THE EFFECT OF INSTRUMENT ASSISTED SOFT TISSUE MOBILIZATION ON THE REDUCTION OF ANTERIOR KNEE PAIN IN A RUNNER: CASE STUDY

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Abstract. *Knee pain is a very common injury among runners, most of which are related to overuse or rather myofascial dysfunction. For this reason, the analysis of the function of the fascia system and its role in running is receiving increasing attention. Our study investigated the contribution of soft tissue mobilization with Richelli devices to the reduction of runner's knee pain. The subject is a 21-year-old male who is a recreational runner. He has anterior knee pain mainly during running. A functional examination of the lower limbs was performed. Pain was measured using the Visual Analogue Scale (VAS) Hip, knee and ankle joint range of motion was measured using a goniometer. The Y Balance test was used to measure dynamic balance. A total of six manual sessions were performed during the study, each lasting 40-50 minutes. The aim of the connective tissue mobilization was to release connective tissue adhesions of the anterior and lateral muscles of the thigh, the gluteal muscles and the hip flexor muscles and to treat Trigger points. Based on our results, instrumental assisted soft tissue mobilization has been shown to be an effective treatment modality in reducing runner's anterior knee pain. The subject's initial pain score of 8 was down to 1 at the final assessment. There was a significant change in the increase in hip joint range of motion and an improvement in the subject's dynamic balance.*

Keywords: *anterior knee pain; soft tissue mobilization; myofascial.*

Introduction

Recreational running has boomed significantly worldwide (Menheere et al., 2020), with its popularity increasing by 57% in the past 10 years (Rizzo, 2021). In 2020, more than 50 million Americans participated in running or jogging activities (Rizzo, 2021). Despite the popularity of running, the risk of injury is high. 79.3% of runners suffer a lower limb injury at least once a year (van Gent et al., 2007). Acute injuries (e.g. ankle sprains) also occur, but the majority of injuries, around 70-80%, are overuse injuries (Kakouris et al., 2021). In recreational runners, the knee is the most commonly injured area, affected in 50% of cases. The most common overuse running injury affecting the knee joint is patellofemoral pain syndrome (anterior knee pain syndrome), which affects 21% of runners (Mellinger & Neurohr, 2019; van Gent et al., 2007; Pollatos et al., 2021). In recreational runners, the knee is the most commonly injured area, affected in 50% of cases. The most common overuse running injury affecting the knee joint is patellofemoral pain syndrome (anterior knee pain syndrome), which affects 21% of runners (Mellinger & Neurohr, 2019; van Gent, et al., 2007; Pollatos et al., 2021).

The main risk factors for the development of patellofemoral pain syndrome are factors that place increased stress on the patellofemoral joint. Among runners, pain is often associated with overuse, sudden increases in exercise intensity, poor running technique, or to the use of inappropriate footwear (Pollatos et al., 2021). Another significant risk factor is decreased connective tissue tightness, or the loss of flexibility of the myofascial system, which causes muscle dysfunction and pain (Molnár & Majzik, 2017). Running injuries, including anterior knee pain, have a number of negative effects on a runner's life, both on running performance and on everyday life activities. The presence of running injuries and pain often forces runners to reduce the distance, duration and frequency of their runs. Among beginner runners, running injuries are the main reason for stopping running. Patellofemoral pain syndrome develops into a chronic condition in 71-91% of those affected, thus affecting the individual's quality of life, with pain causing difficulties not only during running but also in carrying out daily activities (Sinclair et al., 2022).

In recent decades, research on the fascial system has received considerable attention in the study of human anatomy. The Fascia Research Society (FRS) defines the fascial system as a three-dimensional continuous network of soft, collagenous and loose or dense fibrous connective tissue that permeates the body (Adstrum et al., 2017). Myofascia is a fibrous system of muscles that surrounds and envelops the skeletal muscle system, permeates the muscles, and its finer layers penetrate and are continuous down to the bones. Continuity is also observed vertically, from the base of the foot to the skull. The muscles and the fascia around them connect the different anatomical units of the body, creating so-called myofascial chains. There are currently 12 known myofascial pathways (Myers, 2009). The myofascial system is responsible for maintaining skeletal muscle structures and regulating movement (Pegán, 2021). Fascia facilitates gliding between muscle structures, tracking changes in muscle tissue and thus aiding the transfer of muscle forces (Zhang et al., 2020). Flexibility and the ability to adapt are the main properties of myofascia (Őry, 2021). In addition, fascial tissues are capable of storing and releasing kinetic energy. During running, it is the stretching and shortening of fascial elements (anterior myofascial chain elements, Achilles tendon) that 'produce' the actual movement, while muscle fibers contract almost isometrically without significantly changing their length (catapult mechanism). This feature allows the runner to be more efficient, putting less strain on the musculoskeletal system, resulting in a reduced risk of injury (Schleip & Wilke, 2021). Running is essentially a continuous, alternating hopping on one leg, which requires the ability to maintain dynamic stability and balance. The role of the fascia in maintaining balance is through proprioception. The fascia tissue contains the largest number of proprioceptors allowing it to sense stimuli from the external environment and regulate motor responses by triggering tissue contraction or tension (Pawik et al., 2021).

