 16 weeks of isometric versus dynamic resistance training versus a control on knee pain and functioning among patients with knee OA. They concluded that dynamic or isometric resistance training improves functional ability significantly as the time to perform all four functional tasks decreased.

Latham and Liu [13], agreed with the present study, who examined Progressive Resistive Training for OA in 7 studies, results showed highly significant improvement of performance on physical function tasks (i.e., greater distance walked for the 6-minute walk test faster time on a lifting and carrying 10 lbs and faster time to get in and out of a car) and Singh et al., [14] who compared between The effects of traditional strengthening exercises versus functional task training on functional mobility in knee OA. Results indicated that traditional strengthening group improved significantly in functional outcomes as functional performance on stair climbing test and time up and go test.

This agreement could be due to that the strength training program leads to increase in strength and endurance of the muscles around the knee (quadriceps femoris, hamstring, gluteus medius, and gastrocnemius muscles) and the improved muscle

strength was translated into improved functional performance.

*The effect of neuromuscular training with rigid tape on functional mobility in medial compartment knee OA:*

The statistical analysis showed significant improvement of functional mobility after neuromuscular training with rigid tape.

The results of this study came into agreement with these of Diracoglu et al., [15] who investigated the short-term clinical effects of neuromuscular training in the form of kinesthesia and balance exercises in patients with knee OA. Statistically significant improvements were observed post exercise with respect to times for performing activities of daily living (10 stairs climbing, and 10-m walking times).

The present study agreed with Ageberg et al., [6] who examined the effects of neuromuscular training on physical function in patients with severe primary OA of the hip or knee. Assessments included measures of physical function (chair stands, number of knee bends/30 sec, knee extensor strength, 20-meter walk test). Significant improvement occurred in functional performance as chair stands was performed about 3 seconds faster.

Faqih et al., [7] agreed with our study, they assessed using the Visual Analog Scale and gait parameters such as stride length, step length and cadence were assessed using the footprint method pre and post application of a rigid tape. They concluded that after rigid taping there was a significant decrease in the pain intensity and the gait parameters such as step length, stride length and cadence improved in patients with knee osteoarthritis.

This agreement is due to that neuromuscular training lead to the improvement of sensorimotor control and achieving compensatory functional stability as Functional, weight-bearing exercises are used in various positions, resembling conditions of daily life and more strenuous activities. So these lead to improved functional performance in the form of 30 CST, and also rigid taping reduced the pain so lead to faster performance.

*The difference between the effect of strength training versus neuromuscular training with rigid tape on functional mobility in medial compartment knee OA:*

The present study showed significant difference of the mean values of the "post" test between both

groups with ( $p=0.017^*$ ) and this significant increase in favor to group B. These results confirmed the significant difference between the effect of strength training versus neuromuscular training with rigid tape on functional mobility.

*This result is inconsistent with the work reported by the following:*

Bennell et al., [3], compared the effects of NEXA and quadriceps strengthening (QS) on physical function in patients with medial knee OA significant improvements in physical function (30 CST) were achieved in both groups.

This disagreement could be due to that Bennell et al., [3] compared only QS to NEXA but our study compared traditional strengthening exercises to NEXA.

Singh et al., [14] disagreed with our study, who compared the efficacy of functional task training with traditional exercises on knee OA in increasing functional mobility on Time Up & Go Test and Stair Climbing test. Results indicated that both groups improved in functional outcomes with no significant difference between both groups.

This disagreement could be due to the effect of application of the rigid tape during the neuromuscular exercises as Faqih et al., [7] concluded in their study that after rigid taping there was a significant decrease in the pain intensity improvement in gait parameters in patients with knee OA.

#### Conclusion:

*Based on the finding of the present study the following can be concluded:*

- Strength training program have an effective role in improving functional mobility in medial compartment knee OA.
- Neuromuscular training with rigid tape have an effective role in improving functional mobility in medial compartment knee OA.
- There is a significant difference between the effect of strength training versus neuromuscular training with rigid tape in improving functional mobility in favour to neuromuscular training with rigid tape.

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## Appendix

### **Appendix (I) Strength training**

*Exercise 1: Isometric quadriceps (Fig. 1):*

Patients laid in a supine position. A small ball was put beneath the knee. They were instructed to maximally activate their thigh muscles in order to straighten their knee and hold the contraction for 5 seconds (3 sets, 10 repetitions).



Fig. (1): Isometric quadriceps.

*Exercise 2: Four way straight leg raises (each exercise 3 sets, 10 repetitions):*

2A- Straight leg raises (SLR) with hip flexion (Fig. 2):

In a supine position and the contralateral limb knee flexed so that the foot is resting comfortably in a flat position, the patient was asked to raise the exercise limb with the knee in full extension to the height of the contralateral flexed knee, then lower the limb back to the initial position; extra resistance was provided by 1-kg ankle weights.

