THE EFFECTS OF A MYOFASCIAL TREATMENT IN THE REHABILITATION OF ANKLE'S RANGE OF MOTION

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Abstract
Ankle sprain is the most common injury in physically active populations. Individuals who sustain an acute lateral ankle sprain may not receive timely formal rehabilitation. Most ankle sprains are produced during sports activities. The majority of sprains affect the lateral ligaments, particularly the anterior talofibular ligament. Incomplete recovery of the ankle sprain leads to joint instability. The motivation for choosing the theme is to highlight the benefits of using the ergon therapy and dry needling in the recovery program of footballers who have suffered an ankle sprain (grade II). Dry needling contribute in the proprioception recovery and to treat trigger points. Instrument assisted soft tissue mobilization includes several soft tissue mobilization techniques designed to identify and treat myofascial restraints to reduce pain syndrome. Instrumental treatment enhances the body's self-healing process by mechanically influencing soft tissues, establishing a functional balance in the affected segment and helping to re-educate myofascial tone, providing qualitative motor and anatomical information of the central nervous system, based on the concept of functional biofeedback. The study showed that the ergon therapy is a great help on increasing joint mobility. The purpose of the research was to describe the methods and observe the outcomes associated with a comprehensive strategy for managing chronic ankle sprains.
Keywords: sprain, range of motion, dry needling, IASTM.

Introduction

Ankle sprain

By definition, ankle sprains, are tears to the ligaments connecting structures of the ankle joint. Ligament integrity is often disrupted, causing them to lose their original structure and function after ankle injury. Individuals with chronic ankle instability can suffer from a variety of functional deficits (decreased strength, altered proprioception, impaired balance, hypermobility, feelings of instability). The functional deficits may be due to adhesions in the muscles and ligaments around the ankle, as well as damage to sensory receptors within the joint causing delays in muscle activation and sensory feedback (Croft et. al., 2022).

Lower limb injuries constitute a very frequent problem with a high requirement of a solid and effective therapeutic intervention. Understanding the complexity of sports biomechanics and the main risk factors is an advantage for sports physiotherapists (Iacob & Cîtea, 2019).

Performance football has a multitude of intrinsic and extrinsic risk factors that can cause lower limb injuries. Although many epidemiological studies classify muscle injuries as the most common trauma, ankle sprains are overwhelming in many countries and levels of performance (Fares et al., 2022).

Ankle sprain is one of the most common injury in physically active populations. Individuals who sustain an acute lateral ankle sprain may not receive timely formal rehabilitation. Most ankle sprains are produced during sports activities. The majority of sprains affect the lateral ligaments, particularly the anterior talofibular ligament. Incomplete recovery of the ankle sprain leads to joint instability (Kaminski, 2013).

Sprains are a category of injuries caused by violent (forced) joint movements performed either in the axes and physiological (normal) planes of the joint movements, but exceeding their normal amplitude, or in the axes and abnormal planes, in which there is normally no movement in the respective joint. Studies identify ankle injuries as some of the most common injuries observed by specialists in the field, accounting for up to 30% of all sports injuries (44% of all volleyball injuries, 25% of basketball and 23% of those on the football and futsal fields). Their high frequency is determined by the multiple movements controlled by the mobility needs of the foot, exposed to a number of traumatic factors that act under different conditions (Mackenzie et al., 2019).

Improving mobility is often a goal of interventions to prevent injuries, improve performance and rehabilitate lower limb injuries.

Soft tissue mobilization is a form of manual therapy used to manipulate soft tissues to mobilize restraints and promote tissue healing and repair (Rabin et al., 2014). There is evidence to suggest that soft tissue mobilization is therapeutically beneficial, although research remains limited both quantitatively and qualitatively.

Instrument-assisted Soft Tissue Mobilization

Instrument-Assisted Soft Tissue Mobilization (IASTM) is a type of soft tissue mobilization that uses rigid devices to increase the examination and treatment of soft tissues (Gunn et al., 2019).

Joint flexibility parameters, such as the range of motion of the joints and muscle "stiffness", are indicators of physical condition. IASTM is used in sports as one of the methods to improve fitness. It is also an effective method for the treatment and rehabilitation of athletes and non-athletes suffering from repetitive and cumulative injuries, as it modifies the structure and nature of existing tissue to address tissue adhesion and restrict fascia mobility (Ikeda et. al., 2019).

