Effects of Patella Taping on Vastus Medialis Oblique and Vastus Lateralis Excitability and Perceived Pain in Patients with Anterior Knee Pain Syndrome

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ABSTRACT

Anterior knee pain syndrome (AKPS) represents a common problem and challenge to the sports medicine team. Abnormal firing responses of the vastus medialis oblique (VMO) and the vastus lateralis (VL) muscles were proposed as etiological factors for AKPS. The purpose of this study was to find out the effect of patella taping on both vasti muscles activity and the level of perceived pain. Sixty subjects with AKPS were included in the study. Their age ranged from 20 to 43 years (mean =26.1 years ± 7 years). After application of the tap the perceived pain was decreased at all joint angles tested. The integrated electromyographic activity (IEMG) of the VMO showed significant increase and shorter reaction time. This means that patella taping is effective in reducing the level of perceived pain, and in increasing the activity level of the VMO and facilitates its dynamic control of medial patellar tracking. The activity level of the VL muscle showed non-significant decrease.

Keywords: Anterior knee pain syndrome, patella taping, patellar tracking, patellofemoral joint, electromyography.

INTRODUCTION

Anterior knee pain syndrome (AKPS) is a common complaint in the general population; the incidence is more common in women and athletes[3]. The causes of AKPS are numerous, improper tracking of the patella in the trochlear groove is a major factor, but lateral malalignment of the patella has been suggested as a major cause[8, 25]. The mechanical problem usually transfers into a chromic one and affects patients activity especially sports activities[17].

The extensor mechanism provides stability during physical activity. Dynamic and stable forces act on the patella to control its alignment[5]. The VMO is the most important muscle around the knee with respect to patellar mechanics. The VMO is considered the only dynamic mediolizer of the patella, and also the only dynamic restraint to patellar tendency for lateral tracking[11].

The AKPS is characterized by the patient's complain of diffuse knee pain under and around the patella, with or without activity, in one or both knees[2]. Treatment of AKPS was focused on the strengthening of the VMO to improve dynamic patellar stability[6, 7, 19]. Some researches advised stretching of the tight iliotibial tract[24], while others

recommended other therapeutic modalities and anti-inflammatory drugs[16, 25].

Isometric exercises of the knee in neutral and external rotation were found to challenge the VMO and VL muscles. Isolation of the VMO through utilization of specific exercises was not possible[23]. Vastus medialis oblique muscle was found to be possibly selectively activated by performing resisted hip adduction exercises[7, 12]. The same technique was found to reduce pain[9].

A specific medial glide taping procedure was proposed[21, 22], and was claimed to temporarily correct abnormal patellar tilt, glide, rotation, and to facilitate normal patellar tracking and to allow for training in pain free manner. The technique was also reported to decrease VMO inhibition and to improve VMO\VL ratio[3, 14, 20].

Earlier activation of the VMO and delayed activation of VL was believed to allow for more optimal patella and trochlea congruency, to improve the timing of force distribution, and to decrease the pressure placed on a particular portion of the articular cartilage[10, 13].

The purpose of this study was to evaluate the effect of medial tracking patellar taping on VMO and VL muscles excitability and on the level of perceived pain in patients suffering from anterior knee pain syndrome.

MATERIALS AND METHODS

Subjects

Sixty subjects (males and females) 20 to 43 years old (mean age, 26.1 years, standard deviation, 7.11 years) with confirmed unilateral anterior knee pain syndrome AKPS voluntarily participated in the study. All subjects met the following criteria: (1) No osteoarthritis of knee joint or patellofemoral joint; (2) No fractures of any of the bones of the involved limb; (3) No surgery of the knee or ligamentous injury; and (4) No history of patellar subluxation or dislocation. All subjects signed informed consent. All subjects were from the orthopaedic out patient clinic of Kasr-El-Aini university hospitals.

