Effect of Patellar Tracking on Pain, Repositioning Accuracy and Quadriceps Torque in knee Osteoarthritis

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ABSTRACT

Back ground and aim: *Osteoarthritis (OA) is a most prevalent form of arthritis. Maltracking of the patella is one of the common cause of knee joint arthritis, patellar taping could be used in an effort to produce mechanical realignment of the patella.* ***Subjects, Materials and Methods:*** *forty patients from both genders were diagnosed as having knee joint arthritis (age ranged from 40: 60 years). Patients were randomly assigned into two equal groups: (A) medial taping group and (B) lateral taping group. Pain, repositioning accuracy and peak torque of quadriceps muscle were measured by using visual analog scale and isokientic dynamometer instruments respectively. The treatment protocol lasted for six weeks. Outcome measurement was conducted at the baseline and after the end of treatment.* ***Results:*** *The results revealed a significant reduction in pain, improvement in repositioning accuracy and increasing the quadriceps muscle peak torque in the medial taping group compared with lateral taping group.* ***Conclusion:*** *It could be concluded that medial patellar taping can be used as one of the conservative treatment options contributing positively in reducing pain and increasing proprioception accuracy and muscle torque in patients with knee osteoarthritis.*

Key Wards: *Patellar taping - Repositioning accuracy - Muscle torque - Knee osteoarthritis.*

INTRODUCTION

Osteoarthritis (OA) is a most prevalent form of arthritis, slowly evolving the articular cartilage. It is mainly characterized by pain, disability and progressive loss of the joint function[1]. It has been estimated that up to 80% of the populations aged 55 or more affected with hip or knee OA during the late stage of life. Today OA is considered the second only to the cardiovascular disease due to its high rate of morbidity and mortality[2].

The knee joint is commonly affected by OA, started by localized areas of cartilage loss which increase the focal stress across the joint. Further cartilage loss may progress to joint tilt and malalignment. Pain, swelling and quadriceps muscle weakness as common symptoms of knee OA may inhibit the voluntary and reflexive protective mechanism of the knee joint, leading to loss of the joint function with progressive joint Instability[3].

Considering the tri-compartmental nature of the knee joint, and the unique functions of each, various radiographic patterns of knee OA are possible. In fact, the patellofemoral compartment is one of the most commonly affected compartments and the common source of symptoms associated with knee OA. Also it possibly more important than both medial and lateral tibiofemoral compartment[4].

Little attention has been paid to the role of patellar malalignment in the incidence of pain and worsens of the knee joint function. Translational or rotational deviation of the patella relative to any axis of the knee joint is termed as patellar malalignment[5]. At a local level, patella alignment relies on passive (osseous configurations and soft-tissue restraints) and active (quadriceps muscles) structures[6]. Different types of osseous anatomical anomalies affecting the alignment and motion of the patella include: shallowing of the femoral trochlea groove depth and tensions of medial and lateral retinaculae, particularly the two distal expansions of the iliotibial band, the joint capsule and ligaments that contribute to maintaining patella alignment[7]. It was considered that pateller tilt is frequently associated with narrowing of the joint space leading to progression of knee arthritis and increasing of pain severity [8]. The most widely accepted cause of knee joint pain is maltracking of the patella which believed to be related to weakness of the quadriceps muscle[9].

Proprioception is a sensory compartment of the joint protection, that responsible for sense of joint and limb position, preventing acute injury and the evolution of chronic

dysfunction[10]. Impairment in the afferent proprioceptive information which mainly associated with OA leading to delayed onset of quadriceps muscle activity with error in normal coordinated functional that exposing the joint to excessive stress during functional loading and impairment of joint stability[11].

Patellar taping is widely practiced technique among clinicians to mange knee OA, as it is simple, inexpensive, and associated with negligible adverse effects. Patellar taping was introduced by McConnell in an effort to produce mechanical realignment of the patella which improving its tracking within the trochlea and reducing knee pain[12].