IASTM is a popular treatment for myofascial restraint, based on the reason introduced by James Cyriax (Baker et al., 2013). Unlike the friction-based Cyriax approach, IASTM is applied using tools specifically designed to provide a soft tissue mobilizing effect (e.g. scar tissue, myofascial adhesion) to reduce pain and improve the amplitude of friction, movement (ROM) and function (Cheatham et al., 2016). The biggest goal of IASTM is to remove scar tissues and facilitate a return to normal function following soft tissue recovery. When the scar tissue is removed, functional normalization around the soft tissue can be achieved (Kim et. al., 2017).

The fascia is a membrane or any other agglomeration of connective tissue, which can be dissected, which forms inside the human body, having the role of binding, covering and separating the muscles and internal organs.The fascia has the role of maintaining structural integrity, support, protection, shock absorption, function of intermediation between organs and tissues and participates in hemodynamic, metabolic and biochemical processes.

IASTM differs from traditional massage. Specially designed tools are used to apply

longitudinal pressure along muscle fibers, and treatment usually includes applying to more than the tissues in the isolated location of the pain (Fowler et al., 1999). In addition, instruments are believed to provide a mechanical advantage that allows the clinician to reach a greater depth of mechanical force transmission than can be produced with the hands, while reducing the compressive stress on the clinician's hands (Burke et al., 2007).

Contracts at the level of the hamstrings contribute to the inefficiency of the movement and to the increased risk of injury. Stretching is the most common intervention for this problem, but the use of alternatives such as IASTM and proprioceptive neuromuscular facilitation (PNF) is on the rise among therapists. According to studies performed on 40 people, it was shown that PNF and IASTM led to a greater increase in flexion of the hip joint compared to static stretching. These findings demonstrate the effectiveness of PNF and IASTM techniques in static stretching for hamstring flexibility. These interventions offer more effective alternatives for creating flexibility in the clinic, allowing greater progress in a shorter period of time than an equivalent static adjustment program (Gunn et al., 2019).

Various pilot studies on IASTM have also shown promising results for diagnoses such as patellar tendinopathy, chronic ankle pain, plantar fasciitis, postnatal leg pain, knee pain, carpal tunnel syndrome, cumulative trauma disorders, and lateral epicondylitis (Iacob & Citea, 2020; Vidhi et al., 2014).

Clinical trials of IASTM in patients with tendinopathy have shown pain resolution, improved ROM, and a return to normal function at a faster rate than observed for natural healing and traditional therapeutic interventions (Wilson et al., 2000).

The clinical use of soft tissue mobilization tools is intended to increase the effectiveness of treatment, especially in areas with fibrosis. Tissue microtrauma is thought to induce a local inflammatory response that promotes the breakdown of scar tissue, the release of adhesions, the synthesis of new collagen, and the remodeling of connective tissue (Stow, 2011).

Dry needling

Dry needling, used by physical therapists, is a treatment modality used for the management of musculoskeletal pain. It is a technique in which a fine needle is used to penetrate the skin, subcutaneous tissues and muscles, with the aim of mechanically disrupting the inner tissues. This technique is called dry needling as the procedure does not involve the injection of any substance (Blanco-Diaz et. al., 2022).

Dry Needling is a form of treatment of trigger points by precisely stimulating it with a specially designed needle. Dry needling is a very effective form of treatment for muscles and fascia, where the physiotherapist or doctor inserts the needle in the trigger point thus stimulating the oxygen supply of tense muscle fibers and fascia (Iacob & Măzăreanu, 2021).

A myofascial trigger point (MTrP) represents a small microscopic area in the skeletal muscle of the extended band. This area is hypersensitive to mechanical stimulation (pressure or strain). Symptoms of MTrP may include local and/ or related pain, paresthesia, and autonomic symptoms. MTrPs are hypoxic areas located in the skeletal muscle. Hypoxia leads to a so-called "energy crisis" that stops the relaxation of individual muscle fibers - described as the "Rigor Complex". In order to evaluate the concept and the basis of this complex, it is essential to analyze the muscle

contraction way of developing (Simons & Travell 1981).

