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Review article

Efficacy of stretching in physiotherapy and sports

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ABSTRACT

Introduction: Stretching constitutes an important element of therapeutic management in numerous disciplines, starting from neurology to motor training and orthodontic practice. Different models and approaches that apply stretching use their own terminology, and yet they are based on similar assumptions and purposes.

Aim: The aim of this study was to establish scientific fundamentals of using different forms of stretching, and to determine areas of its effective application.

Material and methods: Medline searches were conducted in context of stretching, hold-relax technique, athletic injury prevention and physiotherapy.

Results and discussion: Although stretching is widely recognized as an effective method of working with muscle restrictions, there are many studies that undermine its impact on the muscle length, especially in short-term observation. Similar limitations are noted with regard to its application in patients with neurological paresis, or as an element of warm-up before sports activity.

Conclusions: Stretching is an effective tool in working with myofascial pain syndromes; however, its actual influence on the condition of muscles and fascia remains unclear.

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1. INTRODUCTION

Muscle stretching is highly recommended by a wide range of specialists working with the movement sstem, including various sports disciplines trainers, physiotherapists helping patients with pain and mobility limitations. Based on different explanations, they introduce elements of the therapy aimed at reducing muscle tone or increasing muscle length. Scholars have also been searching for an optimal model affecting body structures so as to permanently increase mobility. Research findings are sometimes astonishing, especially those questioning the impact of stretching on changes in muscle morphology, and reducing the effect of 'muscle is extending' only to changes within the nervous system. According to the sensory theory, the actual muscle length stays the same, and the observed therapy result is only a change in a subjectively sensed level of muscle stretching achieved through increasing the tolerance to stretch.[1] Another interesting research finding is a negative influence of muscle stretching on its kinetic properties, especially on the peak strength moment and explosive force. Even though this effect, known by researchers as the stretch-induced strength loss, concerns only certain forms of stretching, it makes us ponder the real, clinical value of stretching exercises.

2. AIM

The aim of this study was to establish scientific fundamentals of using different forms of stretching, and to determine areas of its effective application.

3. MATERIAL AND METHODS

Medline searches were conducted in context of stretching, hold-relax technique, athletic injury prevention and physiotherapy.

4. RESULTS

Currently used types of stretching methods may be divided into three groups:

(1) Static stretching (SS) which involves holding a muscle in a position of preserving the distance between its origin and insertion. The duration varies and ranges from short 15–30 s sessions repeated 2–4 times a day even to 40-minute interventions.
(2) Dynamic stretching (DS) involves actively and repeatedly moving a limb in the full range of motion.
(3) The majority of techniques derive from the proprioceptive neuromuscular facilitation concept (PNF). Their common characteristic feature is a submaximal isometric contraction, which lasts for several seconds and is followed by a passively performed stretch. The most common of those techniques is hold-relax (HR) and muscle energy technique (MET).

4.1. Stretching efficacy in improving the range of movement (ROM)

Effects of stretching need to be considered in terms of acute changes occurring immediately after workout, and in terms of permanent plastic adaptations. Acute changes result from the viscoelastic properties of muscles, which, while under pressure, are able to change their length temporarily, only to return to their primary length once the stimulus ceases to affect them. The effects in the form of an increase in passive and active range of mobility achieved immediately after stretching are undisputed and concern all the types of stretching: static, dynamic, and stretching with initial tension. A comparative study of the PNF and SS applications demonstrated no difference between those two stretching types when it comes to improving the hamstrings flexibility.[1–3] In order to achieve long-lasting effects, it was essential to ensure adequate duration of a stretching stimulus. In a study where the stimulation was performed 4 × 30 s, the achieved increase in the range of movement (ROM) subsided after 10 minutes. It was only after prolonging this time to 4 minutes or 8 minutes that the effect could be preserved for 10 minutes and 30 minutes respectively at the level of 50% of the reduction occurring immediately after the workout.[4] Long-lasting effects after many weeks of workout also attest to the effectiveness of different forms of stretching. A study comparing two forms of stretching hamstring muscles for 6 weeks, namely PNF and passive stretching, proved to be effective in improving the range of motion.[5] All the forms of workout proved to be equally effective in a study including 117 people after the knee replacement procedure, where 2 weeks of intervention with the SS, DS, and PNF methods brought the improvement of the 20-degree angle.[6] A slight advantage of the SS method was observed in a 4-week training carried out with the exceptionally low intensity of 3 × 30 s per week. After 2 weeks of using PNF, SS and self-stretching all the study subjects had similar results, but after finishing the training only static stretching brought a statistically significant result, while the other methods proved ineffective.[7]