Although some studies noted significant results with patellar taping in alleviating pain and allowing patient to engaged in pain free physical therapy exercises[13,14,15,16]. To date, the effects of taping the patella in various directions on the knee joint pain, proprioception acuity and quadriceps muscle force has not to our knowledge been evaluated. So the current study was done to investigate the efficacy of patellar tracking on pain, repositioning accuracy and quadriceps muscle torque in patients with knee osteoarthritis.

SUBJECTS, MATERIALS AND METHODS

Forty patients with knee osteoarthritis aged from 40-60 years, from both gender were participate in this study. They were selected from the out-clinic of the faculty of physical therapy, Cairo University. All patients were diagnosed and referred by orthopedist. Inclusion criteria was based on 1) fulfillment of the American college of rheumatology criteria for knee OA, 2) history of knee pain ≥6 months, 3) anterior or retropatellar pain and/or tenderness and 4) pain on climbing stairs>3 cm on VAS.

Exclusion criteria include: history of surgical approach for the knee or hip joint, intra-articular injection (previous 6 months), systematic disease affect musculoskeletal system, structure discrepancy such as leg length discrepancy, joint replacement of hip or knee, evidence of neuromuscular disorders that may impair balance .history of allergic reaction to tape.

This study protocol was approved by local ethical committee in the faculty of physical therapy. All the patients provided written informed consent prior to participate in the study. Patients were randomly assigned into two treatment groups with 20 subjects in each group. Randomization was done using a predetermined list based on alpha numeric code. The treatment include two types of patellar taping techniques: group (A) medial patellar taping: in which the tape pulled the patella to the medial side of the knee joint and group (B) lateral patellar taping: in which the tape was used to pull the patella to the lateral side.

Instrumentations

1- Visual analogue scale (VAS): The level of knee pain was assessed using VAS before taping application and after compliance of all treatment sessions. Its validity and reliability have been have been tested[17].

2- Isokinetic dynamometer: Biodex 3 Pro Multijoint system (Biodex Medical Inc., Shirley, NY) was used to detect joint position sense through active repositioning accuracy test. This test can measure the patient's ability to repositioning a target angle. The difference between the target angle and the reposition angle is known as the reposition error. The absolute value of this error was used in analysis[18].

Also the Quadriceps muscle peak torque was measured via Maximum voluntary concentric contraction by using the Biodex 3pro isokinetic dynamometer at 60°/s. The greatest torque reading of the three successive attempts was accepted as maximum voluntary isokinetic contraction.

Procedures

1- Pain assessment: The patient was asked to determine the level of his / her pain on 10 cm scale as (0= no pain) and (10= worst pain) by drawing a line corresponding to the intensity of pain on the 100cm VAS.

2- Proprioception assessment: Active repositioning test was used as an estimate of proprioception acuity. Each patient was seated on the associated chair of the Biodex system with hip and knee of the tested leg at 90° flexion (starting position). The patients were

instructed to wear a wide running short during the testing procedures. The involved limb or the limb with more severe symptoms was tested in each patient.

The tested leg was barefoot and stabilized in the test position by straps around the thigh and lower leg 3 cm above the lateral malleolus. In a quiet environment the patient was blindfolded all through the test. For active testing, the patient's leg was passively moved by the Biodex lever arm to the anatomical reference angle 45° without any assistant or resistant from the patient, the test position was maintained for 10 seconds, with each subject instructed to concentrate on the position of the leg, then the subject leg will be returned to the starting position by the apparatus with a 5 second rest.

After that the patient was asked to move the knee joint actively back to the target angle. The subject was instructed to push on a stop button when he or she thought the test position had been reached. Three trials were done with rest period of 30 seconds between each trial. The absolute error was detected. The absolute error is the difference between the position chosen by the subject and the test position angle.

3- Peak torque assessment: The patient sat upright with the axis of rotation of the dynamometer arm oriented with the axis of rotation of the affected knee. Belts were used to secure the thigh, pelvis, and trunk to the dynamometer chair to prevent additional body movement. The chair and dynamometer settings were recorded to ensure the same positioning for all three of the experimental tests. The lateral femoral epicondyle was used as the bony landmark for matching the knee joint with the axis of rotation of the dynamometer resistance adapter. Subjects were asked to perform three consecutive maximum voluntary isokinetic contraction of the quadriceps femoris muscle group. Calibration of the Biodex dynamometer was performed according to the manufacturer's specifications before every testing session.