The action potential is transmitted by the T-tubes. This results in the release of calcium ions from the L-tubes. Calcium binds to troponin. This connection allows the binding of the myosin head to actin. As soon as myosin and actin are connected, ATP, which is attached to the myosin head, is divided into ADP and P (Phosphates). This reaction is accompanied by the release of chemical energy which results in a change in the angle between the myosin axis and the myosin head. This leads to the movement between actin and myosin and underlies muscle contraction. As long as there is no ATP renewal, the contraction remains. It is also called the Rigor Complex. It is important to understand that contraction is actually the steady state between actin and myosin. But as soon as another ATP molecule binds to the myosin head, it will release actin binding. This is also known as the softening effect of ATP. In addition, ATP has another important function in muscle fibers. Brings calcium ions back into the L-tubes until they shrink (Marcucci & Truskinovsky, 2010; Wakabayashi, 2015).

By stimulating the trigger points, the muscle fiber reacts with a local reflex, releasing the accumulated tension. There are several types of Dry Needling: Dynamic, Static, Intramuscular Electrical Stimulation (Bosch et al., 2018).

The list of biochemical benefits also includes the ability to regenerate muscles. There are records that claim that after about 7-10 days of performing the dry therapy needling, the focal microlesion causes satellite cells to migrate to replace damaged myofibrils. Localized stretching of cytoskeletal structures may allow sarcomeres to resume their resting size. Another effect that combines physiological elements and mechanical is represented by the ability of mechanical pressure to influence intrinsic electrical polarization of collagen fibers, favoring tissue remodeling (Hakim et al., 2019; Iacob & Măzăreanu, 2021).

The resulting biochemical changes can influence the homeostatic mechanisms of of the body (body temperature, gas concentrations, blood pressure), the secretion of endorphins and determine physical and emotional well-being (Cagnie et al., 2013). Dry needling therapy encompasses a significant volume of complex effects that can streamline the recovery of patients by approaching the technique individually or as a part component of a therapeutic plan that combines several therapeutic means.

Manual therapy techniques

The role of manual therapy in the recovery of athletes in general does not include a single specific maneuver, but a set of maneuvers with the role of stimulating the body's self-healing capacity, optimizing the range of motion and properties of muscles that can be directly or indirectly affected by sports trauma. Among them can be listed: different therapies and styles of massage (deep tissue, trigger point, etc.), stretching (passively performed by the therapist, dynamic, etc.) and joint techniques. treatment for inactivating these points.

There are two main ways to approach a manual treatment: direct, when the ischemic pressure is exerted directly on the trigger point, or an indirect approach when opting for fascial techniques that address a much larger area or the entire muscle. Exercise and manual therapy have numerous benefits on the myo-atro-kinetic apparatus and on the reduction of symptoms, with important effects in changing the perception of pain and hypoalgesia (Fredin & Lorås, 2017).

In general, most manual therapies focus on treating the patient's symptoms, with the objectives of reducing them, maintaining/ improving joint range of motion, stability and muscle's properties.

The instrument-assisted soft tissue mobilization (IASTM) and dry needling therapy are considered effective therapies in the rehabilitation of a wide range of sport traumas and pathologies.

The objective of the current study is to identify the effect over a common application of both therapies during a combined treatment for chronic ankle sprains in professional football players from Romania.

Hypothesis

The myofascial therapies have a more effective impact on the recovery of range of motion compared to classical physical therapy.

Materials and methods

Participants and Procedure

Twelve professional football players, men (17-21 years old), with the main selection criteria, a second degree ankle sprain with a maximum of two injured ligaments and found in the chronic phase of the disease confirmed by the clinical and functional diagnosis. Another relevant criteria was the presence of at least one official match during the competition period of the 2021/2022 season.

Functional diagnosis was indicated based on paraclinical and clinical evaluation, visual examination, palpation and test of tenderness (Lunge test). Other inclusion criteria consisted of: participation in the professional football sports league, agreement of the subjects to participate in research, performing therapies such as, deep tissue massage, static stretching and dry needling therapy. Age was not a direct chosen criteria for the subjects of the research. However, there are studies that present adolescents as the main subjects exposed to sports injuries, the association with lack of experience in professional football or with ligament hyperlaxity being the main favoring factors (Johnson et al., 2022).

