ELECTROMYOGRAPHIC ACTIVITY OF THE VASTUS MEDIALIS OBLIQUE AND VASTUS LATERALIS LONGUS MM. DURING OPEN AND CLOSED KINETIC CHAIN EXERCISES

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INTRODUCTION: Many electromyographic studies have been done to evaluate the action of the quadriceps femoris muscle (Stratford, 1982; Moller et al., 1987), especially its components, the vastus medialis oblique (VMO) and vastus lateralis longus (VLL), and the best kind of exercise to recover the stabilizing functions of the tibial femoral and patellofemoral joints (Hanten et al, 1990; Marks, 1993).
The treatment of several pathologies of the knee joint (such as meniscal, ligament injury - ACL reconstruction - and others), including the patellofemoral joint, often include open kinetic chain (OKC) and closed kinetic chain (CKC) exercises (Cook et al., 1992; Reynolds et al., 1992)
In recent years, CKC exercises have been suggested as being safer and more functional than OKC (Bynum et al, 1995). However, it has not been established in which exercise, OKC or CKC (especially in leg-press equipment), the VMO and the VLL muscles have greater electromyographic (EMG) activity.
Therefore, the purpose of this study was to analyze the EMG activity of the VMO and the VLL muscles during OKC exercises, using a knee extension table, and in CKC exercise, using a horizontal leg-press, at 90 degrees of hip and knee flexion.

METHODS AND PROCEDURES: The VMO and VLL muscles were analyzed electromyographically in twelve healthy adult subjects (4 males and 8 females), aged 18 to 23 years (**X**= 21.9; SD= 1.16), without prior hip, knee and ankle joint pathologies at the time they were studied, especially in the patellofemoral joint. Prior to testing, all subjects signed an informed consent form, as required by the Ethics Committee of the Universidade Estadual de Campinas (UNICAMP).
The EMG activity of the VMO and the VLL muscles of the left lower limb was processed by a 16 - channel EMG SYSTEM (Digital Analogue Conversor - CAD 12/36 - 60 K / LYNX Ltda), with 12 bits of resolution. The frequency of the signal acquisition was 1000 Hz, and the recording speed was 400ms. The filter used was of 500 Hz (at low frequency) and 10 Hz (at high frequency).
The EMG signal was acquired with preamplified surface electrodes (DELSYS Inc. # DE02). The root mean square (RMS expressed in μV) EMG signal was used to assess muscle activities. A software package AQDADOS (LYNX Ltda/ 4.7) was used for data collection.
The surface electrodes were placed on the skin overlying the VMO and VLL muscles, in the middle of the muscles bellies, 5 cm superior and medial to the superomedial border of the patella for the VMO muscle, and on the lateral face of the thigh, 10 cm above the superolateral border of the patella for the VLL muscle.

All electrodes were aligned longitudinally to the muscle fibers, and a common ground electrode was placed over the left wrist.
To perform the OKC exercise, the subjects were seated on a knee extension table adjusted to provide 90 degrees of hip and knee flexion in the left lower limb. The subjects were stabilized with two belts: thoracic and pelvic. We instructed the subjects to grasp the sides of the padded seat for added stabilization. The resistance was mechanic on the anterior tibia approximately 2.5 cm above the left medial malleolus.
For the CKC exercise, the subjects placed in a supine position on a horizontal leg-press (VITALLY Top Line), with the left hip and knee at 90 degrees of flexion, and the left foot was placed on the platform at 0 degrees between plantar and dorsal flexion. The resistance was also mechanic and applied only to the left lower limb. The upper limbs were in the extended position and the hands were gripped onto sides of the padded gadget for added stabilization. In both exercises, the subjects were instructed to concentrate on a verbal command to initiate the exercises, and we used other standardized verbal instructions (in a quick and vigorous way to obtain the maximal effort), giving the volunteer instructions in order to keep the strain and the duration of the required response.
The maximal isometric contractions were maintained for 4 seconds. For all exercises, the volunteer performed 3 contractions, and the means obtained were used in the calculations. The interval between each contraction was of 30 seconds and between each exercise of 2 minutes. The subject was instructed to report any possible signal of discomfort or muscle tiredness. Three warm-up repetitions at submaximal contractions were performed prior to testing each exercise.
The data were statistically analyzed employing the Student’s t - test at the 0.05 level of significance.

RESULTS AND DISCUSSION: The results showed that the EMG activity of the VMO muscle was significantly greater than that of the VLL muscle during open kinetic chain and closed kinetic chain exercises (Table).
Table. Means and standard deviations of electromyographic readings (RMS in μV) of the vastus medialis oblique muscle (VMO) and the vastus lateralis longus muscle (VLL) during knee extension in open kinetic chain (OKC) and closed kinetic chain (CKC) exercises (N=12).

	Open kinetic Chain*		Closed Kinetic Chain**	
Muscle	$\bar{X}$	SD	$\bar{X}$	SD
VMO	403.53	192.85	481.97	248.61
VLL	131.62	91.19	154.60	103.14

* A significant difference existed between the means of the VMO and VLL for the OKC exercise (p= 0.0001).
** A significant difference existed between the means of the VMO and VLL for the CKC exercise (p= 0.0002).

There is controversy in the literature regarding the EMG activity of the VMO and VLL muscles, principally in relation to the angle of knee flexion, both in OKC and CKC exercises.

In relation to the OKC exercises, our results are in agreement with Boucher et al (1992) and Cerny (1995), who found greater EMG activity in the VMO muscle than in the VLL muscle in OKC exercises with the knee flexed at 90 degrees. On the other hand, other researches (Worrel et al, 1995 and Signorile et al, 1995) did not find significant differences in the EMG activities of these muscles, despite the methodological differences.
Furthermore, our results also showed greater EMG activity in the VMO muscle relative to the VLL muscle during CKC exercises. These results can not be directly compared, since most of the CKC exercises are carried out in more varied forms such as steps of various heights (Souza et al, 1991 and Monteiro - Pedro et al, 1997), isotonic squats (Wilk et al, 1996) and isometric squats with a smaller angle of knee flexion (Cerny, 1995; Schaub et al, 1995).
It is important to emphasize that more studies are required to determine the differences, not only in the EMG activities of these muscles but also in the type and specification of the exercise to be carrids out (OKC and CKC). Despite not having compared the two types of exercise, we believe as do Fitzgerald (1997) and others that therapists must not completely abandon OKC exercises (principally in ACL injuries) and must choose an appropriate exercise program, both for OKC and CKC, especially when the objective is to selectively strengthen the VMO.

CONCLUSIONS: The results of this research, within the experimental conditions used, suggest that the VMO muscle can recover functionally by MIC at 90 degrees of hip and knee flexion during open and closed kinetic chain exercises, using an extension table and a horizontal leg-press, respectively.

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