Taping procedures

With the patient in supine lying and knees in a relaxed extended position, one strip of tape (base layer) was applied without tension across the centre of the patella. The centre of the tape was as near as possible to the centre of the patella, with its medial and lateral edges aligned with the medial and lateral knee joint lines. The patella was completely covered by the base layer. The length of tape was calculated at 50% of the total circumference of the subject's knee[19].

For the medial taping: two straps of tape were used. The first strip of tape originated at the fibular head and was pulled over the lower half of the patella with a medial force terminating at the pes anserinus. The second strip of tape originated from the same point and terminated on the pes anserinus but was taped 0.75 in. higher (fig. 1). For the lateral.

Fig. (1): Medial patellar taping.

Taping: The same procedure was followed but the origin was the pes anserinus and the termination point was the fibular head (fig. 2) with the gliding force was applied laterally[20]. The New tape was applied every 3 to 4 days. The treatment protocol lasted for six weeks. All Participants were asked to report any adverse symptoms whilst wearing tape and the knee should be inspected after tape removal.

Fig. (2): Lateral patellar taping.

Statistical Analysis

Data analyses were performed using the Statistical Package for the Social Sciences,

version 18 (Norusis/SPSS, Chicago, IL) with an alpha level of 0.05. Descriptive information was examined via mean and standard deviation presenting patients demographic data. T-tests were used to compare means between and within groups before and after treatment.

RESULTS

This study was conducted on 40 osteoarthritic patients with unilateral knee OA (18 male and 22 female). Their age ranged from 40 to 60 years with the mean (56.3±2.4) years, duration of suffering more than six months and the mean weight (86.3±7.4) Kg. According to the design of the study the patients were randomly assigned into two groups each group consists of 20 patients. Table 1 show that there was no significant difference between patients characteristics regarding age, Wight, height, body mass index (BMI) and duration of suffering (P>0.05).

Table (1): Mean values of 40 patients characteristics.

Variables	Group A	Group B	T-test	P-value	Sig.
	Mean ± SD	Mean ± SD			
Age (year)	56.6±2.38	56.4±2.38	0.42	0.65	NS
Height(cm)	163.13±9.02	166.6±8.22	0.76	0.47	NS
Body weight (Kg)	87±5.96	85.47±7.66	0.15	0.85	NS
BMI(Kg/m^2)	33±4.57	30.79±1.64	1.39	0.26	NS
Duration of suffering(month)	12.3±2.2	11.73±4.3	1.53	0.34	NS

SD= Standard deviation BMI= Body mass index, NS=non-significance

Pain

Pain in this study was assessed using VAS. The results revealed that there was non significant difference in pain score between groups before taping (P>0.05). The analysis between the groups using the unpaired t-test showed a significant difference in post-treatment values of VAS score between the groups in favour of group (A) (table 2, fig. 3).

Table (2): Comparisons of pain intensity pre and post treatment between and within groups.

Pain intensity (cm)	group A	Group B	t-test	P value	Sig.
	Mean ± SD	Mean ±SD			
Pre	7.73±1.27	7.93±0.88	0.13	0.87	NS
Post	3.13±0.63	5.47±1.06	33.05	0.001	S
% of improvement	59.5	31.02			
t-test	19.57	18.5			
P –value	0.001*	0.01*			
Sig.	S	S			