However the results obtained in this area do not allow us to draw definite conclusions. Some researchers claim that the observed improvement of mobility after stretching workout does not result from the muscle rebuilding, but from increased stretch tolerance, that is, from sensory adaptation.[8] The outcome of a 4-week stretching regime conducted in a group of 14 healthy volunteers demonstrated a significant improvement in the subjectively sensed mobility even though there were no changes in flexibility of the stretched muscles.[9] Also workout of muscle stretching performed for 30 minutes daily over 6 weeks by 60 young volunteers did not change elasticity of the examined muscles, although stretch tolerance improved, with the effect of mobility increasing by 10° on average.[10] No alteration in the stretched muscles flexibility was observed in many other studies, which seems to confirm the hypothesis of the sensory conditioning of mobility changes.[8,11,12]

4.2. The influence of muscle stretching techniques on biomechanics

The majority of recently published reports support the thesis that stretching workout has a negative influence on muscular activity. This negative effect, known in literature as stretch-induced strength loss (SISL), concerns mainly the impact of pre-exercise SS and PNF. In people undergoing static stretching, researchers have noted a considerable loss of muscle strength (22% on average) and explosive force, as well as impaired quality of performance regarding many functions, e.g. vertical jump (mean reduction by 3%–4%), sprint (mean reduction by 2.4%), or bench press lying face up.[13] This effect is transient in character and subsides with time. After 3 minutes of stretching, complete elimination of SISL in the lower leg muscles occurred only after 30 minutes, although in a study by Power et al. the quadriceps femoris strength loss (by 9.5%) and the decrease in the level of its activation (5.4%) persisted even after 2 h following stretching.[14] It has been observed that stretching exerts a particularly adverse effect when it lasts over 60 s, while shorter sessions, below 45 s and 30 s, do not cause such significant changes in muscular work.[13] Intense stretching, especially at the end range of physiological mobility, near the point of discomfort (POD), leads to a greater SISL effect than less intensive activity. According to a study by Young et al., reducing the intensity of 2-minute stretching to 90% of POD eliminates its negative impact on a vertical jump result.[15] PNF training has a comparably negative influence on kinetic parameters and function. When applied immediately before the main workout, it adversely affects the forms of activity that requires maximum intensity performance, namely sprint, weight lifting or vertical jump. A study by Bradley compares and contrasts the effects of SS and PNF on vertical jump performance. The author noted the result deterioration by 4.1% and 5.0%, but this effect subsided completely 15 minutes after the intervention.[16] Yet another study by Marek demonstrates a negative impact of PNF on muscular strength and power.[17] A good alternative to static stretching and PNF is dynamic stretching.[18] Research comparing the influence of SS and DS on vertical jump, conducted in a group of 11 athletes, demonstrated the occurrence of the SISL effect only in the SS group, whereas the DS group presented improvement in the jump results.[19] Similar findings were observed when testing balance, the upper limb pace, and agility, where negative influence typical of SS application did not occur after dynamic stretching; on the contrary, improvement was noted in the results concerning the areas observed.[20]

4.3. Application of stretching in physiotherapy

A common indication for stretching is prevention of contractures and muscle shortening. This is the case when immobilization or dysfunction may lead to restrictions of mobility, and also when patients are at risk of muscle shortening resulting from paresis. The key to understanding muscle length changes as an adaptive process seems to lie in muscular activity in the course of immobilization.[21] Animal testing has provided a chance of comparing the effects of passive stretching and passive stretching with contraction on the soleus muscle length after the Achilles tendonectomy. Passively stretching the muscle for 20 minutes daily, under anaesthesia, did not have any impact on reducing the number of sarcomeres. It was only after applying muscular contractions simultaneously with passive stretching that the loss of sarcomeres in the sequence was prevented. Negative results were also obtained when examining the influence of passive stretching on denervated or anaesthetized muscles, which indicates that the method is ineffective as prevention of muscular contractures.[22,23] The outcome of work with patients having contractures after the spinal cord lesion is equally dissatisfying. The analysis of 24 studies on effectiveness of contracture prevention revealed lack of clinical impact of stretching on patients after spinal injuries both in terms of shortterm effects (first degree improvement) and longterm effects (no improvement).[24] In fact, these conclusions are similar to the inferences in this scope of work with neurological patients in general. According to Katalinic et al. there is no possibility of effectively preventing contractures by means of regular stretching, and a different form of therapy is needed.[25] When the course of therapy is aimed at preventing contractures and restoring normal mobility in orthopaedic patients considerably better results are achieved. Stretching is a confirmed method of restoring normal ROM in patients after knee replacement. Two weeks of training may increase the range of movement by 19.9%–25.3%, depending on the method used.[6]

