

Motor imagery in the treatment of acute lateral ankle sprains in soccer athletes: a pilot study

Imagética motora no tratamento da entorse lateral de tornozelo em atletas de futebol de campo: um estudo piloto

Imagética motora en el tratamiento de esguinces de tobillo lateral en los atletas de fútbol de campo: un estudio piloto

Guilherme S. Nunes¹, Marcos de Noronha^{1,2}, Vanderlei A. de Carvalho Jr.¹

ABSTRACT | Ankle sprain is a common injury in soccer athletes and has a high relapse rate. Motor imagery (MI) may be an alternative treatment to diminish the neuromuscular consequences after the injury. Thus, this study aimed to verify the preliminary results of the effectiveness of MI in the rehabilitation of soccer athletes with acute ankle sprain. Twenty young athletes of the male sex participated in the study. They were randomly divided into two groups: intervention (IG) and control (CG). Participants underwent conventional rehabilitation (cryotherapy, electrotherapy and kinesiotherapy) for ankle sprain, but only the IG performed imagery exercises to try to recognize the ankle-foot figures, projected by a computer, from various perspectives and angles. The ranges of motion (ROM) were measured for dorsiflexion and plantar postural control, edema and functional stability. After treatment, no difference between groups were observed regarding dorsiflexion ROM ($p=0.23$), plantar flexion ROM ($p=0.50$), Star Excursion Balance Test (SEBT) in the anterior direction ($p=0.70$), SEBT in the posterolateral direction ($p=0.29$), SEBT in the posteromedial direction ($p=0.79$), perimeter in “8” ($p=0.50$) and the Cumberland Ankle Instability Tool (CAIT) questionnaire for functional instability ($p = 0.70$). The MI was not an effective method for ankle sprains treatment in field soccer athletes to improve ROM, dynamic balance, edema and functional stability. However, this is a pilot study and further investigations are required.

Keywords | Ankle Injuries/rehabilitation; Imagery (Psychotherapy); Functional Laterality; Postural Balance.

RESUMO | A entorse de tornozelo é uma lesão comum em atletas de futebol e apresenta um alto índice de recidivas. A imagética motora (IM) pode ser uma alternativa no tratamento para diminuir as consequências neuromusculares apresentadas pós-lesão. Dessa forma, este estudo teve como objetivo verificar os resultados preliminares da efetividade da IM na reabilitação de atletas de futebol com entorse aguda de tornozelo. Participaram 20 jovens atletas do sexo masculino, que foram divididos de forma aleatória em dois grupos: intervenção (GI) e controle (GC). Os participantes passaram por um processo de reabilitação convencional (crioterapia, eletroterapia e cinesioterapia) para entorse de tornozelo, porém apenas o GI realizava exercício de imagética ao tentar reconhecer as figuras do tornozelo-pé, projetados em um computador, em várias perspectivas e ângulos de orientação. Foram mensurados as amplitudes de movimento (ADM) de flexão dorsal e plantar, controle postural, edema e estabilidade funcional. Após o tratamento não foi observada nenhuma diferença entre os grupos quanto à ADM de flexão dorsal ($p=0,23$), ADM de flexão plantar ($p=0,50$), Star Excursion Balance Test (SEBT) na direção anterior ($p=0,70$), SEBT na direção póstero-lateral ($p=0,29$), SEBT na direção póstero-medial ($p=0,79$), perímetria em “8” ($p=0,50$) e questionário CAIT-P para instabilidade funcional ($p=0,70$). A IM não foi um método eficaz no tratamento de entorse de tornozelo em atletas de futebol de campo para melhora de ADM, equilíbrio dinâmico, edema e estabilidade funcional. Entretanto, este é um estudo piloto e maiores investigações são necessárias.

¹Physiotherapy Department, Health and Sport Science Center, Universidade do Estado de Santa Catarina – Florianópolis (SC), Brazil.

²Department of Community and Allied Health, La Trobe University – Bendigo (VIC), Australia.

Mailing address: Guilherme S Nunes - Rua Pascoal Simone, 358, Coqueiros - CEP 88080-350 - Florianópolis, SC - Brazil.

E-mail: nunesguilherme@live.com - Phone: +55 48 3321-8660

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Descritores | Traumatismos do Tornozelo/reabilitação; Imagens (Psicoterapia); Lateralidade Funcional; Equilíbrio Postural.