SD= Standard deviation Sig=significance NS=non-significance

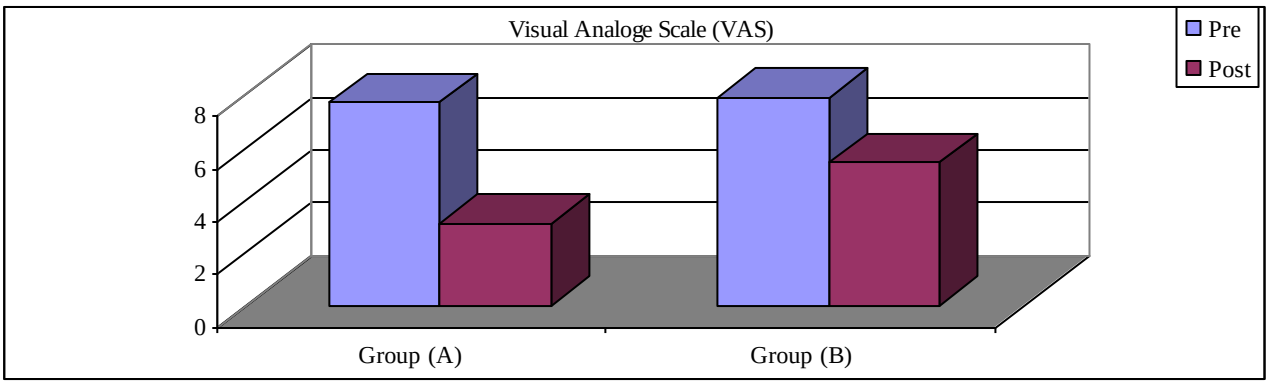

Fig. (3): Pre and post treatment values of pain intensity (VAS).

Reposition accuracy

Reposition accuracy was measured by isokinetic dynamometer; the results showed that there was non significant difference between groups before tape application. After taping, the medial taping group showed a significant increase in the repositioning accuracy with no significant difference in lateral taping group (table 3, fig. 4).

Table (3): Comparisons of repositioning accuracy pre and post treatment between and within groups.

Repositioning Accuracy	group A Mean ± SD	Group B Mean ±SD	t-teat	P value	Sig.
Pre	8.32±3.45	8.68±2.87	0.05	0.94	NS
Post	2.47±1.7	7.02±1.84	51.9	0.001	S
t-test	8.74	6.42			
P –value	0.001*	0.07			
Sig.	S	NS			

SD= Standard deviation Sig=significance NS=non-significance

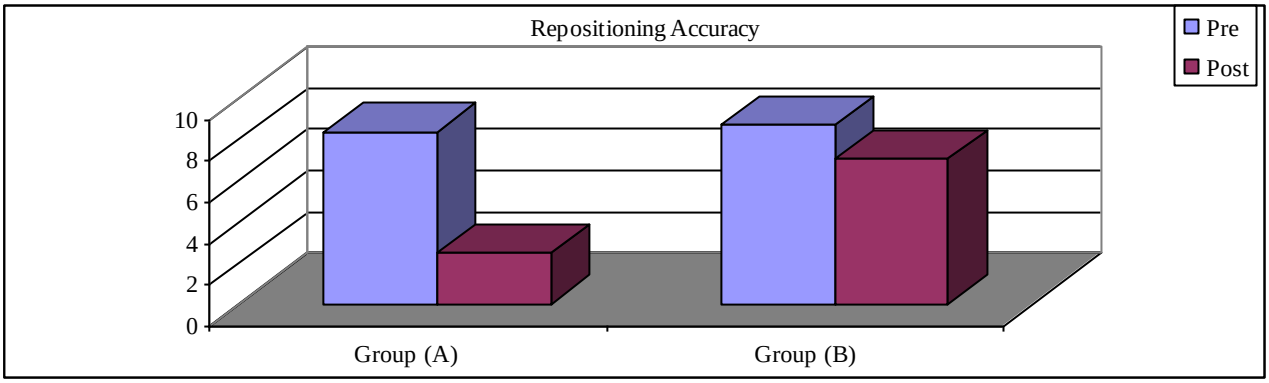

Fig. (4): Pre and post treatment values of repositioning accuracy.

Comparison of the pre and post treatment values of quadriceps muscle torque revealed non significant difference between groups before taping application (P>0.05). The analysis pre and post treatment between the groups showed a significant increase of the peak torque in the medial taping group (P=0.041) while there was no significant difference in lateral taping group (P=0.086) (table 4 and fig. 5).

Table (4): Comparisons of peak torque values pre and post treatment between and within groups.