2B- Straight leg raises with hip abduction (Fig. 3):

Lying sideways, the patient was asked to bend the knee and hip of the lower leg and raise the upper leg, keeping it straight; extra resistance was provided by 1-kg ankle weights.

2C- Straight leg raises with hip adduction (Fig. 4):

Lying sideways, the patient was asked to bend the hip and the knee of the upper leg and raise the lower leg, keeping it straight; extra resistance was provided by 1-kg ankle weights.

2D- Straight leg raises with hip extension (Fig. 5):

Lying prone, the patient was asked to raise the exercise limb with the knee in full extension then lower the limb back to the initial position; extra resistance was provided by 1-kg ankle weights.



Fig. (2): SLR with hip flexion, SLR with hip flexion using ankle weights.



Fig. (3): SLR with hip abduction, SLR with hip abduction using ankle weights.



Fig. (4): SLR with hip adduction, SLR with hip adduction using ankle weights.



Fig. (5): SLR with hip extension, SLR with hip extension using 1 kilo ankle weight.

*Exercise 3: Seated knee extension (Fig. 6):*

Sitting with knee at 90° flexion, the patient was asked to fully extend knee using resistance of 1 kilo ankle weights (3 sets, 10 repetitions).



Fig. (6): Seated knee extension.

**Exercise 4: Calf raises (Fig. 7):**

In a standing position, patient was asked to rise up on toes and return; extra resistance provided by 1-kg ankle weights (3 sets, 10 repetitions).



Fig. (7): Calf raises, then calf raises with ankle weights.

**Exercise 5: Elastic-bands leg -press exercise (Fig. 8):**

Long-sitting, lying horizontally on the bed, with the back against the bed the patient was asked to glide the heel along the bed against the resistance of the theraband until the knee joint was extended nearly completely straight and then flex the knee again. (3 sets, 10 repetitions).



Fig. (8): Elastic bands leg press exercise.

**Appendix (II)****Neuromuscular exercises with rigid tape****Rigid tape application before exercises (Fig. 1):**

Rigid tape was applied for the knee prior to the neuromuscular exercises, Patient was in a supine position with knee in full extension. Leg hair should be shaved and skin should be cleaned with alcohol. The clinician placed one anchor strap over the superior pole of patella. And attached One strip of tape to the anchor on the medial side of the knee, pulled it obliquely downwards to the lateral side with the top edge of the tape passing just under the inferior pole of the patella. The same action was repeated lateral to medial to make a cross-over effect.

After application of rigid tape all patients were asked to do the following exercises in the neuromuscular training program.





Fig. (1): Steps of rigid tape application on patients knee.

*Exercise 1: Forward and backward sliding or stepping (Fig. 2A,2B):*

The patient was asked to Stand on affected leg and sliding or stepping opposite leg forward and backward, with progression achieved by adding an elastic resistance band around the affected leg

to apply a varus-directed force during the movement, which the patient had to counteract in order to maintain the knee in the neutrally aligned position 3 sets of 10 repetitions.



Fig. (2A): Forward and backward sliding or stepping.



Fig. (2B): Forward and backward sliding or stepping using elastic band results in varus directed force on the affected knee.

*Exercise 2: Sideways exercises (Fig. 3A,3B):*

The patient was asked to Stand on affected leg and sliding or stepping opposite leg sideways, Progression was achieved by adding an elastic

resistance band around the study leg to apply a varus-directed force throughout movement, which the patient had to counteract in order to maintain the knee in the neutrally aligned position, 3 sets of 10 repetitions.



Fig. (3A): Sideways exercises.



Fig. (3B): Sideways exercise with elastic band results in varus directed force of the affected knee.

*Exercise 3: Functional hip muscle strengthening (Fig. 4):*

The patient was asked to Stand isometric abduction (2 sets of 5 repetitions), with progression to elastic band-resisted abduction during side stepping (from 2 steps to 30 steps).

*Exercise 4: Functional knee muscle strengthening (Fig. 5):*

Squatting against a wall with flexing knees to the degree of comfort, with progressing to rising from sitting with increased weight taken through the study leg (3 sets of 10 repetitions).

*Exercise 5: Step-ups and down (Fig. 6A,6B):*

the patient was asked to Step onto a step, with progression to add 2-kg hand weights and then

step down with forward touch-down of opposite leg (3 sets of 10 repetitions).

*Exercise 6: Balance (Fig.7):*

Standing on affected leg, with progressions including adding arm movements (2 minutes practice).

The neuromuscular exercises were applied to the patients with progression according to pain response and patient tolerance. Progression was provided by increasing number repetitions, changing direction, and increasing velocity of the movements and the load. Safety was ensured by using hand support or having hand support within easy reach. This was used for balance support and for maintaining quality of performance throughout the movements.



