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Review

Exercise and tropism of the multifidus muscle in low back pain: a short review

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Abstract. [Purpose] The purpose of this review was to investigate the types of exercises that can improve the tropism of the multifidus muscles, based on clinical evidence. [Methods] Following to the PICO (Problem, Intervention, Comparison, Outcome) model, we considered studies of subjects with specific or non-specific LBP that used exercises aimed at activating the lumbar multifidus muscle and measured its cross-sectional area or thickness with ultrasound, computed tomography or magnetic resonance imaging. [Results] This review found that most studies compared different types of exercises for lumbar muscles, but without specifically investigating the multifidus muscle. However, a few studies showed that the cross-sectional area and thickness of the multifidus muscle can be increased by activating this muscle, and they progressed from motor control to increased static and dynamic loads. [Conclusion] A review of the literature revealed that specific supervised and home exercises may improve the symmetry of the multifidus muscle.
Key words: Multifidus muscle, Exercise, Diagnosis

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INTRODUCTION

Several studies have shown that subjects suffering from low back pain (LBP) frequently show persistent involvement of the lumbar multifidus muscle. For example, atrophy and fatty infiltration have been reported[1–7)], reduced activity has been demonstrated in persistent LBP[8–11)], and fiber transformation from type I to type IIC has also been observed[12–15)]. Recovery of multifidus muscle activation and endurance is considered essential for restoring the proper function of the lumbar muscle “core”[16–18)]. European guidelines for the management of chronic non-specific LBP also recommend supervised exercises as the main treatment for LBP, but they do not indicate which exercise is best[19)].

Physical therapists use different exercises to recruit and strengthen the lumbar multifidus muscle[20, 21)], but whether they are actually supported by instrumental evidence demonstrating their ability to change the anatomical characteristics of this muscle is unknown, particularly in the treatment of LBP-induced atrophy.

The purpose of this paper is to illustrate and comment on how exercise can improve the physical parameters (tropism) of the multifidus muscle in patients with specific or non-specific LBP, using diagnostic imaging as the outcome measure.

The effect of exercise on the tropism of the lumbar multifidus muscle in LBP

Following to the PICO (Problem, Intervention, Comparison, Outcome) model, we considered studies of subjects with specific or non-specific LBP that used exercises aimed at activating the lumbar multifidus muscle and measured its cross-sectional area or thickness with ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI). Most published studies comparing different exercises for the lumbar muscles did not carry out specific training for the multifidus muscle, and/or did not evaluate the effect of the exercises on the physiological characteristics of that muscle; and only a few works have investigated the most effective exercise for changing the cross-sectional area or thickness of the multifidus muscle.

The first of these is, a paper of moderate quality (PEDro score = 6)[22)] by Danneels et al.[23)], that investigated which type of exercise/muscle contraction is more effective for multifidus muscle atrophy recovery. This randomized clinical trial involved 59 patients with chronic LBP. Subjects who practiced sports or lumbar muscle training during the three months prior to the intervention were excluded. The cross-sectional area of the multifidus muscle at three levels was measured on CT images taken by an independent assessor. The exercises program was conducted for ten weeks,

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with a frequency of three sessions per week. Each patient was randomly assigned to one of three different treatment methods. Group 1performed stabilization exercises. This training was based on a series of daily activities in various positions, aimed at improving lumbar dynamic stability in a functional way. Multifidus muscle activation followed the specific progression of the exercises described by O'Sullivan et al.[24], requiring about 30% of maximal contraction. Group 2 performed stabilization exercises combined with dynamic training. This group paired the stabilization exercises described for group 1 with progressive resistance training in three standardized exercises (hip and knee extension in the quadruped position, trunk extension in the prone position, lower limb lifting in the prone position). Each progressive resistance training exercise was done in a controlled and standardized way, at the same speed and with the same duration. Group 3 performed stabilization training combined with static and dynamic training. This group differed from group 2 only in the interval between the concentric and eccentric exercises, as five seconds of static contraction were performed between the two movements. Analysis of the differences between the groups after the intervention period showed statistically significant differences only in group 3 at the three levels tested (p=0.014, 0.008 and 0.002 respectively). The results of this study suggest that maintaining static positions between concentric and eccentric contractions is essential for inducing muscle hypertrophy during 10 weeks of treatment. A study of equal quality by Akbari et al.[25] (PEDro score = 6) also investigated the effectiveness of two different exercise programs for the trunk muscles of subjects with chronic LBP. This randomized controlled trial compared a motor control program to a general exercise program. The study enrolled sixty-three subjects and lasted eight weeks, with twice-weekly half-hour sessions for both groups. Modifications in the structural characteristics of the investigated muscles were assessed by measuring the thickness of the lumbar multifidus and transversus abdominis muscles with an ultrasound device (B-mode US). Group 1 performed motor control exercises wich were based on the suggestions of O'Sullivan et al.[24], Richardson et al.[26], and Moseley[27]. It consisted of initial exercises to first isometrically activate local stabilizers with low loads in the supine, quadruped, sitting and standing positions. Then, subjects were asked to maintain these contractions for 10 seconds while breathing normally. Finally, dynamic tasks were introduced (from the simplest to the most complex), once again maintaining the stabilizers contraction. Group 2 performed general exercises which implemented abdominal and paravertebral muscle strengthening, based on McGill's proposal, which was tailored to individual tissue load capacity[12]. At the end of the intervention, both groups showed increased strength and the motor control exercise program was significantly better at reducing pain (p=0.004) and, to a lesser extent, in increasing the lumbar multifidus and transversus abdominis muscle thicknesses.

