Management of Mechanical Dysfunction of The Patellofemoral Joint

Bassem G. El Nahass, Sc. D, RPT.
Department of Traumatology And Orthopaedic Physical Therapy, Faculty of Physical Therapy, Cairo University.

ABSTRACT

A study of the effect of a selective functional training of the quadriceps muscle on mechanical maltracking of the patellofemoral joint was conducted using electromyographic (EMG) biofeedback training. The quadriceps angle (Q - angle), Sulcus angle (SA), and Congruence angle (CA) were used as parameters to assess the effect of the training. Thirty patients were included in the study. The vastus medialis (VM) muscle was trained to contract independently of the vastus lateralis (VL) muscle, six sessions per week for four weeks. The differences between pre treatment and post treatment parameters were significant. This means that a program of selective quadriceps muscle training had a significant correcting effect upon the patellofemoral joint maltracking.

Key words: Patellofemoral Alignment, Quadriceps Contraction, Electromyography, Biofeedback.

INTRODUCTION

Many disorders of the patellofemoral joint are secondary to tracking abnormalities of the patella. Tracking abnormalities could be congenital such as congenital dislocation, or acquired as patellar subluxation, chondromalacia, and osteoarthritis. The normal patellar movement is dependent on patellofemoral articulation, soft tissues support, and lower extremity alignment. Abnormalities of these factors cause some or all of the following clinical symptoms: pain, crepitation, popping, buckling, giving way, difficult squatting, effusion, subluxation, and difficulty with stair climbing[2,8,13].

The realignment of the patella conservatively is the main goal of all rehabilitation programs. Dynamic patellar stability is provided by the pull of the vastus medialis obliquus (VMO) and VL. Lateral movement of the patella is controlled by the dynamic medial pull of the VMO and the static pull of the medial retinaculm. Correct biomechanical alignment of the extensor mechanism is extremely dependent upon the function of the VMO[6,10].

To selectively strengthen the VMO the addition of hip adduction during knee exetension exercises, and internal tibial rotation could facilitate the VMO while inhibting the VL[4,7].

The purpose of this study was to investigate the effect of selective training of the VMO, using EMG biofeedback during knee extension exercises, on the Q-angle, SA, and CA in case of patellofemoral maltracking.

MATERIALS AND METHODS

Subjects:

Thirty subjects (17 males and 13 females) 20 to 43 years old (mean age, 32.5 years; standard deviation 5.8 years) with confirmed patellofemoral maltracking voluntarily participated in the study and all signed an informed consent document.

Instrumentation:

a) Cyborg J33 EMG biofeedback unit (Cyborg Corp, 342 Western Ave, Boston, MA 02135).
b) Silver-silver chloride adhesive electrodes.
c) Universal Goniometer.

Procedures:

A) ***Evaluation:***

An initial assessment was done including:

a) Q-angle: This is measured in a supine position with extended knees, relaxed quadriceps muscle, feet in neutral position, and the lower extremities straight with 10 cm. distance between both feet using a standard goniometer. The angle is formed by drawing a line from the anterior superior iliac spine to the center of the patella, and a line connecting the center of the patella to the middle of the anterior tibial tuberosity[9].

b) SA: This angle is measured on the axial (Merchant tangential) x-ray view of the knee for its simplicity, reproducibility, and accuracy[11]. The view is obtained with the quadriceps relaxed and knees at 45° flexion. It lies between the two lines connecting the deepest point of the intercondylar sulcus to the most prominent point on each femoral condyle.

c) CA: This angle is measured on the axial view of the knee described above. It lies between the line projecting from the apex of the SA to the lower most point of the patella. The CA is negative if the second line is medial to the reference line, and positive if it is lateral to the reference line[5].

B) ***EMG Biofeedback*:**

The electrodes were applied using standard technique to areas of greatest muscle bulk of the VM and the VL during the first two weeks and during the following two weeks the VM electrodes were placed more downward and medial to the upper medial quadrant of the patella to pick up from the VMO[1,14]. The two active electrodes from each EMG channel were placed as close together as possible, the ground electrode was equidistantly located.