RESUMEN | El esguince de tobillo es una lesión común en los atletas de fútbol y presenta una alta tasa de recaídas. La imagética motora (IM) puede ser un tratamiento alternativo para disminuir las consecuencias neuromusculares presentadas post-lesión. Por lo tanto, el objetivo de este estudio fue verificar los resultados preliminares de la efectividad de la IM en la rehabilitación de atletas de fútbol con esguince agudo de tobillo. Participaron 20 atletas jóvenes del sexo masculino, divididos de manera aleatoria en dos grupos: intervención (GI) y control (GC). Los participantes experimentaron un proceso de rehabilitación convencional (crioterapia, electroterapia y cinesioterapia) para esguince de tobillo, sin embargo sólo el GI realizaba ejercicio de imagética al tratar de reconocer las figuras del tobillo-pie, proyectados en una computadora, en

diferentes perspectivas y ángulos de orientación. Se midió las amplitudes de movimiento (ADM) de flexión dorsal y plantar, control postural, edema y estabilidad funcional. Después del tratamiento no se observó ninguna diferencia entre los grupos en relación a la ADM de flexión dorsal ($p=0,23$), ADM de flexión plantar ($p=0,50$), Star Excursion Balance Test (SEBT) en dirección anterior ($p=0,70$), SEBT en la dirección posterolateral ($p=0,29$), SEBT en la dirección posteromedial ($p=0,79$), perimetría en "8" ($p=0,50$) y cuestionario CAIT-P a la inestabilidad funcional ($p=0,70$). La IM no fue un método eficaz en el tratamiento de esguinces de tobillo en atletas de fútbol de campo para la mejora de ADM, equilibrio dinámico, edema y estabilidad funcional. Sin embargo este es un estudio piloto y mayores investigaciones son necesarias.

Palabras clave | Traumatismos del Tobillo/rehabilitación; Imágenes (Psicoterapia); Lateralidad Funcional; Balance Postural.

INTRODUCTION

The ankle is considered one of the most susceptible body parts to injury during sports activity. About 30% of sports injuries involving contact, jumping and running are ankle injuries, and ankle sprains account for 77% of ankle lesions¹. Repetitive episodes of ankle sprains cause chronic injury in the proprioceptive and sensory-motor function, by generating a deficit in the neuromuscular reflex response time². In 20% of the cases, repeated ankle sprain events can result in instability of the ankle joints^{3,4}. This can lead to disturbances and reduction of nerve information concerning the ability to resist unexpected displacements and to maintain functional stability of the joint.

Studies have investigated more effective methods for treating ankle sprains. Among the possible treatments already investigated, muscle strengthening and proprioceptive exercises can be mentioned as effective techniques for the treatment of ankle sprains^{5,6}. Recently, motor imagery (MI) has been investigated as an alternative treatment for injuries related to peripheral joints⁷⁻⁹. It is an exercise of mental origin that possibly stimulates the reorganization of lost motor function due to a deficit in the integration of motor processes that occurs in the cortex after the injury, seeking an unconscious action of the involved members¹⁰⁻¹². The use of MI in the rehabilitation of upper limbs motor function in individuals after a stroke

is supported by evidences^{13,14}. Thus, we expect MI to be of some benefit in the rehabilitation of musculoskeletal injuries, such as in ankle sprains, since these lesions also relate to changes in motor control¹⁵.

Some studies have investigated the effects of MI in the treatment of musculoskeletal injuries. Stenekes et al.⁹, used MI as a form of rehabilitation during the immobilization period for patients who underwent surgery to repair injury to the flexor tendon in the wrist. The MI positively influenced the recovery time of the flexor tendon after surgery. Other studies have attempted to assess the effectiveness of MI in the treatment of ankle sprains^{7,8}. MI, in these studies, was used by asking participants to mentally review all physical therapy performed at the end of each session. Athletes from different types of sports were included and positive results in rehabilitation regarding increased muscular resistance were obtained⁷. However, the quality of these studies is questionable, since they present some methodological flaws such as lack of blinding of evaluators and proper allocation of participants. This means that it is not possible to reach conclusions about the use of MI in the rehabilitation of ankle sprains in athletes, which leaves further doubt as to the ability of the MI to assist the rehabilitation of ankle sprains in athletes. The objective of this pilot study was, therefore, to assess preliminary results regarding the effectiveness of motor imagery rehabilitation in soccer athletes with acute ankle sprain. Our hypothesis was that the association of MI rehabilitation with field

soccer athletes with acute ankle sprains could contribute to a more effective rehabilitation.