Another pilot study was conducted on five female health professionals affected by non-specific chronic LBP[28]. A lumbar stabilization program was carried out for 10 one-hour sessions over 12 weeks and the subjects were requested to do home exercises twice a week, for about 30–40 minutes. The lumbar multifidus and transversus abdominis muscle thicknesses were measured by ultrasound. Multifidus muscle images were acquired in the paravertebral right and left areas three times in succession and the arithmetic mean of the measured values was calculated in order to reduce random error. While there was no evidence of significant changes in tropism of the transversus abdominis after the intervention, the multifidus muscle thickness on the more hypotrophic side was augmented in four of the five subjects. A statistically significant improvement in pain and disability was also found and the improvements were stable at the two month follow-up.

Different results were obtained by Willemink et al.[29], who investigated the effect of extensor muscle training on multifidus muscle morphology by measuring the muscular transverse area via MRI. Participants performed progressive resistance training of the isolated lumbar extensors carried out on a back training device for 12 weeks and continued, more specifically, for an additional 12 weeks. Participants were instructed to move in a relatively slow and controlled manner through the full range of lumbar motion (in approximately 2 seconds from flexion to extension, and in approximately 3 seconds back to flexion), thereby activating both global and deeper trunk muscles. At the end of this training, there was a statistically significant improvement in disability, but it was not accompanied by changes in the multifidus muscle cross-sectional area. The study's authors concluded that change in muscle morphology does not seem to be a determining factor for better functional status in patients with chronic LBP, at least in the short term.

DISCUSSION

The assessment of pain, disability and recurrence rate is commonly used to measure the effectiveness of LBP treatments. Unfortunately, these assessments do not allow us to isolate the individual treatment components that contribute to the result. Moreover, the majority of studies considered multifidus muscle training within a stabilization program that involved other muscles (e.g., transversus abdominis, internal oblique) and the changes induced in this specific muscle were not usually measured. This literature review is usefully identified the few studies that have evaluated the effects of specific therapeutic training on the multifidus muscle using instrumental outcomes (ultrasound, CT, MRI).

In the first study, Danneels et al.[18] showed that it is possible to increase the cross-sectional area of the multifidus muscle, with a concomitant decrease in pain, using an exercise protocol progressing from motor control to increased static and dynamic loads. In the second study, Akbari et al.[24] showed that both specific stabilization training and generic exercises led to a positive effect on the thickness of the multifidus muscle, and that stabilization treatment was the more effective of the two. The third pilot study[28] seems to indicate that stabilization training promoted the recovery of symmetry of the multifidus muscle between the affected side and contralateral side. Previous studies have reported multifidus muscle asymmetry in patients with acute and chronic LBP[5] and demonstrated that specific motor control training resolved this asymmetry by improving most hypotrophic cross-sectional areas[30, 31]. In contrast, Willemink et al.[29] reported that clinical improvement was not supported by anatomical muscular changes. Similar findings were also reported by Mannion et al.[32] for the transversus abdominis muscle. These authors hypothesized that motor control exercises could have a "central" effect, but not necessarily in relation to the specific peripheral muscle function. This hypothesis is also supported by Steiger et al.[33], in a review of the changes in clinical outcomes and changes in physical function after therapeutic exercises. These authors did not confirm the relationship between the effect of exercises and musculoskeletal system changes in patients with chronic LBP.

The present review was not able to clearly identify which exercise best modifies the multifidus muscle structure in subjects with LBP, but it did reveal that the multifidus muscle thickness and/or cross-sectional area may increase when more than one exercise at the same time and progressing from motor control to increasing static (overall) and dynamic loads. This training appeared to be more effective than generic exercises at improving muscle tropism and, when coupled with home treatment, may facilitate recovery from muscular atrophy.

This short review aimed to provide a more complete picture about the exercises and tropism of the multifidus muscle in low back pain and contribute to its applicability in rehabilitation practices. The data from the studies found provide us with some information about the type, number of repetitions and exercise methods.

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