Instrumentation

Cyborg J33 EMG unit (Cyborg corp., 342 western Ave., Boston, MA. 02135).
A pre gelled adhesive silver-silver chloride electrodes (Cyborg Corp.) 1 cm in diameter.
A 70% ethyl alcohol.
Standard universal goniometer.
Silkplast SK-013, adhesive tape 5 cm. x 5 cm. (Pharma plast, P.O. Box 38 Kafr-El-Zayat, Egypt).
A 10 cm visual analogue scale (vas) for pain measurements.
Treatment table, a strap, and distal tibial cuff to fix the strap.

Procedure

Subjects were seated unsupported at the lower end of the treatment table. The distal end of the tibia of the involved side was fixed by the tibial cuff and the strap to the lower frame of the table to keep the knee flexed at 0°, 30°, 60°, 90°, and 120°.

Skin surface was prepared using pads saturated with 70% ethyl alcohol. The active electrodes of the EMG were placed 1 cm apart from the following muscles according to Basmajian and Blumentein, 1980[1].

Vastus medialis oblique: the active electrodes were placed on a line 45 to 50 degrees from the line of the femoral shaft starting one centimeter away from the most proximal point of the medial border of the patella. The ground electrode was placed on the distal end of the leg[26].

Vastus lateralis: The active electrodes were placed one third of the distance from the

patella to the anterior superior iliac spine, in a line parallel to the shaft of the femur. The ground electrode was placed on the distal end of the leg[26].

Following electrode placement and signal calibration, the EMG activity was sampled at 1,000 Hz. Signals were amplified and a high pass filtering of the raw data was set at 10 Hz. The signals were then fully rectified and expressed as integrated EMG (IEMG).

The subject was asked to perform a maximal isometric contraction for 5 seconds according to the critical test[14, 22]. The patient was encouraged to exert maximal effort through verbal instructions and encouragement given to all subjects by the same instructor. The EMG data was collected, and VAS score was taken immediately after the five seconds contraction. All joint angles were measured by the use of the goniometer and the procedure was repeated at each angle of them.

All subjects then received a medial glide taping of their patella. The measurements and the VAS scores were repeated once more.

RESULTS

The paired "t" test was used for comparison between pre and post taping VAS scores, VMO and VL muscles activity level, differences were considered significant at p 0.05.

In this study, the experimental knees showed a significant response to the taping procedure. The VAS scores in all sixty subjects post taping were significantly less (p 0.0001) than that pre taping (table 1 and fig.1) represent the average before and after taping VAS scores for each joint angle.

Table (1): Comparison between the pre and post taping VAS scores of the affected side.

	0		30		60		90		120	
	Before	After	Before	After	Before	After	Before	After	Before	After
Range	3-9	1-4	4-9	1-4	2-5	0.5-2	4-9	0.5-5	3-10	1-6
Mean	7.45	3.01	5.45	2.11	3.02	1.16	6.70	2.7	6.20	3.34
St. deviation	2.50	0.75	1.41	0.90	1.01	0.51	1.28	0.8	2.11	1.70
St. error	0.30	0.11	0.24	0.20	0.19	0.10	0.32	0.14	0.30	0.29
t-value	29.01	0.0001*	20.21	0.0001*	15.50	0.0001*	23.70	0.0001*	19.99	0.0001*
2-tail probability										

