Mechanisms of muscle stretching exercises for reduction of low back pain: narrative review

Mecanismos de exercícios de alongamento muscular para redução de dor lombar: revisão narrativa

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ABSTRACT

BACKGROUND AND OBJECTIVES: Stretching exercises are present in physical training and muscle rehabilitation programs. Within the context of rehabilitation of patients with low back pain (lombalgy), there is still a gap about the mechanisms that these exercises should reduce pain and disability in these patients. The aim of this study was to investigate what are the possible mechanisms through which muscle stretching exercise could reduce pain in individuals with chronic low back pain.
CONTENTS: Pain in the lumbar region is one of the most disabling pains when it comes to limitations for daily functions, so it's necessary to investigate alternatives that provide relief for these patients. As the cause of non-specific chronic low back pain is multifactorial, the treatment of the pathology occurs mainly to reduce the sensation of pain. As an alternative, the flexibility training through stretching exercises can be efficient because they generate biomechanical and sensory changes, which would result in an analgesic effect. Additionally, it's still possible that these two effects occur together to explain the reduction in low back pain after performing stretching exercises.
CONCLUSION: There is theoretical basis in the literature to support the performance of stretching exercises as a non-pharmacological strategy for the treatment of chronic low back pain. Biomechanical and neurophysiological mechanisms can be pointed out to explain these benefits.
Keywords: Low back pain, Muscle stretching exercises, Pain.

RESUMO

JUSTIFICATIVA E OBJETIVOS: Exercícios de alongamento estão presentes em programas de treinamento físico e reabilitação muscular. Dentro do contexto da reabilitação de indivíduos com dor na região lombar (lombalgia), ainda existe uma lacuna sobre os mecanismos pelos quais esses exercícios reduzem dor e incapacidade nesses pacientes. O objetivo deste estudo foi descrever os possíveis mecanismos pelos quais o exercício de alongamento pode reduzir dor em indivíduos com lombalgia crônica.
CONTEÚDO: A dor na região lombar é uma das dores mais incapacitantes quando se trata de limitações para as funções no cotidiano. Por isso, é necessário investigar alternativas que possam proporcionar o seu alívio nesses pacientes. Considerando que a causa da lombalgia crônica não específica é multifatorial, o tratamento desta doença ocorre principalmente na tentativa de reduzir a sensação dolorosa. Como alternativa, o treinamento da flexibilidade por meio de exercícios de alongamento pode agir reduzindo a dor lombar por gerarem alterações biomecânicas e sensoriais que resultam em efeito analgésico. Adicionalmente, ainda é possível que esses dois efeitos possam atuar em conjunto para explicar a redução da dor lombar após a realização de exercícios de alongamento.
CONCLUSÃO: Existe suporte teórico na literatura para sustentar a realização dos exercícios de alongamento como estratégia não farmacológica para o tratamento da dor lombar crônica. Mecanismos biomecânicos e neurofisiológicos poderiam ser apontados para explicar tais benefícios.
Descritores: Dor, Dor lombar, Exercícios de alongamento muscular.

INTRODUCTION

The concept of pain is an unpleasant sensorial and emotional experience that may or may not be associated to a real tissue injury[1]. It's nature is subjective and individual, since it involves sensitive and cultural aspects, as well as influence from the environment, and low back pain (LBP) is one of the most common types of pain[2]. Despite the multifactorial etiology, physical therapies that result in analgesic effects, such as stretching exercises, could be viable alternatives as non-pharmacological therapies for reducing pain intensity in individuals with LBP[3] through biomechanical and neurophysiological

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mechanisms[4], besides improving body posture, musculoskeletal disorders, and muscle pain[3].

LBP causes absenteeism and disability, pain, and limitations in daily life[5]. It can affect between 60 and 80% of the population worldwide, and it's common for people to experience this episode of pain at some point in their lives[6]. Most cases of LBP, about 85%, do not present a single and easily identifiable causal factor, being considered nonspecific and with psychosocial repercussions linked to the clinical scenario[3,5,6].