Peak torque	group A Mean ± SD	Group B Mean ±SD	t-test	P value	Sig.
Pre	76.6±31.8	65.5±21.9	1.11	0.274	NS
Post	104.3±5.2	67.7±27.8	2.53	0.02	S
t-test	2.23	3.93			
P –value	0.041*	0.086			
Sig.	S	NS			

SD= Standard deviation Sig=significance NS=non-significance

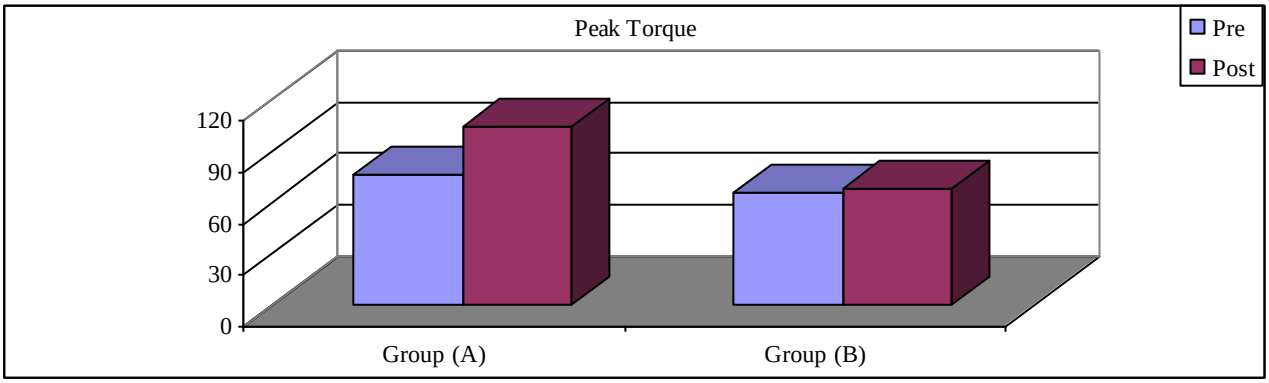

Fig. (5): Pre and post treatment values of quadriceps peak torque.

DISCUSSION

There has been only limited research on the effect of patellar taping technique on knee OA. The current study was conducted to investigate the effect of patellar tracking on pain, reposition accuracy and quadriceps muscle torque in patients with knee osteoarthritis. The results of this study showed a significant pain reduction, increasing of repositioning accuracy and quadriceps muscle torque in medial patellar taping group compared with lateral taping one.

One potential mechanism that might account for the observed pain relief is fit with the accepted theory of patellar malalignment in both anterior knee pain and knee OA, where there is lateral displacement of the patella relative to the femoral trochlear groove resulting in increase the peak patellofemoral pressure forces and loading of the lateral facet[21]. Medial taping is thought improve patellar alignment by correct tracking of the patella, so change the patellofemoral joint contact area, which relieving pressure on the damaged lateral facet of the patellofemoral and reduce joint stress[22].

Additionally, it is possible that alternative mechanisms may explain the pain relieving effects of patellar tape. Importantly, the infrapatellar fat pad is one of the most pains-sensitive structures in the knee joint which inflamed secondarily to knee joint pathology[23] and is often described as a potential source of pain in knee OA, it is possible that the patellar tape may shortening the soft tissue of the fat bad, that reliving pain based on the principle that inflamed soft tissue doesn't respond well to stretching[24].

Bockrath et al., argued that patellar tape may elicit neural inhibition by facilitating large afferent fiber input. Changes in neural input through afferent receptors, such as cutaneous mechanoreceptors and Messner corpuscles, from the patellar tape application may have been enough to block nociceptive input and cause neural inhibition via the large afferent fibers[15.] Another possibility is that reduced pain as the result of medial puling of the patella may be due to stretching the tight latrela structure, increasing activity of vastus medialis obliqus a dynamic medial stabilizer of the patella which provide more optimum positioning of the patella and ease its gild in the treochlear grove during locomotion activities[25].

The findings of the present study lend support to the work of Hinman et al., who concluded that therapeutic taping has a significant immediate impact on pain when compared with neutral and untapped condition in patients with knee arthritis [21]. in the study of Cushnaghan et al., who compared between different patellar taping techniques, the result showed that medial taping of the patella was significantly better than neutral or lateral taping for pain score, symptom change, and patient performance[12].