Fig. (4): Functional hip muscle strengthening exercises.



Fig. (5): Functional knee muscle strengthening exercise (squats on wall).

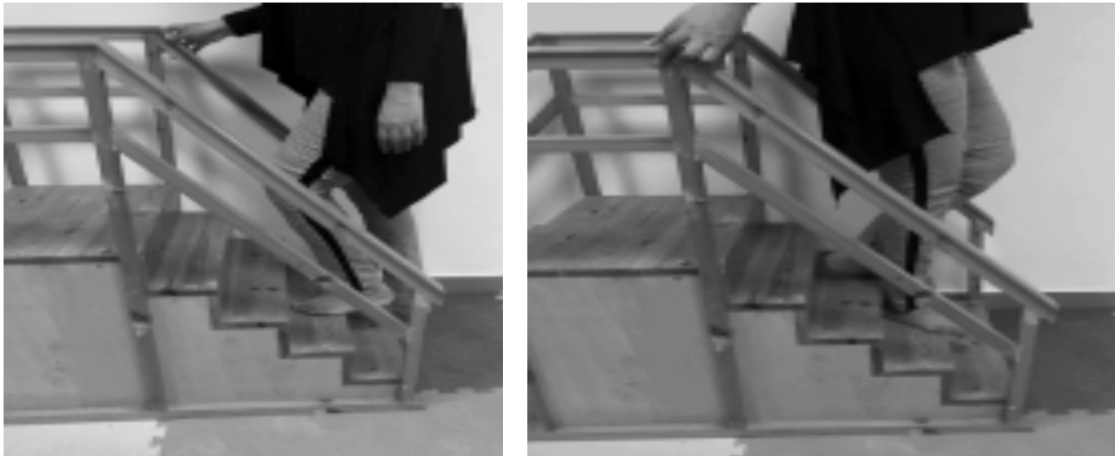


Fig. (6A): Step up and down exercises.

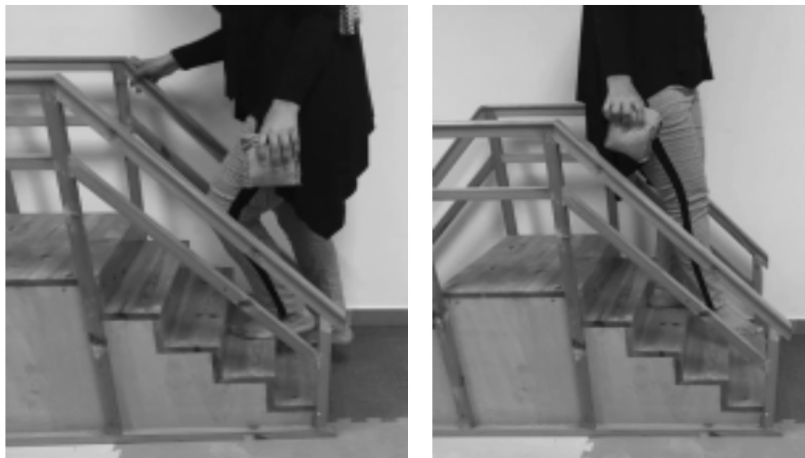


Fig. (6B): Step up and down exercise using arm weights.



Fig. (7): Balance exercise.

## تأثير التدريب العصبى العضلى مع استخدام الشريط الصلب على الأداء الوظيفى للتهاب العظمى المفصلى الانسى للركبة

اجريت هذه الدراسه على ثلاثين مريضا يعانون من التهاب العظمى المفصلى الانسى للركبه وكان متوسط العمر من خمس واربعين الى خمس وخمسون تم تقسيمهم الى مجموعتين متساويتين المجموعه الاولى ( أ ) والمجموعه الثانيه (ب).

المجموعه الاولى: تتكون من خمسة عشر مريضا تلقوا تمارين تدريبيات القوى.

المجموعه الثانيه: تتكون من خمسة عشر مريضا تمارين تدريب العصبى العضلى مع استخدام الشريط الصلب.

طريقه القياس: تم تقييم الاداء الوظيفى عن طريق اختبار الاداء الوظيفى.

اظهرت النتائج وجود تحسن فى المجموعتين الاولى و الثانيه، و بالاحص الثانيه حيث ان اضافته الشريط الصلب اثناء تمرينات تدريب العصبى العضلى كان له عامل اساسى فى هذه النتائج .

الاستنتاج: كلا من العلاج بتطبيق تمارين تدريبيات القوة للركبه المصابه بالتهاب العظمى المفصلى الانسى او تمارين تدريب العصبى العضلى مع الشريط الصلب يعطى نتائج كبيرة .

تطبيق تمارين تدريب العصبى العضلى مع استخدام الشريط الصلب يعطى نتائج اعلى من تمارين تدريبيات القوة.