Running is a complex, elastic/spring-like movement involving the whole body gait mechanism, where the elastic and sensorimotor properties of the fascia are key role (Schleip & Wilke, 2021). During each ground contact, large mechanical forces are applied to the lower limb. In turn, the ability of the fascia to adapt allows it to adapt and distribute these forces appropriately throughout the fascial system (Őry, 2021). Thus, the correct application of loads has been shown to improve the load tolerance threshold of tissues (Schleip & Wilke, 2021). However, excessive loading, mainly due to training errors, causes repetitive microtrauma to tissues, which over time leads to overloading of musculoskeletal structures (Kakouris et al., 2021). Repetitive microtrauma is associated with overproduction of collagen, resulting in thickening of connective tissue and loss of elasticity. This leads to reduced muscle strength, connective tissue breakdown (thickening) and increased pain. In this context, reduced elasticity limits the adaptive and force-absorbing capacity of the fascial system and the lack of elastic energy leads to increased muscle work. Reduced flexibility thus leads to a limitation of joint range of motion, which increases the risk of musculoskeletal injuries (Jurecka et al., 2021).

Patellofemoral pain syndrome is pain without injury, localized to the anterior part of the knee, accompanied by crepitation and a feeling of instability. Symptoms are exacerbated during strenuous activities when the knee is in a flexed position (Pollatos et al., 2021). The active and passive stabilizers of the knee joint are closely interconnected in the fascial system, so the function of the knee joint is directly influenced by the tendons and muscles that are connected to it: the gastrocnemius, biceps femoris and hamstring muscles, as well as more distal structures such as the gluteus maximus muscle, tensor fascia lata and iliotibial band. Lesions and impairments of the fascial system therefore play a role in overloading the knee joint and in the development of pain (Jurecka et al., 2021). The receptors whose stimulation triggers pain sensations are called nociceptors. The fascia contains many such receptors, such as free nerve endings. Tissue stretching and thickening causes deformation and continuous stimulation of these nerve endings, resulting in the appearance of pain. In the long term, it can be the cause of the development of chronic pain. Furthermore, trigger points (tender, painful knots) can also develop in the tight myofascial tissues, which can also generate pain (Schleip & Wilke, 2021).

Instrument assisted soft tissue mobilization is a commonly used method in the treatment of sports injuries, as it has been shown to be effective in relieving connective tissue adhesions and adhesions due to repetitive soft tissue injuries (Ikeda et al., 2019). Myofascial release reduces pain and compressive forces on the patellofemoral joint (Manjit et al., 2021). Instrument assisted soft tissue mobilization targeting myofascial stretches the fascia and helps to loosen abnormal attachments between muscles and fascia to eliminate pain, improve movement and maintain myofascial balance in the body (De Souza & Kumar, 2020). Instrument assisted soft tissue mobilization can have a greater effect on tissue flexibility than manual mobilization by hand, as tools can be used to apply pressure to the deeper layers of tissue (Ikeda et al., 2019). Jurecka et al., (2021) conducted a systematic literature review of the results of 8 studies. The patients included in the study were diagnosed with patellofemoral pain syndrome, patellar tendinopathy, lateral compartment syndrome of the knee joint and degenerative lesions. Their results showed that myofascial therapy was effective in all patients with knee joint disorders studied. A reduction in pain and an improvement in physical function and joint range of motion were observed. The results of another study have shown that manual therapy improves the distribution of loads on the knee joint. The increased activity of the vastus lateralis muscle is closely related to the tension of the lateral patellar retinaculum and the iliotibial band. It was observed that this increased activity decreased with treatment, resulting in improved joint contraction of the vastus lateralis and biceps femoris. The increase in joint muscle contraction during the support phase results in a lower knee adduction moment, which allows for a better distribution of loads on the knee joint (Cruz-Montecinos et al., 2016).

The aim of this study is to investigate the role of myofascial dysfunction in the development of running injuries, especially patellofemoral pain syndrome. The primary objective is to reduce the pain of the subject using instrumental assisted soft tissue mobilization targeting the myofascial system. Specifically, the aim of the soft tissue mobilization used is to release connective tissue adhesions, thereby reducing pain and restoring normal range of motion of the lower limb joints, improving dynamic balance, thereby promoting pain-free running and increasing running performance.