Changes in the connective tissue involving tendons, ligaments, and muscle fasciae caused by factors that directly influence the range of motion (ROM) of a joint (aging, work, immobilization, injuries, metabolism disorders, or nutritional deficiencies) can predispose an individual to LBP[7,8]. In addition, low levels of flexibility of passive muscle structures (tendons, ligaments, and fasciae) may be associated with LBP[9].

In conditions of LBP, the muscles become spasmodic even at rest and the accumulation of metabolites can cause irritation in the nerve endings of the area, generating reflex spasm and increased pain[5,6]. The treatment for chronic LBP may involve physical exercises, medication, injections, physical therapy treatment, and, as a last resort, surgical intervention[10,11]. Regarding the use of physical exercises, despite the lack of clinical trials, there is theoretical support that suggests stretching exercises are an effective alternative for the treatment of chronic LBP[3-6,12].

Despite the existence of studies showing the positive effects of stretching exercises on LBP[13-18], most of them combined these exercises with other therapeutic interventions[14-16], and few of them evaluated stretching exercises alone[17,18]. Within this context, there is a need for studies that review the available theoretical evidence on the physiological mechanisms that could explain how stretching exercise alone could reduce LBP. Such information could assist health professionals in the appropriate use of this non-pharmacological strategy for treating LBP. However, as far as is known, no studies performing this analysis were found.

The purpose of the present work was to analyze the mechanisms that might explain how stretching exercises could reduce LBP intensity.

CONTENTS

Low back pain

The experience of pain is multidimensional, with differences in sensation, quality and/or intensity, and can be influenced by the individual's affective and emotional aspects. It is also proposed as a protective mechanism, since it's an alert of tissue injury, causing the individual to react to certain painful stimuli[2,3,6]. Pain can be evaluated through uni and multidimensional strategies[19]. For the first possibility, the analysis is made from scaling or values measured by unidimensional instruments, measuring the intensity of pain, such as the numerical pain scale[19,20]. On the other hand, multidimensional assessment seeks to investigate other aspects related to pain, such as its meaning and/or influence in the individual's life, with the participation of the multiprofessional team[19,20]. The adequate assessment of the pain sensation is fundamental to perform the best possible pain diagnosis, prognosis, planning and control[20].

Pain can be divided mainly into acute or chronic. The first is directly linked to tissue injury in response to the body's defense, lasting less than six weeks and regressing with tissue healing[6]. Chronic pain, on the other hand, has a multifactorial origin, persists for more than 12 weeks, and requires a multidisciplinary approach to treatment[6]. In this aspect, some factors lead to the chronification from acute to chronic pain, such as low physical activity level, aging, bad posture at work and repetitive strain.

In this context, the different etiologies also result in different treatment strategies. In acute pain, the aim is tissue recovery and pain relief, in addition to conservative treatment for the improvement of the inflammatory process[6,21]. On the other hand, in chronic pain, the treatment focus is on the psychosocial, physiological, and cultural aspects, reduction of muscle tension and fatigue, as well as the disability that was generated in the individual[20,21]. Therefore, the results from stretching exercises in reducing pain, changing the rigidity of passive structures, and increasing flexibility make their use promising as a non-pharmacological treatment strategy for LBP.

Flexibility, stretching, and low back pain

Flexibility is an important physical capacity for health-related physical fitness, and it may be directly linked to body posture and musculoskeletal disorders[4,22]. This physical capacity can be evaluated using the maximum range of motion (ROM_{max}) achieved by one or more joints and it is usually trained in stretching exercises[22]. Such exercises can be performed with different possible organizations regarding the stretching techniques used, mainly passive-static[22], passive-dynamic[23], active-dynamic[24], and proprioceptive neuromuscular facilitation (PNF)[25].

Thus, as there seems to be no superiority of the effects of one stretching technique over another[26,27], the mechanisms addressed in the present study will be those that are widely used to explain the effects of stretching exercises on ROM_{max} and are related to biomechanical and/or sensory changes[4,22].