Another group of patients includes those with pain as the main therapeutic problem. Possibilities of working with those individuals are confirmed in a study by Levit and Simons, who achieved immediate improvement in 94% of patients through the application of postisometric relaxation.[26] A significant improvement caused by stretching was also noted in a 12-month observation of patients with neck pain. The effect was similar after applying only stretching and stretching combined with muscle strengthening,[27] even though it is usually more effective to apply stretching with strengthening, a phenomenon revealed by researchers from Cochrane in 2015.[28] Patients suffering from low back pain (LBP) may also be significantly relieved after stretching. The result is comparable to the effectiveness of yoga and concerns 51% of the individuals subject to observation over 26 weeks, in whom the mitigation of symptoms was significant or complete.[29] DS when combined with spine stabilization is recommended to regain optimal elasticity and to minimize the risk of irreversible structural changes and occurrence of LBP.[30]

4.4. Influence of stretching on athletic injury prevention

Since the 1980s it has been widely accepted that muscle stretching reduces the risk of sports injuries. That is why different forms of stretching are commonly applied as an element of preparation for workout. However, up-to-date reports show that this approach is not scientifically proven, and

may sometimes even lead to the opposite effect, increasing the risk of injuries.[31] The majority of recent studies, as well as systematic reviews repeated over the last years, question the influence of stretching on the incidence of injuries.[32–34] The ranking of 5 exercises most commonly applied in the framework of injury prevention in football does not include any form of stretching, and instead enumerates eccentric training, training of balance, proprioception, global stability and the gluteus maximus activation.[35] This opinion appears to have been shared by sports physicians during the 2014 FIFA final; in their view the most common injury risk factors included a previous injury, fatigue, muscular imbalances and poor physical capacity. Stretching was not regarded as a commonly recommended training method.[36] It is thus possible to assume that stretching in sports, especially professional sports, is becoming less trendy, although its influence on injury incidence, especially within ligaments and muscle-tendon units, should be taken into account and analysed in further research. In a study comprising 1538 American recruits the incidence of injuries was significantly lower in a group practicing stretching than in the control group, and muscle tears were noted 5 times less frequently.[37] Similar results were achieved by Hadała after introducing stretching to the training of America's Cup regatta participants.[38]

5. DISCUSSION

Diversity of potential techniques and the intuitively felt need to stretch out suggest that this activity should be effective and that it is worthwhile to stretch muscles. And yet the material discussed above undermines, at least partially, reliability of this approach. The most surprising part is the fact that the very effect of stretching on the actual tissue length remains unclear. The sensory theory put forward by Magnusson and later on confirmed by other researchers reduces stretching exclusively to the process of modifying stretch tolerance, which abolishes the basic assumption of muscle stretching as a plastic process with a permanent effect.[8,11,12] Although some studies demonstrate different results, the discrepancies in the findings do not allow us to unanimously determine whether we are able to stretch muscles, or just increase our resistance to stretching stimuli.

The effectiveness of stretching in athletic injury prevention is lower than commonly expected. Numerous studies conducted over the years, particularly systematic reviews, indicate that there is almost no relationship between flexibility improved through stretching and a decrease in the incidence of injuries.[32,34]

The findings of the research concerning effects of stretching on contracture formation and prevention in neurological patients clearly and undoubtedly demonstrate ineffectiveness of this form of therapy, which, therefore, should not be applied.[24]

The effectiveness of stretching in the field of physiotherapy is unquestionable. The ROM alteration, no matter if sensed subjectively, involving an increase in tolerance to stretch, or existing in reality, is well documented and refers to all the therapy types to a very similar extent. Both static and dynamic techniques, as well as those with initial contraction have proved to be effective tools in counteracting contracture formation and in restoring the normal range of movement.[39,40] Although the negative effect that SS and PNF techniques exert on certain biomechanical parameters (SISL) may be of concern, replacing them with DS eliminates this effect, preserving beneficial results of work on mobility.[19,41] Dynamic stretching positively affects ROM, balance, agility, vertical jump and strength.[18–20]

The application of stretching techniques in pain management has strong scientific basis. The pioneer study by Levit and Simons, demonstrates enormous (90%) efficiency of this course of treatment.[26] Various stretching techniques have proved to be effective in treating impingement syndrome in the shoulder joint, neck pain and LBP.[27,29,42] Those findings and similar results of other studies in the area of orthopaedic physiotherapy give us hope that correctly applied stretching adjusted to a particular dysfunction may effectively help patients with pain.

6. CONCLUSIONS

(1) Stretching is an effective method in relieving pain in many musculoskeletal dysfunctions
(2) The effectiveness of stretching in athletic injury prevention is lower than commonly expected.
(3) Stretching should not be recommended as a contracture prevention method applied to neurological patients.
(4) PNF and SS forms of stretching should not be performed prior to exercise due to their negative influence on biomechanics.
(5) Stretching is an effective method of improving ROM, though some researchers claim its efectiveness is only due to the modified stretch tolerance of elongated tissues.

Conflict of interest

None declared.

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