* Significant

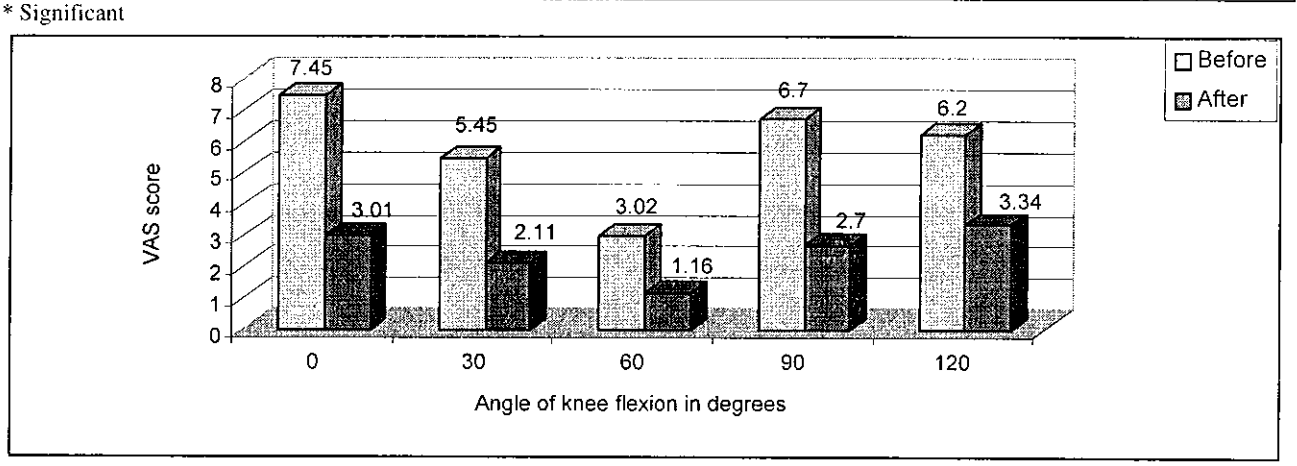

Fig. (1): Average pain scores before and after taping.

The IEMG activity of the VL muscle was 4.2 % greater than that of the VMO muscle pre taping, the difference was constant through out all the tested angles of the knee joint flexion.

The IEMG activity of the VMO muscle was 11.10 % greater than that of VL muscle post taping, and the difference was also constant through out all the tested angles of the knee joint flexion (tables 2 and 3, and figs. 2 and 3).

Table (2): The IEMG of maximum isometric activity of the VL muscle at different angles of knee joint flexion before and after taping.

	0		30		60		90		120	
	Before	After	Before	After	Before	After	Before	After	Before	After
Range	27-67	19-70	6-73	2-67	10-72	12-79	27-173	13-156	14-160	8-150
Mean	48.00	43.57	37.11	35.56	57.10	55.34	69.13	56.10	70.11	61.35
St. deviation	17.50	15.06	21.01	14.20	16.11	14.91	36.01	18.12	25.92	18.17
St. error	0.22	0.24	0.25	0.36	0.22	0.24	0.30	0.36	0.70	0.58
t-value	0.79	0.63	3.58	0.12	-0.90	0.40	1.68	0.48	2.55	0.18
2-tail probability										

* Significant

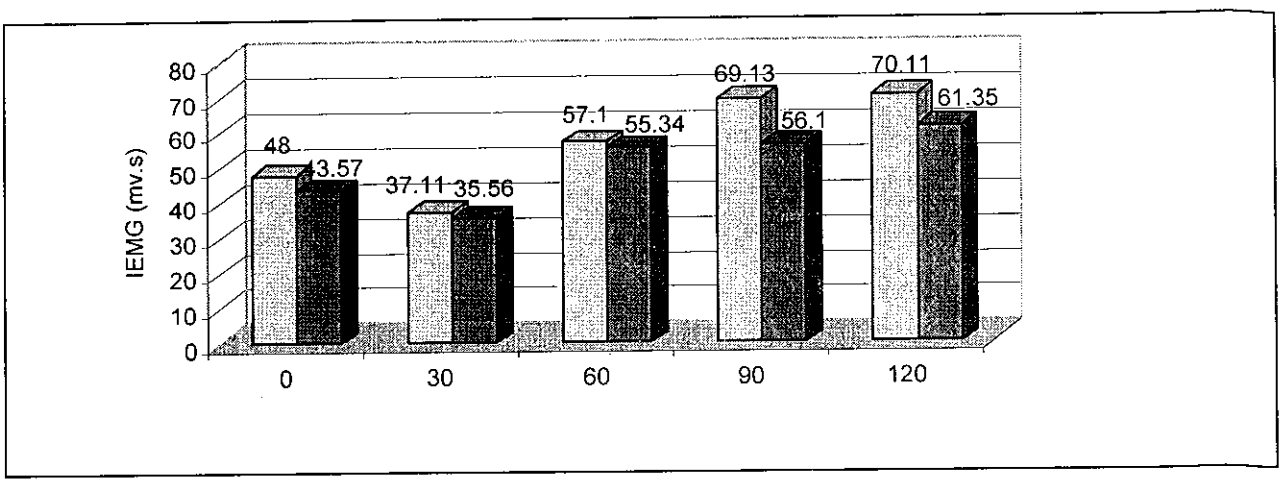

Fig. (2): Average VL muscle IEMG activity before and after taping during maximum isometric contraction at different knee flexion angles.