METHODOLOGY

This was a randomized clinical study, controlled by the Brazilian registration of clinical trials number

RBR-2tthr. Participants were randomly allocated to the intervention group (IG) or control group (CG). Both groups received the standard treatment for rehabilitation of ankle sprains, but the IG also received MI stimulus. Randomization was done by a researcher not involved in the recruitment or evaluation of participants, using sealed and opaque envelopes (Figure 1).

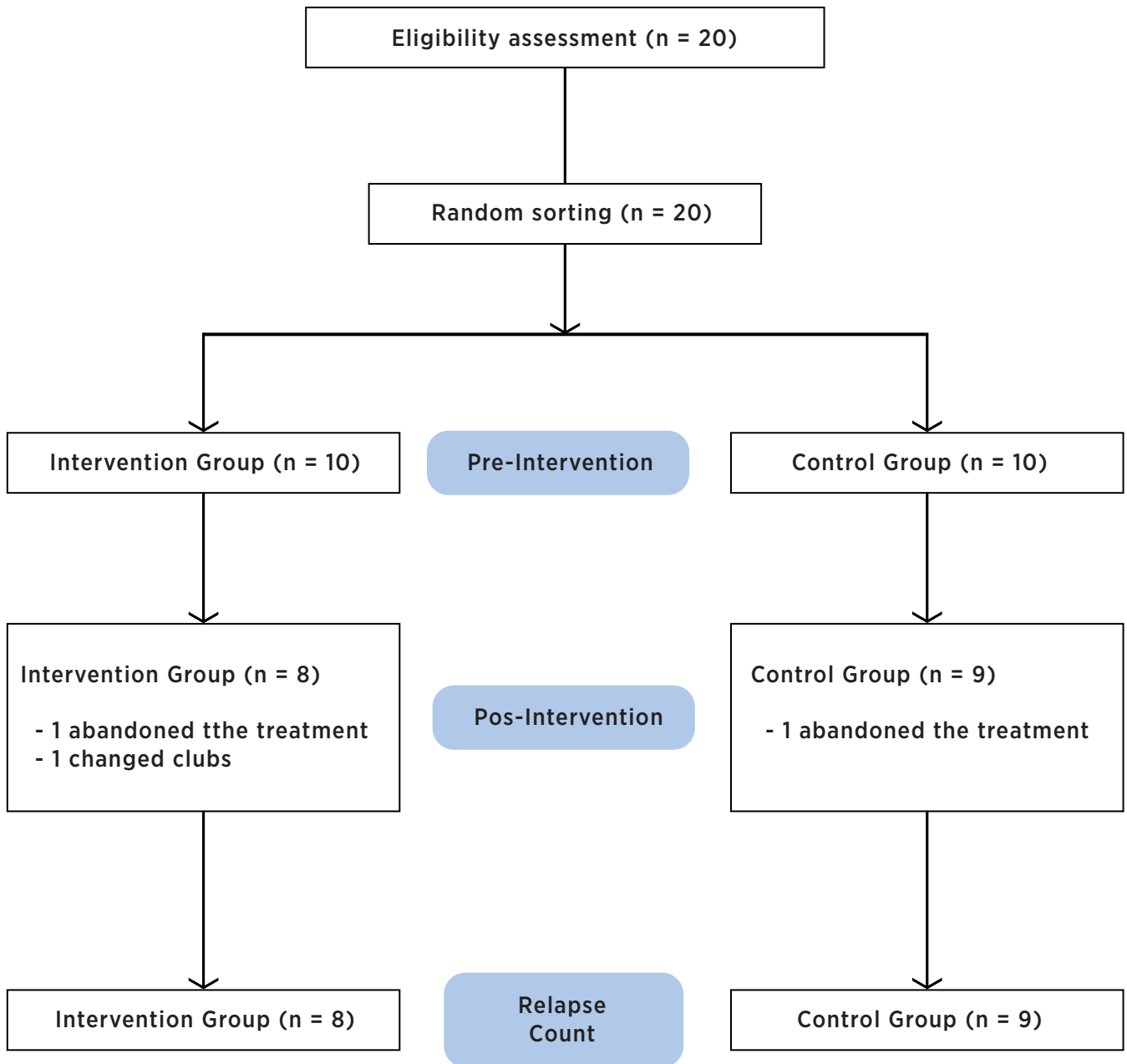


Figure 1. Study fluxogram

Participants

Twenty athletes, male, field soccer players in the lower soccer clubs from Florianópolis participated in the study. Participants trained regularly at least five days per week prior to injury. To be included in the study, participants had to be aged between 16-20 years, have suffered recent lateral ankle sprain that incapacitated their sport performance, and had their allocation carried out within 72 hours after the sprain. Ankle sprain was diagnosed when the participant had at least one of these symptoms: pain, swelling, bruising or inability to perform physical activities for more than a day¹⁶. Participants who had ankle sprain associated with lower limb fracture, athletes undergoing invasive treatment or those who had their ankles immobilized after the sprain were excluded from the study. This research was approved by the Human Research Ethics Committee of the State University of Santa Catarina under the protocol number 88/2011. The consent was obtained from all participants or their legal guardians before procedures were performed.

Procedure

The evaluations and interventions were carried out within the premises of the club's physiotherapy department. First, athletes with acute ankle injury were taken to the medical department of the club, where they were evaluated by a doctor specialized in sports medicine, responsible for diagnosing the degree of the ankle sprain¹⁷. Afterwards, the athletes were evaluated by a physical therapist regarding the inclusion and exclusion criteria. The athletes were included in the study regardless of whether the affected ankle was or not in the dominant leg. Once they were included and consented to participate, participants were assessed by a blind investigator for the allocation of