The main exclusion criteria was for patients who had to interrupt their recovery plan due to infection with the Covid-19 virus or direct contact with an infected person. Another exclusionary criteria related to dry needling therapy was for group A, regarding the existence of a needle phobia. The subjects of the research were divided into two equal groups (group A and group B) following a treatment plan based on myofascial therapy techniques (dry needling and ergon therapy) for group A, and tissue massage and static stretching techniques (including a maximum of 15-20 minutes of manual therapy) for group B.

The Lunge test was performed to highlight the degree of range of motion in the affected and non-affected ankle at the baseline and at the end of the rehabilitation program.

The evaluation was performed bilaterally to compare the degree of mobility and to highlight muscle imbalances. This indicator was used for both groups before the first session and the last session. The rehabilitation time was structured in 3 weeks. The first session took place after the resumption of unipodal support and the last after the first normal training with the sport team.

Methods

Lunge Test

The Lunge test is performed against the wall using a standard tape measure or a smartphone, and the unit of measurement is the centimeter (Figure 1). The subject is positioned with the foot so that an imaginary line drawn through the heel and big toe is aligned with the floor. A vertical line is drawn on the wall along the tape measure route. The athlete is instructed to lunge forward until the knee touches the wall (vertical line) causing

the ankle joint to be in maximum dorsiflexion. The leg that is not being tested can remain on the floor and the athlete is allowed to hold on to the wall for support. The maximum distance from the wall to the tip of the thumb is recorded. Distance is measured in centimeters (cm), with each centimeter corresponding to approximately 3.6° of ankle dorsiflexion (Bennell et al., 1998). All these measurements were taken at the same time:

A. Observation of the ankle joint in 2D format.

B. The inclinometer is placed 15 cm below the tibial tuberosity.

C. Distance between the wall and hallux

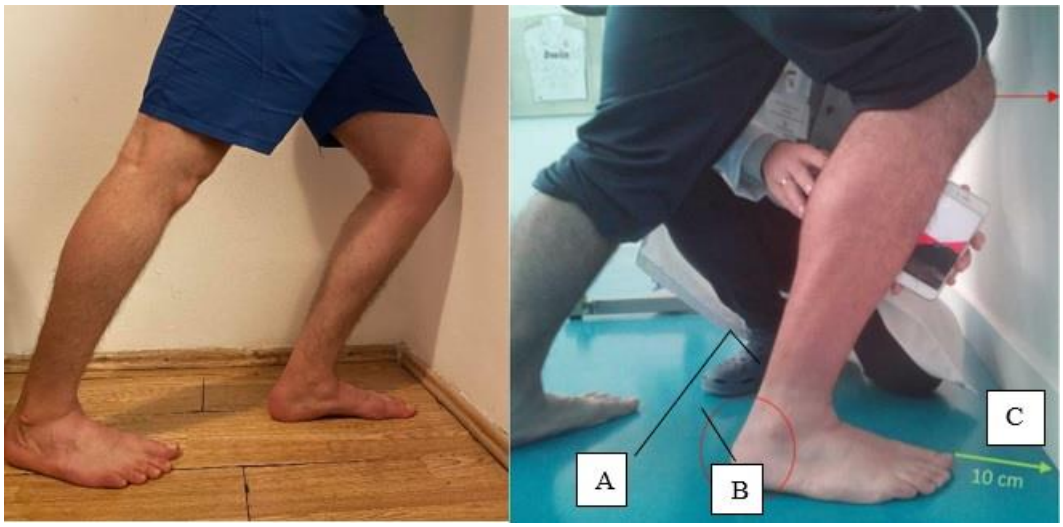

Figure 1. Lunge Test

Therapeutic intervention

The main anatomical structures treated in the therapies were: long and short peroneal muscle, soleus muscle, tibial anterior, gastrocnemian, Achilles tendon, plantar fascia.