Although the mechanisms responsible for the increase in ROM_{max} and consequent improvement in flexibility are not clearly elucidated, there are two main approaches[4] which can be analyzed regarding the beneficial effects for LBP. One points to changes in the biomechanical properties of the muscle-tendon unit (MTU), such as reduced passive stiffness (PS)[4,22]. Another approach suggests modifications in stretch tolerance, resulting from a change in the individual's pain perception[4]. Together, these two approaches may contribute to explain the benefits of stretching exercises in reducing LBP pain intensity.

From a biomechanical perspective, the joint flexibility is also determined by the resistance caused by the tissues surrounding it[28] and can be reduced due to adaptive shortening of the soft tissues[29,30]. This shortening can be caused by immobilization, sedentary lifestyle, and the aging process of collagen, which leads to less elasticity of the fasciae near the spine[29].

One of the basic tissue structures is collagen, which loses its elasticity with aging[30]. Within the collagen matrix there is an increase in the formation of cross-links, affecting the biomechanics of the discs, possibly resulting in mechanical failures with increased viscosity and reduced tissue elasticity[30]. Therefore, the reduction in fascia elasticity, which may affect the ROM achieved by the joint, would be related to muscle tension and LBP due to the generation of a compression of nerve roots[3,5,9].

Within this context, from a biomechanical approach, stretching exercises could reduce muscle tension on the nerve roots, thus minimizing LBP. Studies have shown a reduction of passive muscle stiffness[22] in the resistance of the MTU to stretching[31] and increased ROM_{max} [4,22,31]. The reduction in passive stiffness could result from the elastic deformation generated by the mechanical load of stretching exercises in the MTU structures, such as non-contractile intrasarcomeric proteins; intramuscular connective tissue, especially the perimysium; and extracellular matrix[30]. It is also proposed that, chronically, muscle stretching would reduce the amount of cross-links in collagen fibers, increasing the elasticity of passive tissue[31-33]. Taken together, these biomechanical effects could indirectly explain how stretching exercises reduce LBP[34,35].

In addition to the biomechanical approach, the sensorial approach[4] could help to comprehend the analgesic effect of stretching exercises for LBP. Although this effect is still not completely explained, the hypothesis is that mechanical tension would stimulate free nerve endings sensitive to mechanical stimuli[36,37]. These stimuli, transmitted by afferent pathways with larger caliber and greater conduction velocity than nociceptive afferent pathways, would reach the posterior horn of the medulla first, in the *substantia gelatinosa*, generating presynaptic inhibition, a mechanism known as the gate control theory[38]. Stimulated by the nervous impulse from mechanoceptors, the *substantia gelatinosa* would modulate the synaptic transmission of nervous impulse between peripheral and central afferent fibers, acting as a gate system and reducing the passage of painful stimuli[38].

Furthermore, MTU stretching could also elongate nerve fibers, reducing fibrosis and adhesion between the surrounding connective tissue and neural tissues, allowing better intrafascicular gliding[38] and pumping/flushing of intraneural fluid, facilitating axoplasmic flow, minimizing the deposition of chemical sensitizers, resulting in pain relief[39-41]. Taken together, these neurophysiological mechanisms could explain how stretching exercise would reduce LBP and allow for improved function[42].

Thus, stretching exercises could decrease LBP through biomechanical and neurophysiological mechanisms, which also need to be analyzed together, because biomechanical changes in muscle properties can influence the amount of tension that is transmitted to the nervous tissues and sensory receptors by the connective tissue[43]. Thus, a less rigid MTU would transmit less tension to the other nerve structures, allowing for a greater joint ROM without the sensation of pain[43].

Nonetheless, the stretching exercise prescription must be properly organized, as previous studies have shown that the effects of stretching exercise on biomechanical variables depend, for instance, on the technique used[22] and the duration performed[44]. Thus, the present study focused on the analysis of the mechanisms and biological plausibility for the use of stretching exercises in patients with chronic LBP. Based on the mechanisms here identified, randomized clinical trials should be conducted, especially with adequate sample size, definition of the type of stretching applied and adequate internal consistency.

CONCLUSION

There is theoretical support to propose that stretching exercises can reduce pain intensity through biomechanical and neurophysiological changes. Such effect is fundamental for individuals to return to their functional and labor activities.

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