groups; and thus the treatment was initiated. After the treatment was completed and the patients were discharged from physical therapy, participants underwent the same battery of tests initially performed by the blind investigator during the allocation of the groups. After treatment, participants were observed for six months for any recurrence of ankle sprains. Monitoring of relapses was conducted via e-mail, every fortnight. When participants failed to respond to e-mails for one month, contact was made via telephone. Following this telephone contact, e-mail contact was resumed.

Evaluations

Range of movement in ankle plantar flexion

The participant was put into a supine position with the knee flexed and the sole of the foot in full contact with the stretcher. In this position, the participant was instructed to extend the knee and slide the foot on the rigid stretcher, keeping the heel, the 5th and 1st metatarsal head in contact with the stretcher. With the help of a measuring tape, the vertical distance between the highest point of the knee and the stretcher was measured, as well as the horizontal distance from the heel to the point of projection measured between the knee and the stretcher (intersection point) forming a 90° angle. The maximum ROM for plantar ankle flexion was calculated by trigonometry, using the measured distances¹⁸. This measure had an intraclass correlation coefficient (ICC) between 0.88-0.92¹⁸.

Range of movement in ankle dorsal flexion

The participant was placed standing in a squatting exercise position, facing a wall. In this position, he was instructed to squat, dorsal flexing the ankle to the maximum position of dorsiflexion, without loss of contact between the heel and the ground, while being able to touch the knee to the wall. The subtalar joint position was controlled by maintaining alignment of the foot perpendicular to the wall with the aid of measuring tapes fixed to the ground and the wall. From this position, the horizontal distance between the posterior region of the heel wall, and the vertical distance between the knee point of contact with the wall and the floor were measured. The maximum ROM for ankle dorsiflexion was calculated by trigonometry, with the use of the measured distances^{19,20}. This measure has an ICC between 0.97-0.98¹⁹.