For dry needling and ergon therapy (group A), the players were lying on the supine position to treat the posterior area of their calves and in a prone position to treat the anterior area of their legs. Dry needling therapy was performed using Seirin B type needles: no.8 (0.30) x 30mm and no.8 (0.30) x 50mm. Dry needling therapy can be a very effective therapy in the management of myofascial pain syndrome located in the areas where trigger points are present that directly influence the joint mobility deficit. Dry Needling Therapy is an effective way to treat myofascial trigger points. These points can develop when the sprain occurs by rupturing the sarcoplasmic reticulum and releasing a larger amount of calcium, which compresses the blood vessel that irrigates that muscle fiber and thus producing an energy crisis locally. Excess calcium in the muscle fibers causes a defense contraction to protect the surrounding fibers from further degenerating.

Lateral sprain is recognized by the mechanism of its production, inversion, stretching or degeneration of the lateral ligaments of the ankle (ATFL, AITFL, CFL), by local hematoma or edema, functional hypotension or reduced functionality. As a precautionary measure, dry needling therapy will not be applied to the hematoma/ edema, in that area the muscles can be treated with ergon, and manual lymphatic drainage therapy.

The therapeutic protocol that includes dry needling was performed on the following muscles (Figure 2): Long peroneal (from the first phase of recovery); Short peroneal (from the 2nd phase of recovery after fighting hematoma/ edema); Extensor Digitorum Brevis (from phase a2a of recovery after fighting hematoma / edema); Extensor Digitorum Longus (from the first phase of recovery); Anterior Tibialis (from the first phase of recovery); Soleus (from the first phase of recovery); Gastrocnemius (from the first phase of recovery); Hallucis Longus Extender (from the first phase of recovery); Hallucis Brevis Extender (from the 2nd phase of recovery after fighting hematoma / edema).

The effects of the Dry Needling therapy are: improves tissue circulation, improves muscle control, improves joint range of motion, reduces pain by removing trigger points from the affected area. The ability to act on an entire system of muscle-tendon-joint connection was the main reason for approaching the group of subjects through dry needling therapy. Each recovery session included dry needling therapy (15-30 minutes) and ergon therapy.

Ergon therapy was performed 3 sessions per week with sessions lasting 10-15 minutes, the intervention was done after dry needling.

Figure 2. Dry Needling technique
(a) Gastrocnemius – lateral head; (b) Extensor Digitorum Brevis; (c) Extensor Hallucis Brevis; (d) Peroneus Longus; (e) Tibialis anterior

The effects of IASTM are: it improves the long-term local blood and lymphatic circulation, both superficially and deeply, increases the value of nutrients and fibroblasts in the affected region, regulates collagen levels, which speeds up the healing process of the segment, focuses on applying pressure to the tissue in a way that is not possible, by

which manual, reduces the degree of fibrous tissue, creates conditions for the correct alignment of the fascial fibers, stimulates the restoration of viscoelasticity of the fascial tissue, increases elasticity and mobility of the fascia, positively influences posture, reduces pain and prepares the fascial tissue for physical therapy.

With the help of the specialized tool (IASTM), the tissue restrictions were identified and an appropriate pressure was exerted in a certain direction, in order to treat the injured area.

The maneuvers that were applied, stimulate the area and thus begins the resorption of fibrosis or scar tissue and a series of healing activities are initiated that help to reshape the structures of the damaged soft tissues. Soft tissue adhesions that have developed as a result of trauma, immobilization, repeated tension, or other mechanisms are broken down, allowing for complete functional recovery.

The ergon could also stimulate the proprioceptive system by regulating the functionality of the mechanoreceptors found in the talocrural articulation.

For tissue massage and static stretching, the players were lying on their backs to feel their posterior chain leg muscles and on their stomachs to treat their anterior chain leg muscles.

A massage session lasts about between 15 minutes and a half an hour with a frequency of 3 times a week. Warming up the muscles is done using initially a lighter touch. After the body warms up, it will start working on the injured areas, using alternating deep kneading and friction, varying the pressure from light to intense.

Deep Tissue massage involves using palms and fingers of the physiotherapist to knead and manipulate tissues, as well as using your elbows and forearms to apply increased pressure to certain areas. After the tissue massage there was performed some static stretching maneuvers for about 10-15 minutes.

Static stretching involves reaching a point of tension and maintaining tension for a few seconds, during the time your body remains at rest. After immobilization with orthosis/ gypsum, mobility is decreased in them and the neuromuscular system has dysfunction in the injured area. by static stretching we produce a muscular stretch by reorganizing the disordered fibers. Applying 10-15 minutes of static stretching after the massage helps to relax the muscles. The number of rehabilitation session was 3 per week, same as in the procedure for group A.