Table (3): The IEMG of maximum isometric activity of VMO muscle at different angles of knee joint flexion before and after taping.

	0		30		60		90		120	
	Before	After	Before	After	Before	After	Before	After	Before	After
Range	30-78	26-70	31-77	12-81	14-90	14-100	12-140	10-139	9-140	10-146
Mean	45.99	49.01	35.45	40.02	60.06	65.01	66.11	68.10	67.17	69.01
St. deviation	17.11	14.16	25.01	19.22	15.55	14.90	31.08	22.11	28.67	24.77
St. error	0.22	0.18	0.24	0.22	0.15	0.30	0.80	0.17	0.99	0.90
t-value	0.08	0.94	-7.22	0.0001*	-4.26	0.0001*	-6.59	0.0001*	0.31	0.87
2-tail probability										

* Significant

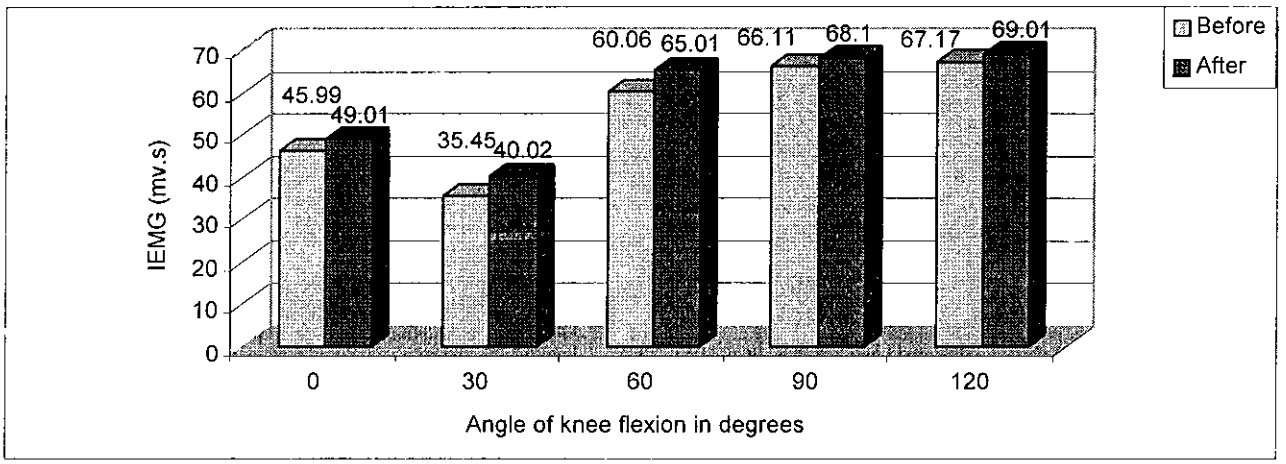

Fig. (3): Average VMO muscle IEMG activity before and after taping during maximum isometric contraction at different knee flexion angles.

DISCUSSION

The prevalence of any of the many clinical findings associated with AKPS is not very well described. In this study all the patients were found to have restricted medial glide of the patella and iliotibial band tightness. The tightness tracked the patella laterally and overstretched the medial structures[21].

All patients experienced pain at every joint angle tested. The altered position of the patella and its lateral tracking in the trochlear groove may generate overstretching of some of the soft tissues and/or compression of other soft tissue structures, they all have the potential to cause pain. It was reported that the greater degrees of pain were experienced at the lower angles of knee flexion below 30 degrees[13, 15].