Star Excursion Balance Test (SEBT)

Performed to assess dynamic balance²¹. The participant performed the test standing in a single-leg stance, barefoot, on the center of three measuring tapes arranged on the floor. Measuring tapes stretched out from the center going three different directions: anterior (SEBT Ant), posterolateral (SEBT PL) and posteromedial (SEBT MP). Between the two posterior measuring tapes we had an angle of 90°, and between the posterior tapes and the anterior tape we had an angle of 135°²². The position of the subtalar joint was controlled by the alignment of the third finger on the anterior line marked on the floor. Thus, the participant was asked to use their opposite foot big toe to

reach each of the lines as far as possible and the distance they were able to reach was recorded. The procedure was repeated three times for each direction. Before the test, participants were familiarized with it. Between familiarization and each repeat testing, an interval to rest was allowed until participants felt comfortable to repeat testing. For test analysis, the distance achieved was standardized by dividing the distance obtained by the length of the lower limb multiplied by 100. The length of the lower limb was measured using a measuring tape and the distance between the anterior superior iliac spine and the medial malleolus was measured²². This measure has an ICC between 0.84-0.92²³.

Ankle perimetry

The patient in a supine position and with the use of a measuring tape had the swelling in their ankle sized. Initially, the measuring tape was placed on the tendon of the anterior tibia, taken to the middle of the navicular tuberosity, then placed into the base of the 5th metatarsal bone for crossing the sole of the foot and finally directed to the medial malleolus. After that, it was taken posteriorly, crossing the Achilles tendon, through the lateral malleolus to reach the starting point. Thus, the tape was placed around the ankle in an "8" shape²⁴. Three measurements were performed and the average of these three measures was used for analysis. This measure has an ICC between 0.98-0.99²⁴.

CAIT Questionnaire

Used to evaluate the functional instability showed by participants. CAIT questionnaire is a tool composed of 9 questions with a modified Likert scale that generates a score between 0 and 30, with high reliability (ICC = 0.95) and discriminative validity²⁵.

Intervention

After the initial assessment, the groups received the same physical therapy treatment, following the conventional physical therapy practices for the treatment of lateral ankle sprain^{5,6}. All participants received the same treatment protocol, adapted for each individual in terms of intensity: (1) cryotherapy: 20 minutes in the first two sessions and repeated at the end of each session should inflammatory signs be exacerbated; (2) electrotherapy: TENS, ultrasound, or laser used in the first few sessions according to the disability reported by patients; (3) kinesiotherapy, initiated according

to the exercise capacity of the patient, with intensity and volume being increased as the patient evolves: (a) stretching of the muscles in the lower limbs to maintain muscle length, (b) joint mobilization of the ankle, firstly passive, limited by the pain of the participant, and then evolving for active mobilization with circular movements of the ankle and squatting exercises, (c) sensorimotor training, starting with exercises of body support transfer, evolving into balance exercises, first with bipedal support advancing to single leg support and balance with eyes closed, (d) strengthening of the ankle muscles performed with elastic bands at moderate intensities, (e) return to sport activities in the final phase of rehabilitation. The sessions occurred five times a week, lasting an average of two hours.

The MI group, at the end of each treatment, was taken to a room attached to the physiotherapy department where each participant sat in front of a computer, in a calm environment, without external disturbance or assistance from others. On the computer screen, 40 different ankle-foot images were randomly projected (20 left and 20 right), in different angles and with different ankle-foot positions (Figure 2). The participant was asked to press the right arrow or the left arrow of the computer keyboard when he was able to identify the image of the foot to be the right or left limb. The right arrow should be pressed when the participant identifies a right foot and the left arrow when he identifies a left foot. The maximum time that the image remained projected on the screen was 4 seconds, after which the image changed, should the participant fail to identify it. Before the MI exercise, participants received explanations on the use of the program, and were shown some images of the ankles, from the right and left foot. At the end of the 40 images, the software specified the time used to identify each foot and the number of right guesses¹².



Figure 2. Example of image shown for identification

Statistical Analysis

Descriptive statistics were used to calculate the averages, standard deviations and confidence intervals of the differences in the data collected. Mann-Whitney test was used to compare the effect of MI on the measured variables among groups. Analyses were performed using SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA). The size of the effect of the differences between the groups was also measured and considered for the classification of the effect size: 0.2=small; 0.5 = moderate; 0.8 = large^{26,27}. The intention-to-treat principle was used for analysis. Participants were asked to perform reevaluation even without completing the treatment, though none accepted the offer to return (Figure 1).