Materials and methods

The case study method was used in the research, describing the characteristics of a specific case that is representative of the selected phenomenon. This allowed a more detailed and multifaceted approach to the problem. The method of interviewing was used to record the anamnesis, while the method of literature collection was used to gather information.

The measurements used in this research were taken before and after the intervention. The aim of the initial survey was to assess the subject's condition. Post-intervention surveys were designed to determine the effectiveness of the intervention. Conclusions were drawn by comparing the results of these two surveys. The analytical method and statistical procedures were used to evaluate the results. The results of the pre- and post-measurements of the research were compared. Microsoft Word and Microsoft Excel programs were used to analyze the data, which were processed in the form of tables and graphs.

Case presentation

The subject of the study was A. A., 21 years old male, height 185 cm, weight 75 kg, BMI 21.9 kg/m2, which indicates normal body weight. In addition to his university studies, A. A. runs regularly and often participates in running races. He runs mainly cross-country, 2-3 times a week. The distance varies between 7 and 20 km per run. His knee pain first appeared 2½ years ago, when he started running more intensively. The pain usually appears during runs, after a few kilometers. The subject has not previously undergone any other treatment for her knee problem. He does a general warm-up before runs, stretching and then hanging at the end of the run, but not regularly. He has no other medical problems apart from knee pain. His previous injury was in May 2021: inflammation of the Achilles tendon on the left side, which was treated with physiotherapy. No other traumatic injuries to the lower limb in the last year, no kneecap fractures or dislocations, no knee surgery. The Patellofemoral Pain Syndrome test is often used for patellofemoral pain syndrome. When the test was performed, the subject had pain in both the anterior and posterior parts of the patella and crepitation was noted. Thus, the test result was positive.

The joint range of motion was measured using a handheld goniometer. Since the development of knee joint dysfunctions is associated with limited joint range of motion of both the hip and the ankle, these joints were also included in the measurements. Each measurement was performed three times and averaged to obtain the final result, which was expressed in degrees.

The Y balance test is a dynamic stability test that is effective and clinically applicable for the accurate assessment of neuromuscular control of the lower limb. The test subject stands on one leg while trying to touch the other leg in 3 directions according to the Y-branch at the furthest point possible. Repeated standing on the right and left foot. Three repetitions were performed in each direction, the largest of which was taken as the maximum value, the result being given in cm (Plisky et al., 2021). The calculation formula was: [(A + PM + PL)/ Leg length × 3] x 100, where A - previously, PM - posteromedial, PL - posterolateral. Composite reach distance (%) = Sum of the 3 reach directions/ 3 times the limb length*100.

To determine the pain level, the visual analogue scale (VAS) was used. The scale has scores from 0 to 10, where a score of 0 means no pain and a score of 10 means very severe pain.

Interventions

The research was carried out in Cluj-Napoca over a period of one month, from 10 March 2022 to 14 April 2022. The subject received instrument assisted soft tissue mobilization sessions twice a week for three weeks, lasting 40-50 minutes. A total of six treatments were performed. Richelli's instrumental manual therapy is a myofascial diagnostic and treatment method that uses movement to try to identify the primary cause of injury or pain. The main aim is to restore the flexibility of fascial tissues and to facilitate the sliding of tissue layers over each other. The tools used in the treatment were those of Richelli, more specifically the Painreliever, the 3D-Thumb, the Spinemover and the Dino (Richelli, 2021). Functional tests were carried out at each treatment. The pain, tightness, feeling of restriction during the tests, as well as the movement analysis I observed (presence of compensatory movements, difference between two sides, reduced range of motion) and the tightness I observed during palpation determined the area to be treated. Treatment of a particular area/muscle was continued until tissue relaxation was achieved. The subject was actively involved in the treatments, reporting continuously on the level and nature of the pain and also on the changes observed. The treatments were fully personalized. The functional tests used during the treatments were: forward bending with knee extended, the 4 position test, the lower limb rotation test from supine, the lower limb internal rotation test from prone position, the lower limb flexion test from prone position, the lateral flexion test. The techniques used during the treatments were: longitudinal superficial and deep pulls, transversal pulls, friction (rubbing), circular movements and hooking with the hook part of the Painreliever and Trigger Point treatment. Instrument assisted soft tissue mobilization was mainly applied to the front and side of the thigh, the gluteal area and the hip flexor muscle.

Results

In the preliminary assessment, the subject gave a score of 8 on the Visual Analogue Scale (VAS) used to determine pain level. He reported pain during strenuous sports activities, mainly running. On completion of the post-treatment questionnaire, his score was 1 (table 1).