The use of the maximal isometric quadriceps contractions during testing in this study clarified the potential for compression and/or overstretching of the soft tissues to still be present. Even at flexion angles more than 30 degrees when the patella entered the trochlear groove and the transverse movements were restricted by the bony architecture, compression and/or overstretching of soft tissues could have generated pain.

Taping the patella using the medial glide technique produced a significant reduction ($p < 0.01$) in VAS scores in all patients at all tested knee joint flexion angles.

The reduction in the level of perceived pain could be related to patellar realignment, or to changes in the afferent nervous system. It was found radiologically that taping moved the patella medially[20]. The normal joint stabilization has been shown to be inhibited by dysfunction of the large afferent nerve fibers carrying articular mechanoreceptors feedback to the central nervous system. Taping could have provided strong inhibition via the large afferent fibers, to block the small nociceptors input through pain gait mechanism[3].

Use of the maximum isometric EMG activity to express muscular activity has been shown to provide better reliability (ICC) than using either dynamic maximal or sub maximal EMG activity[18].

In AKPS changes in muscle recruitment and EMG activity was noticed[21]. The IEMG

activity level of VMO muscle at different angles of knee flexion was increased after taping, while the IEMG activity level of VL muscle at different angles of knee flexion was decreased but not significantly. These changes could be due to changes in the recruitment order and threshold of the motor units of both the VMO and VL muscles[4], and these changes could be due to cutaneous stimulation by the tape or changing of the patella position.

The absence of significant changes in the VL activity level after taping could be because its role is secondary to the role of the passive restraining structures in the pathology of AKPS. Restoration of normal VL muscle activity level could be only possible when the tight structures have been lengthened. The lengthening of the tight structures needs time to occur.

Response times of the VMO and VL muscles were measured[10, 27]. The VMO fired significantly faster than VL muscle in normal subjects, but the phenomenon was reversed in AKPS patients.In the present study taping could be considered to correct the firing sequence of the two muscles, furthermore, to correct the mechanical and neuromuscular origins of the symptomatic and orthopaedic implications.

It was suggested that isometric contractions at 90 degrees of knee flexion may improve the VMO activity relative to the VL, and may assist in retro patellar articular cartilage repair[2]. The data from this study showed significant increase in the VMO muscle activity level at 90 degrees of knee flexion after taping.

It could be concluded that patellar taping was found to improve VMO and VL muscles excitability, and to significantly reduce perceived pain in patients with AKPS.

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الملخص العربي

تأثيرات الشريط اللاصق للرضفة على استثارة الألياف المائلة من الفص الداخلي والفص الخارجي من العضلة ذات الأربعة رؤوس والألم المُدرَك في المرضى بمتزامنة الألم الأمامي للركبة

تعتبر متزامنة الألم الأمامي للركبة مشكلة شائعة وتحدياً لفريق الطب الرياضي . الاستثارة غير الطبيعية للألياف المائلة من الفص الداخلي والفص الخارجي من العضلة ذات الأربعة رؤوس اقترحت كمسببات للإصابة .

تهدف هذه الدراسة لمعرفة تأثير الشريط اللاصق على نشاط تلك العضلات والألم المُدرَك . اشترك في الدراسة ستون مريضاً متطوعاً تراوحت أعمارهم بين 20 43 عاماً (متوسط 26.10 7 عاماً) .

أظهرت نتائج البحث أنه بعد استخدام الشريط اللاصق كان هناك انخفاض معنوي في كمية الألم المُدرَك في جميع أوضاع مفصل الركبة المختارة للدراسة . كذلك أوضحت النتائج زيادة معنوية في النشاط الكهربي المتكامل للألياف المائلة من الفص الداخلي للعضلة ذات الأربعة رؤوس وانخفاض غير معنوي للنشاط الكهربي المتكامل للفص الخارجي لنفس العضلة ، مع استعادة ترتيب الاستثارة الكهربية لتبدأ بالألياف المائلة من الفص الداخلي أولاً .

يستخلص من النتائج السابقة أن الشريط اللاصق يُيسر التحكم الديناميكي للألياف المائلة من الفص الداخلي للعضلة ذات الأربعة رؤوس في المسار الداخلي لعظمة الرضفة .