During the first two weeks the training program aimed at decreasing the VL activity level and maintaining a constant activity level of the VM. The muscle activity reference level for the VL and VM were determined daily from the maximum amount of weight that the subject could hold at 170 degrees of extension of the affected knee, this weight was the value used for one repetition maximum. The EMG unit was set in such a way that the VL and the VM would contract at 25 percent of their activity reference level. Daily training sessions, six times a week were conducted. During each session the subject performed six sets, five contractions each, with a thirty second rest between each set. At the end of each session the lowest achieved level of activity for the VL and the highest level for the VM were used as starting level by the subject the following day.

During the second two weeks the training program aimed at maintaining the lowest achieved level of the VL and increasing the level of the VMO. Everything was exactly performed as in the first two weeks except that, the VM electrodes are now on the VMO; and medial tibial rotation, and hip adduction components were added to the knee extension exercise to activate the VMO fibers. On the last day of training the VMO electrodes were moved back to VM for final comparison. A final assessment was done including post treatment measurement of the Q-angle, SA, and CA.

RESULTS

The effects of the EMG biofeedback procedures on the level of activity of the VL and VM were averaged for all subjects and showed a decrease in the VL activity accompanied with a decrease in the activity level of the VM during the first two weeks of training. The difference was 1.51 percent.

At the end of the four weeks of training the VM showed great increase in the activity level and difference between the VL and VM activity level of 6.11 percent.

As for the Q-angle, SA, and CA the results were averaged for all subjects mean, standard deviation for the pre and post training results and the significance of the differences using student t-test, before and after treatment (P < .05) were presented in Table (1) and Fig. (1to3).

Table (1): Comparison of the pre and post training measurement of the Q-angle, SA and CA

Parameter	Pre Training		Post Training		t
	X	SD	X	SD	
Quadriceps - angle	15.80	3.40	14.5	2.50	2.248*
Sulcus angle	128.30	10.00	127.6	5.29	0.481
Congruence angle	-1.29	14.03	-7.0	8.49	2.325*

* Significant

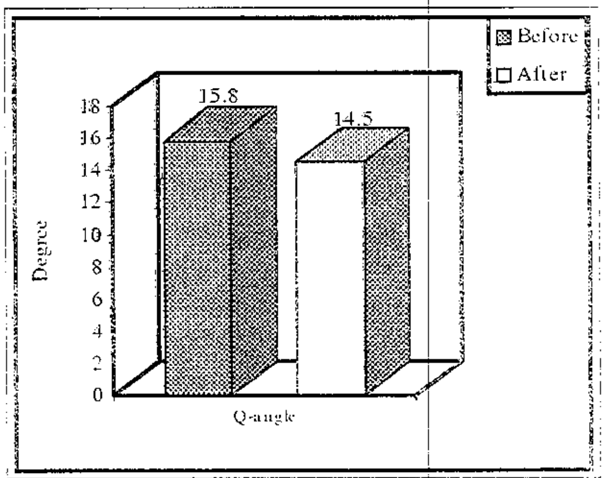

Fig. (1): The mean Q-angle before and after training.

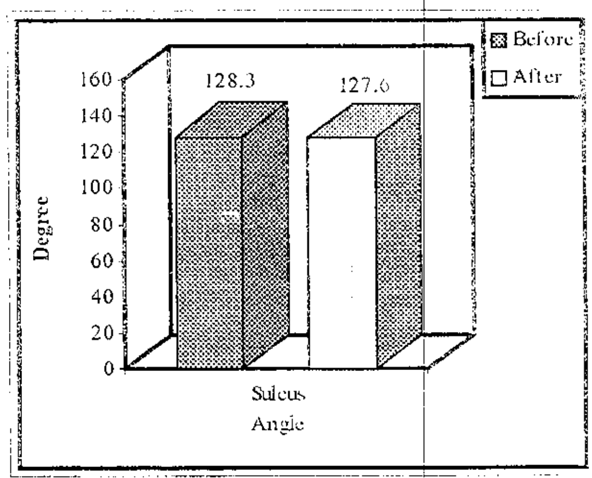

Fig. (2): The mean sulcus angle before and after training.