Table 1. *VAS result for pain during running*

	Pre-interventions	Post-interventions
Visual Analogue Scale (VAS)	8	1

The preliminary joint range of motion measurements showed that the hip joint had the most limited range of motion of the lower limb joints, for both the right and left leg. These results were associated with excessive tightness in the anterior and lateral thigh, gluteus and hip flexor muscles during treatment. Post-intervention measurements showed significant improvements in all directions of movement. The most significant change was in flexion, with a 34 degree increase in flexion of the right hip joint and a 31 degree increase in the left. There was also an increase in knee joint flexion and a significant increase in left ankle plantar flexion. Table 2 shows the pre- and post-joint range of motion measurements.

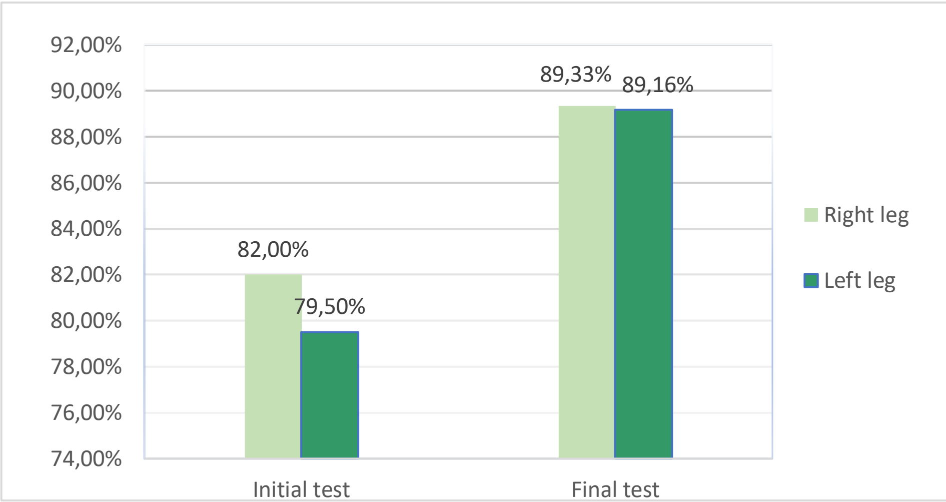

Table 2. *Results of pre- and post-joint range of motion measurements of the lower limb*

	Right leg Initial test	Final test	Left leg Initial test	Final test
Hip				
Flexion	96°	120°	99°	112°
Extension	10°	18°	7°	16°
Abduction	24°	33°	22°	26°
Adduction	21°	28°	20°	28°
External rotation	24°	39°	18°	27°
Internal rotation	22°	29°	25°	33°
Knee				
Flexion	123°	142°	129°	138°
Ankle				
Dorsiflexion	11°	14°	13°	17°
Plantarflexion	49°	53°	43°	54°
Inversion	26°	31°	19°	25°
Eversion	9°	17°	13°	18°

To measure the dynamic balance, the Y balance test was used. The distances in the three directions (anterior, posteromedial, posterolateral) were measured separately in cm. A formula was then used to calculate a composite score, which is shown as a percentage in Figure 1. It can be seen that the initial survey had significantly lower values for both lower limbs, with the subject finding it difficult to move the other leg a greater distance while standing on one leg. Furthermore, a difference was observed between the two limbs. The results of the post-treatment assessment show that the values for the right and left leg are almost identical, with a large improvement in both legs.

Figure 1. Y balance test results expressed as a percentage

Conclusion

Our study shows that it was important to show the role of the fascia system in running. As the involvement of the myofascia is of paramount importance during running, its dysfunction is a major contributor to the development of running injuries and pain. As demonstrated by our results, fascia-focused instrumental manual therapy has been shown to be an effective treatment modality in reducing pain in a subject with anterior knee pain.

Prior to the use of instrument assisted soft tissue mobilization, the subject reported severe pain during running, but the pain also occurred during other activities and affected the performance of daily tasks. After the intervention, the pain almost completely disappeared. In addition, hip joint range of motion returned to near normal and dynamic balance improved significantly. The combination of all these factors contributed to improved function of the myofascial system and thus to a more efficient, injury-free running movement. We believe that this, in addition to the reduction in pain, also contributed to the outcome of the study, namely improved running performance. The subject was able to run effortlessly without pain or strain.

Overall, the targeted use of instrument assisted soft tissue mobilization to release connective tissue adhesions helps to reduce pain, helps to restore flexibility and elasticity of connective tissues, which leads to better loading of joints and improved performance.

Due to the case study nature of this thesis, only one person was involved in the research, so it is recommended that this study be carried out as part of a larger case study. Furthermore, the long-term effects of the results need to be investigated and we also recommend that the effectiveness of instrumental manual therapy treatments for other similar overuse running injuries be investigated.

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Conflicts of interest: The authors report no conflicts of interest.

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