RESULTS

Of the 20 participants, two dropped out of treatment and one transferred clubs during the treatment (Figure 1). Characterization data can be found in Table 1. As for the pre-intervention measurements, the groups were similar and not significantly different. The groups were not significantly different after treatments regarding dorsiflexion ROM, plantar flexion ROM, SEBT Ant, SEBT PL, SEBT PM, perimetry and CAIT (Table 2). The greatest effect was observed in ROM measurements (effect size =0.5 – Table 2). Of the participants who completed the study and the follow-up period of relapses, one IG participant had a recurrent ankle sprain.

Table 1. Participants' characterization data

Measurements	Intervention Group	Control Group
Number of participants	10	10
Age (years)	17.2±1.6	17.4±1.8
Height (m)	1.76±0.09	1.73±0.10
Body weight (Kg)	68.6±10.5	67.7±8.3
History of sprain ankles (% n)	40	50
Degree of ankle sprain		
Degree I	9	7
Degree II	1	3
Degree III	0	0
Field position		
Goalkeeper	1	0
Central-back	3	1
Wingback	1	2
Midfield	3	4
Striker	2	3
Number of visits	6.3±3.9	8.2±4.4

Data presented in averages ± Standard deviation (SD)

Table 2. Group average and the average difference intra and inter groups

Measurements	Pre-intervention (average ± SD)	Post- intervention (average ± SD)	Intra groups comparison Post minus pre-intervention (Average difference ± SD)	Inter groups comparison IG minus CG* [Average difference (IC 95%)] (p value/ size of the effect)
Dorsal flexion (degrees)				
IG	53.1±4.5	54.3±2.9	1.2±2.8	2.2 (-1.8-6.2) p=0.23 / 0.5
CG	54.3±5.0	53.3±4.1	-1.0±5.3	
Plantar flexion (degrees)				
IG	29.2±7.0	31.4±7.6	2.2±2.1	-1.8 (-1.7-5.3) p=0.50 / -0.5
CG	27.7±4.2	31.7±5.1	4.0±4.9	
SEBT Ant (%)				

continues...

Table 2. Continuation

Measurements	Pre-intervention (average ± SD)	Post- intervention (average ± SD)	Intra groups comparison Post minus pre-intervention (Average difference ± SD)	Inter groups comparison IG minus CG* [Average difference (IC 95%)] (p value/ size of the effect)
IG	79.2±10.9	83.4±9.0	4.2±4.4	-0.1 (-5.8-5.6) p=0.70 / 0.0
CG	80.6±8.9	84.7±7.8	4.1±7.4	
SEBT PL (%)				
IG	90.7±8.1	92.3±8.3	1.6±5.8	-2.3 (-8.0-3.4) p=0.29 / -0.4
CG	85.4±10.2	89.3±6.3	3.9±6.3	
SEBT PM (%)				
IG	93.1±8.8	95.8±10.7	2.7±4.5	1.5 (-3.5-6.5) p=0.79 / 0.3
CG	91.9±10.6	93.1±9.3	1.2±6.1	
Perimetry (cm)				
IG	56.6±2.2	55.6±1.9	-1.0±1.1	0.3 (-0.8-1.4) p=0.50 / 0.3
CG	55.1±2.5	54.4±2.1	-0.7±1.3	
CAIT (points)				
IG	23.4±5.0	23.4±5.0	0.0±3.7	-1.9 (-6.0-2.2) p=0.70 / -0.4
CG	22.8±4.9	24.7±2.8	1.9±5.0	

*Calculations using the difference post minus pre-intervention in each group. IG: intervention group; CG: control group; SEBT Ant: Star Excursion Balance Test Anterior; SEBT PS: Star Excursion Balance Test Posterolateral; SEBT PM: Star Excursion Balance Test Posteromedial; CAIT: Cumberland Ankle Instability Tool

DISCUSSION

Preliminary results of this pilot study indicate that MI may have no effect on increasing ankle ROM, postural control, edema, and functional stability in ankle sprains treatments for athletes.

The focus of the ankle sprain post-rehabilitation should be to restore joint function and also prevent possible deficits caused by sprains, which may lead to relapse and chronic instabilities^{5,6}. The main factors of rehabilitation include the restoration of ROM, since dorsiflexion ROM restriction is a major deficit after ankle sprains²⁸, and permanent restrictions of this ROM could be a leading factor for the occurrence of new sprains²⁹. Another concern is the sensory motor system integrity, which can be affected by disuse during rehabilitation or also by central changes^{2,3}. Thus, the MI exercise could be an auxiliary tool in the recovery process after ankle sprains.