REFERENCES

1. Basmajian, J.V., Blumentstein, R.: Electrode placement in biofeedback. PP 82, Baltimore: Williams and Wilkins Co., 1980.
2. Carson, W.G., James, S.L., Larson, R.L., Singer, K.M., and Winternitz, W.W.: Patellofemoral disorders: Physical and radiographic evaluation. Part I. Physical examination. Clin Orthop 185: 165-177, 1984.
3. Doucette, S.A., and Gable, E.M.,: The effect of exercise on patellar tracking in lateral patellar compression syndrome. Am. J Sports Med 20 (4): 434-440, 1992.
4. Engle, R.: Dynamic stabilizers of the knee, part II: facilitation approaches and concepts of anterior knee instabilities. Presented at the shoulder and knee injury seminar of the Cincinnati Sports Medicine Institute, Cincinnati, Ohio, June 12-14, 1987.
5. Ficat, R.P., Hungerford, D.S.: Disorders of the patellofemoral joint. PP 183-193, Baltimore: Williams and Wilkins Co., 1977.
6. Fineston, A., Eric, L.R., and Milgrom, C.C.: The treatment of overuse patellofemoral pain. Clin Orthop 293: 208-210, 1993.
7. Hanten, W.P., and Schulthles, S.S.: Exercise effect on electromyographic activity of the vastus edialis blique and vastus lateralis muscles. Phys Ther 70 (9): 561-565, 1990.
8. Insall, J.N., Aglietti, P., and Tria, A.J.: Patellar pain and incongruence. II clinical application. Clin Orthop 176: 225-232, 1983.
9. Jackson, J.P.: Surgical anatomy. In Jackson, J.P., Waugh, W., eds. Surgery of the knee, PP 5-9, London: Chapman and Hall, 1984.
10. Lieb, F.J., Perry, J.: Quadriceps function: an anatomical and mechanical study using amputates limbs. J Bone Joint Surg 50-A (8): 1535-1548, 1968.
11. Merchant, A.C., Mercer, R.L., Jacoben, R.H., and Coal, C.R.: Roentgenographic analysis of patellofemora congruence. J Bone Joint Surg 56-A (7): 1391-1396, 1974.
12. Paulos, L., Rusche, K., Johnson, C., and Noyes, F.R.: Patellar Malalignment. Phys Ther 60 (1): 1624-1632, 1980.
13. Puniello, M.S.: Iliotibial band tightness and medial patellar glide in patients with patellofemoral dysfunction. J Orthop Sports Phys Ther 17 (3): 144-153, 1993.
14. Reynolds, L., Levin, T.A., Medeiros, J.M., et al: EMG activity of the vastus medialis oblique and vastus lateralis and their role in patellar alignment. Am J Phys Med 62: 61-70, 1983.
15. Seitz, H., et al.: Anterior instability of the knee despite an intensive rehabilitation program. Clin Orthop (328): 159-164, 1996.

الملخص العربى

علاج الخلل الميكانيكى لمفصل عظمة الرضفة مع أسفل عظمة الفخذ

يهدف هذا البحث لدراسة تأثير التدريبات الاختيارية لأجزاء عضلة الفخذ الرباعية بإستخدام جهاز التغذية الرجعية فى إستعادة التوازن بين الرأس الخارجية والرأس الداخلية للعضلة وتأثير ذلك على إستعادة توازن عظمة الرضفة فى المرضى المصابون بخلل ميكانيكى بمفصل عظمة الرضفة مع أسفل عظمة الفخذ .

إشترك فى الدراسة ثلاثون متطوعا تتراوح أعمارهم بين ٢٠ و ٤٣ عاما ، منهم سبعة عشر من الذكور وثلاث عشر من الإناث وقد تم تقييم أداء المفصل باستخدام قياس زاوية العضلة الرباعية الرؤوس وقياس زاويتى الأخدود والتطابق بطريقة ميرشنت قبل وبعد التدريب . أشارت نتائج البحث إلى إمكانية التدريب الاختيارى لأجزاء العضلة الرباعية الرؤوس ، وأشارت كذلك إلى وجود فروق معنوية فى قياسات زاوية العضلة الرباعية وزاوية التطابق قبل وبعد إجراء التدريبات الاختيارية .