Statistical analysis

Evaluation of the therapeutic effect for both groups was made using SPSS software (SPSS Inc., Chicago, IL) with the following descriptive parameters: arithmetic mean (Mean), and Standard deviation (SD), the T-test (Paired-Samples T-Test, and Independent-Samples T-Test), Levene's test (in order to assess the equality of variances for groups of subjects) and Cohen's d (for computing an effect size measurement). The statistical significance was set at the level of $p < 0.05$.

Results

The interpretation of the results has the role of comparing the initial and final results within the two groups of subjects. They benefited from a 3-week rehabilitation protocol based on different therapeutic procedures.

Table 1 includes the main parameters that have been analyzed during the initial (M=27.33, SD=1.751) and final evaluation (M=41.83, SD=1.472) of the group A; t(5)=-11.774, p=.000. There is a high relevant impact of the homogenous values of the group for the functional evaluation of the ankle's range of motion. The effectiveness is

confirmed by the 14.5 (± 3.017) degrees mean difference value between baseline and the final measurement and a large effect size according to Cohen's d (d = 0.9, p = 0.00).

After 3 weeks of rehabilitation program based on 3 sessions per week of dry needling and ergon therapy, the subjects of group A showed a favorable progress of the range of motion.

Table 1. *Differences between initial and final measurement of the group A*

Variables	Subjects	Age (years old)	Period	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Lunge test (degrees)	6	18.3	Initial	27.33	1.751	.715	-11.774	.000
			Final	41.83	1.472	.601		

Table 2 includes the main values of the parameters that have been analyzed during the initial (M=27.33, SD=1.211) and final evaluation (M=37.17, SD=1.472) of the group B; t(6)=-10.808, p=.000. The results demonstrate a statistically significant improvement of the ankle's range of motion for group B as well (9.83 ± 2.229 degrees in the mean difference between both measurements) with a relevant large effect size according to Cohen's d (d = 0.8). At the same time, significant progress is being made for group B, which has benefited from tissue massage and static stretching, methods known to be effective in reducing symptoms and increasing range of motion.

Table 2. *Differences between initial and final measurement of the group B*

Variables	Subjects	Age (years old)	Period	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Lunge test (degrees)	6	18.5	Initial	27.33	1.211	.494	-10.808	.000
			Final	37.17	1.472	.601		

The analysis of the results has a major importance on the identification of potential differences between the groups of subjects. The transposition of the results in the therapeutic context has the role of testing possible hypotheses that confirm an element of therapeutic novelty or validate a concept.

Table 1 and Table 2 show the results of the T-test (Paired-Samples T-test) which tested the difference between the initial and final measurements of the both groups. Based on the results, it can be concluded that both groups benefited of effective therapies sessions.

Ankle rehabilitation, especially in the case of performance athletes, requires a multi-factorial understanding of the favoring and risk factors involved.

Table 3 contains the results of the Independent Sample T-test performed in order to analyze the final results of Lunge test for group A (M=14.5, SD=3.017) and group B (M=9.83, SD=2.229). In order to compare more efficiently the final results, the analyzed parameter was the difference of the Lunge test between the initial and final measurement.

According to Table 3, group A had an average increase in the ankle's range of motion by 14.5 degrees, while group B had an increase of 9.83 degrees (the initial assessment identified similar values for both groups of subjects). The situation of similar initial values for the two groups of subjects confirms

their homogeneity and the presence of similar movement deficits before the initiation of the treatment plan.

The average values and the independent sample t test - t(10) = 3.048, p=.012 (< 0.05) confirms a statistically significant difference between both groups, in the favor of group A, at the end of the experimental intervention.

The present results confirm the effectiveness of the combined therapy between dry needling and ergon. Dry needling therapy is a technique that is considered beneficial in pain management and flexibility of the lower limb (Ansari et al., 2020) and other regions (Espejo-Antúnez, 2017).

The goal of the research was to identify perhaps the most appropriate therapeutic management option for this category of sports injuries. In the treatment of professional athletes, every day in addition to the absence from the training ground can influence the sports performance. The current study confirms the effectiveness of the intervention through dry needling therapy on the range of motion. This favorable consequence is based on the multitude of positive effects on the myofascial tissue.