During the mental process of imagining the position of the ankle and foot during image identification, constant joint mobilization can occur, thus promoting an improvement in ankle ROM. In addition, the movements caused by MI could promote an increase in muscle activation as shown in the study by Christakou et al.⁷, and thus assist in the restoration of ROM. Preliminary results of this study do not support such an assumption. Christakou and Zervas's⁸ study, like this study, treated athletes with ankle

sprains and observed no differences between the MI treated and the control groups regarding ankle ROM. Perhaps the micro movements caused in the ankle by the imaginary process is not effective in adding or excelling the stimuli already conducted during conventional treatment, which includes stretching and invigoration of the muscles involved in movements and the dynamic of ankle stabilization. Another argument is that the mental process may have no effect on physical aspects such as ankle ROM. However, the moderate size effect values for ranges of movements may indicate that, with the continuity of the study, MI may end up having a significant influence on ankle movements.

The same hypothesis of effectiveness could be considered for edema reduction. The micro movements could cause continuous muscular contractions, increased metabolism and copy metabolic exercises performed to reduce edema. The position at which the participants performed the MI exercise may have been a hindrance to the conduction of the interstitial fluid by lymphatic vessels. As participants performed the exercise in a sitting position, gravity may have hindered the lymphatic return to thicker lymph vessels, lymph nodes and lymph ducts, for subsequent reabsorption of lymphatic fluid. In the study of Christakou and Zervas⁸, which evaluated ankle edema through volumetry, MI also showed no edema reduction.

The main purpose for using MI in rehabilitation processes is to stimulate the central nervous system to obtain a stimulus to the reorganization of lost motor function, either caused by central or peripheral injuries⁹⁻¹². In this study, the task of identifying foot and ankle laterality caused the participant to imagine the position of his own foot. This imagination process of the body itself could help in improving body image, facilitating the control of movements and disturbances around the ankle and improving postural control as a whole. However, MI showed no effect on balance in this study. The stimulation caused by MI may not have been sufficient to cause an improvement in postural control, especially because IG participants required few physical therapy sessions before being discharged, an average of about six sessions (Table 1). A longer MI stimuli time may be needed to cause postural control improvements. However, the study by Christakou et al.⁷, which included a larger number of MI interventions (12 sessions), also failed to observe any difference between the groups regarding postural control measured by the Biodex Stability System.

Thus, it seems the addition of MI to the treatment does not add any benefit to the conventional treatment, regarding structural and functional aspects, as evaluated by the CAIT questionnaire. Perhaps the MI method used in this research is the cause of the lack of positive results. The participants had to identify static images of feet and ankles, mental accommodation may have occurred during treatment and its benefits remained limited. However, the lack of positive results in this study should be considered with caution since this is a pilot study and results are only preliminary.

Some points can be decisive in these preliminary results, such as the low number of sessions performed. This may be due to the participants being athletes and young people, who complete the rehabilitation process faster than most. Another point is the amount of degree I ankle sprains. This degree of damage cause less structural and functional alterations and, thus, the effects of MI could be limited in this degree of injury. Another item was the lack of control over the motor imagination condition of the patients prior to treatment. Participants may have started treatment in different conditions, as almost half of the participants had a history of ankle sprains and their bodily and mental outlook are different from those who suffered a first sprain.

On the other hand, with continuing research and the collection of the sample size suggested by the preliminary results, more consistent data regarding the evidence of the use of MI in ankle sprains treatment may be provided. Continuing the research will also allow collection of more concrete data on the monitoring of recurrent ankle sprains after treatment. Other studies using MI for longer periods of time can verify their effect on proprioception, postural control, pain and strength of individuals post-rehabilitation for ankle sprains, or to verify its effects as a method of prevention.

CONCLUSION

From the results of this study, we can conclude that MI was not an effective method for treating ankle sprains in field soccer athletes to improve ROM, dynamic balance, edema and functional stability. The experimental model proposed in this pilot study proved to be feasible and may bring concrete evidence regarding the use of MI as a therapeutic tool in the rehabilitation of athletes after ankle sprains.

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