Regarding the effect of patellar taping on repositioning accuracy. The post treatment results revealed that there was a significant improvement in the reposition accuracy in the medial taping group compared with the lateral taping group. These results may be attributed to the effect of medial taping in modulating knee pain and improving of patellar alignment[26].

There are many possible underling mechanisms that explain how medial taping can increase reposition accuracy in knee OA. It has been suggested that the joint proprioception was enhanced through increased facilitatory effect of cutaneous feedback supplied from the tape, as the applied pressure and stretch of the skin stimulate the cutaneous mechanoreceptors. The sense of stretching is thought to possibly signal information of joint movement or joint position[27]. Furthermore, it has been stated that cutaneous mechanoreceptors might play a role in detecting joint movement and position much like joint mechanoreceptors. While the exact role of cutaneous mechanoreceptors is still under discussion, it has become evident they can signal joint movement and to some extent joint position[28].

Regarding to the effect of patellar taping on the peak torque of quadriceps muscle, it is possible to explain the significant increase in the muscle torque following medial taping technique by effect of taping on the skin surface apparently provided tactile input, which interact with motor control by altered the excitability of the central neuron system. This tactile input generated by taping might be strong enough to modulate muscle torque[29]. Other mechanisms must also be considered include the reduction in pain achieved by the application of therapeutic tape, the mechanical change of the patellar position which provided the needed mechanical support to the medial ligaments of the patellofemoral joint allowing for more joint stability and proper muscle performance, facilitation of proprioceptive feedback mechanism and changes in gait kinematics that may have occurred with taping of the patellofemoral joint[30].

A limited number of studies have evaluated the effects of patellar taping on radiographic patellar alignment. Two studies have demonstrated that medial patellar taping can change the radiographic position of the patella in patellofemoral pain syndrom patients[31,16]. In contrast, Bockrath et al. found no changes in radiographic alignment despite significant reductions in pain[15]. Moreover the activation of the quadriceps muscle should allow for amore optimal positioning of the patella into the trochlea. As the muscle afferents play very important role in providing proprioceptive information at most joints in the body so the increasers muscle torque provide also increased repositioning accuracy of the knee joint in osteoarthritis patients[32].

Conclusion

The result of this study provide evidence that tracking of the patella specially to the medial side through patellar taping can be used as one of the conservative treatment options in rehabilitation of patients with knee osteoarthritis as it contributes positively in reducing pain, increasing repositioning accuracy and quadriceps muscle torque.

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الملخص العربي

تأثير التغيير المسارى لغطاء الركبه على معدل الالم واستعادة وضع المفصل واداء العضله الرباعيه في حالات خشونة الركبة

أجريت التجربة بهدف دراسة تـأثير تغيير مسار غطاء الركبه على معدل الالم واستعادة وضع المفصل وأداء العضلة الرباعية في حالات خشونة الركبة . اختير لهذه الدراسة 40 مريضا من الجنسين تراوحت أعمارهم بين 40 - 60 سنة ، تم استخدام لشريط العلاجي اللاصق في تغير مسار غطاء الركبة . تم تقسيم المرضى عشوائيا إلي مجموعتين : مجموعة (أ) تم تغير مسار غطاء الركبة للداخل ومجموعة (ب) تم تغير مسار غطاء الركبة للخارج وذلك لمدة 6 أسابيع متتاليه . تم قياس شده الالم والقدره على استعادة وضع الركبه واداء العضله الرباعيه وذلك قبل وبعد وضع الشريط العلاجى الاصق فى كلا المجموعتين وقد أسفرت النتائج عن تحسن ذو دلاله إحصائية في درجة الألم وزيادة دقه استعاده وضع المفصل وأداء العضلة الرباعية في المجموعة (أ) بالمقارنة بالمجموعة (ب) . ويستنتج من هذه الدراسة إن تغير مسار غطاء الركبه إلى الداخل يمكن ان يساعد على خفض معدل الالم وزياد ة القدرة على استعادة وضع المفصل وأداء العضلة الرباعية في حالات خشونة الركبة .