In order to provide a better outcome's assessment, the difference between injured and non-injured leg were identified for the same Lunge test measurement. Table 3 contains the results according to the Independent Samples T-test, between the main two categories of lower limbs (non-injured, injured) of the subjects from the both groups (Levene's test is insignificant).

The following upcomes have the targeted role to identify if there is any significant deficit of range of motion between affected and non-affected ankle. These results are able to confirm if the stage of functional rehabilitation is completed, or requires more time and rehabilitation methods to be performed.

The results obtained by the subjects from group A confirm the minimum deficit, insignificant from a statistical point of view t(10)= .200, p = .845 (>.005).

Although the previous measurements and the comparison between the initial and final values of the Lunge test, also, identified a significant progress for group B, the comparison in Table 3 and Figure 2 expresses a visibly lower efficiency compared to group A. The statistically significant result of the T test, between injured and non-injured limb on the lower, demonstrates that there is still a range of motion deficit of the ankle; t(10)= 6.081, p= .000.

Table 3. *Comparison of the final assessment between injured and non-injured lower limb*

Variables	Group	Age (years old)	Lower Limb (side)	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Lunge test (degrees)	A	18.3	Non-injured	42.00	1.414	.577	.200	.845
			Injured	41.83	1.472	.601		
	B	18.5	Non-injured	41.83	1.169	.477	6.081	.000
			Injured	37.17	1.472	.601		

Figure 2 provides a more elaborate perspective to observe the limited potential to reduce the range of motion deficit for the group B - specific rehabilitation protocol. The figure below shows the difference in the range of motion deficit specific to the two groups.

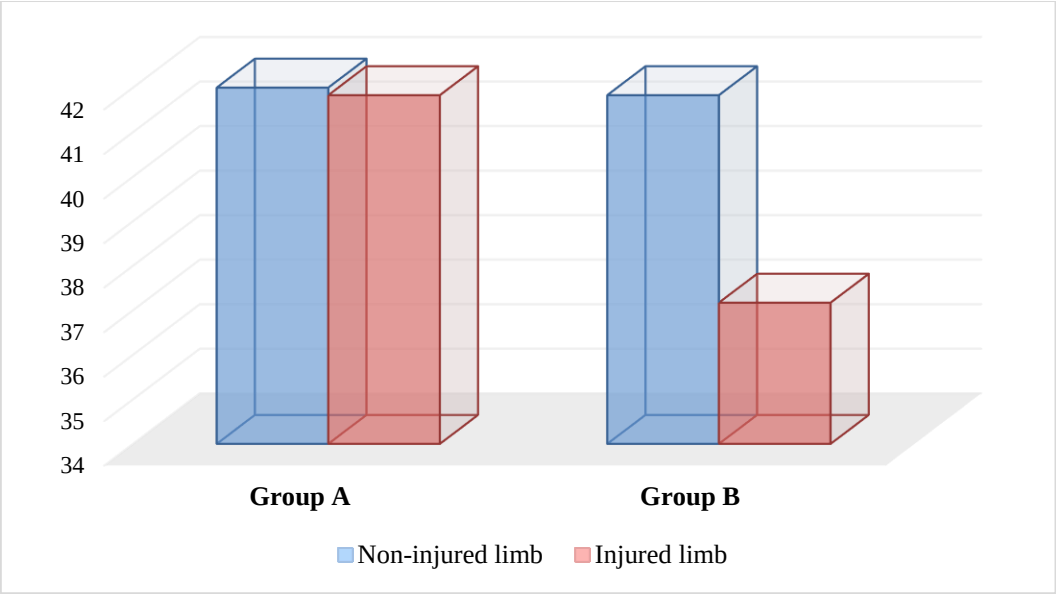

Figure 3. Final values of the Lunge test (degrees) for non-injured and injured limb

The Lunge test is an objective method of good accuracy to identify the patient's progress and provide a valuable prognosis for further stages of treatment. Range of motion deficit analysis is a significant milestone in testing functionality. The issue of range of motion deficit may be a factor favoring a chronic involvement of the subsequent symptoms as a risk factor for a future injury. The analysis of this parameter can represent a benchmark in the evaluation of potential risk factors for a program to prevent possible complications.

The results analyzed above confirm that group A benefits from a more efficient rehabilitation protocol than group B. In order to reach the functional parameters necessary for sports reintegration, group B continued the functional rehabilitation stage for another week.

Even if from a functional point of view or after the measurement with a goniometer the differences are not apparently major, each favorable degree of movement compared to a lower unit of time represents an option towards the therapeutic progress necessary for the rehabilitation of performance athletes.

Discussions

This study aimed to identify the differences in the rehabilitation of ROM (range of motion) in patients with ankle sprain performing modern therapy. The research results contribute to expanding the therapists' knowledge about the role and impact of myofascial therapies, but especially dry needling therapy and IASTM on the motor and clinical-functional rehabilitation of patients with anke sprain. The analysis of the study results highlights that there are statistically significant differences between the final and initial tests for the assessment of ROM.

Combining the most efficient rehabilitation methods is a basic goal in recovering performance athletes and returning to the training ground in the shortest time. Range of motion is an arbitrary therapeutic parameter that indicates the functionality of the affected limb. Lunge test is an effective functional test especially by the ability to identify the deficit of range of motion between injured and non-injured limb. There are a number of principles that sports therapists must follow during their medical rehabilitation programs - adapting the

intervention to the patient's particularities, appropriate dosage, addressing all the factors involved (psycho-social, psycho-emotional), and the variables that make up the level of compliance with treatment. Personality factors, the temperament type seems to influence, also, the likelihood of an athlete getting injured and how he/she reacts at stimuli (Rizescu & Predoiu, 2022). The analysis of these factors determines the creation of an adequate environment to optimize the medical recovery in the best way.

Clinically, in chronic pain situations, a patient's understanding of the mechanism behind the pain is considered crucial. Second, it is important to understand the role of trigger point needling, its interventions in nociceptors, their pathways and the effects of technology on pain relief. Third, combining dry needling with a good understanding of the mechanism behind its effects is key to reducing kinesiophobia (Dib-Zakkour et al., 2022).

Dry needling improves range of motion, motor control, and pain in a multitude of neuro-musculoskeletal conditions by decreasing spontaneous electrical activity and muscle contractility (Mullins et al., 2021). The instruments are believed to facilitate the therapist's ability to detect the properties of the altered tissues, as well as facilitate the patient's awareness of the altered sensations in the treated tissues (Hammer, 2008).

The study aimed at designing and implementing a modern interventions, more specifically, dry needling therapy, instrument-assisted soft tissue mobilization and manual therapy for the clinical-functional and motor rehabilitation of patients with ankle sprain, in order to identify the impact of this programme on the improvement of range of motion.

The relatively small number of patients represents a limitation of the study and, also, involvement of only male patients. The same combination of therapeutic methods may be chosen for subjects of different ages to confirm efficacy (and on a larger group of subjects). This combination of treatment, with or without the addition of other methods, also, has a huge potential for applicability in the management of different categories of chronic sports injuries.

In order to establish the effectiveness of a protocol based on the particularities of the sports branch, a possible research direction can compare the results of football players with other sports. The analysis can target both the functional parameters and those that target the behavior of the subjects during the treatment and compose the therapeutic compliance.

Conclusions

The combination of dry needling and IASTM (group A) showed an increased efficiency during the treatment period. The final values of the Lunge test proved to be statistically significant compared to the initial values, a confirmed detail by the comparison of the values with those of the non-injured limb.

Group B apparently obtained adequate results after the initial and final comparison, but the difference from the non-injured limb confirms that the functional recovery cannot be complete in the same unit of time.

The results of the study confirm that treatment based on dry needling and ergon therapy is a topical therapeutic option for managing chronic ankle sprains. The study confirms the ability of subjects to react positively to novel therapies in the treatment of ankle sprains. The possibility of being aware of the beneficial effects of a combined treatment is an essential factor in the development of intrinsic motivation by each injured athlete.

Author Contributions

All authors contributed equally to this article. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the principles set out in the Declaration of Helsinki. Written informed consent was obtained from all participants. The study was approved by the Ethics Commission of the National University of Physical Education and Sport in Bucharest, with no. 33/27.09.2021.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare no conflict of interest.

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