Improvement of Mobility, Strength, Stability and Pain in Soccer Players with Recurrent Ankle Sprains Through Myofascial Release, Strength Exercises and Taping: A Randomized Controlled Trial.

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Research article

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Abstract

Background. Recurrent ankle sprains are common in soccer players, characterized by restricted range of motion, pain, and decreased proprioception, strength, and postural control.

Methods. In this randomized controlled trial over 4 weeks, 36 recreationally active male football players randomly to experimental group (myofascial release applied to the subastragaline joint, eccentric training with an isoinertial device and neuromuscular taping) or control group (same intervention without neuromuscular taping). Outcomes measures were range of motion, strength, stability and perceived pain in the ankle joint. The within-subject effect and group interaction were obtained by means of a repeated measures ANOVA.

Results. We found significant differences in range of motion in dorsiflexion ($p < 0.001$; $\eta^2_p = 0.31$) and plantar flexion ($p < 0.01$; $\eta^2_p = 0.23$). We also found differences depending on the moment in the strength in dorsiflexion ($p = 0.001$; $\eta^2_p = 0.19$) and plantar flexion ($p < 0.001$; $\eta^2_p = 0.29$) and in the intra-subject effect in the variables perceived pain ($p = 0.03$; $\eta^2_p = 0.11$) and the mean anteroposterior and mid-lateral velocity with eyes open ($p < 0.001$; $\eta^2_p = 0.25$). No significant changes in group interaction were found in any of the variables ($p > 0.05$).

Conclusion. The combination of fascial therapy and eccentric strength training with an isoinertial device improves ankle mobility, strength and stability in footballers with recurrent ankle sprains. The use of taping techniques failed to provide a greater improvement of the study variables when combined with manual therapy and strength techniques.

Trial Registration Number: www.clinicaltrials.gov (id: NCT04257916; Date of registration: 2nd, April, 2020).

Background

Most soccer-related injuries are located in the lower limbs, especially in the joints and thighs [1]. Soccer heavily loads the ligamentous structures, the anterior cruciate ligament being the most frequently injured (31%) [2]. A high prevalence of injuries in the external lateral ankle ligament has been reported in professional players [3]. Almost 62% of these injuries are recurrent, while the remaining 38% are due to mechanical instability [4, 5].

Small et al. [6] noted how a proper sprinting technique during a given stage of the game declines due to fatigue, whereby muscle coordination, flexibility and strength are affected [7]. As the soccer match progresses, the center of gravity shifts, decreasing joint stability, which is reflected in the time pattern of the higher incidence of ankle sprains at that point in the match [8]. Functional asymmetries in the strength of the ankle joint flexor muscles promote the development of sprains in professional players [9]. Similarly, loss of muscle flexibility can reduce active joint mobility [10].

The FIFA *Medical and Research Centre* developed the new version of the warm-up video game for soccer players known as FIFA 11+ [11]. This version includes sprinting, strength, plyometric and balance components compared to the initial version, incorporating an increase in intensity to potentially improve soccer players ' physical performance. Playing FIFA Soccer 11 + after training has been associated with a 72% reduction in the number of injuries [12].

Eccentric strength training alters muscle architecture, acting as a prevention factor [13] by creating adjustments when performed before or after training [14]. Eccentric muscle strength also influences the performance of athletes using isoinertial training devices [15].

Different physiotherapy techniques such as electrostimulation, ultrasound and manual therapy are used to reduce pain and accelerate functional recovery in athletes with ankle sprains in the subacute phase [16]. Balance and stability training has shown [17] its effectiveness in reducing the risk of unstable ankle injuries, by reducing pain and increasing muscle strength and endurance [18]. Similarly, training the joints adjacent to the injured ankle joint should be considered [19].

Stabilizing taping is placed in close contact with the skin and provides strong skin proprioceptive signals, and it is expected that the ability to detect ankle movement will also improve with taping. It has been noted how taping applied to the ankle joint can improve gait functionality (gait speed, step length and stride length) in amateur soccer players with lateral ankle sprains [20]. Taping has also been used as a preventive technique to avoid relapses [21].

Manual therapy aims to enable proper transmission of mechanical information through treatment strategies that may include therapeutic exercises and trigger point treatment [22]. The term myofascial refers to an interconnected three-dimensional network, which surrounds and connects the musculoskeletal system [23]. During gait, the tendon of the tibialis posterior muscle absorbs energy when the subastragaline joint is in pronation and can cause strain injury [24]. Long-term improvements in postural control and plantar fascia mobility has been observed using myofascial techniques [25].

The objective of this study is to evaluate the effectiveness of an intervention using myofascial release and eccentric strength training, combined with the application of taping, in improving range of motion, stability, strength and perceived pain in footballers aged 18 to 35 years with recurrent ankle sprains.

Methods

This is a randomized single-blind clinical trial approved by the Research Committee of the European University of Madrid (registration No: CIPI/18/084) and followed the principles of the Helsinki Declaration. Prior to the study, it was registered in an international clinical trials registry (ClinicalTrials.gov ID: NCT04257916). Recruitment took place between February and June 2020. This trial has been designed and reported in accordance with the CONSORT guidelines for reporting randomized controlled trials.

Study population

Thirty-six male soccer players were recruited from the *Federazione Italiana Giuoco Calcio* in Turin, Italy, between. Before recruiting the players, approval from all coaches was obtained. Of the thirty-six soccer players, thirty-three completed the study, 3 dropped out during the experimental stage due to schedule incompatibilities. Players who met the selection criteria were randomly assigned to the study groups. The thirty-six participants were federated soccer players with a medical record of recurrent ankle sprains. The study included only males with a mean age of 26.09 years (SD: 5.06), a mean weight of 73.52 kg (SD: 5.91) and a mean height of 176 cm (SD: 7.35).

Selection criteria

The inclusion criteria were: male soccer players, with ages ranging from 18 to 35 years; and who presented recurrent ankle sprains. Those excluded were: athletes who had suffered a sprain in the month prior to the start of the study; who were taking anti-inflammatory drugs; who received any physical therapy or performance improvement interventions at the time of the study; and who failed to sign informed consent.

Randomization and blinding

At baseline, a physiotherapist with years of experience randomly allocated the thirty-six participants with recurrent ankle sprains to the study groups using an opaque envelope system. After randomization, the two study groups (experimental and control) had eighteen athletes each. The 36 subjects who accepted were randomized to the two study groups: experimental (n = 18) and control (n = 18), receiving an intervention using myofascial release on the subtalar joint, kinesiotaping and eccentric training with an isoinertial device, and myofascial release on the joint subtalar and eccentric training with an isoinertial device, respectively.

All soccer players were evaluated by the same physiotherapist, blinded to subject allocation to study groups. Blinding of the evaluator was ensured by the evaluation procedure: upon arrival, the athletes were directed to an evaluation area, where the evaluator assessed all subjects at pre-treatment (T0), after the intervention (T1) and at follow-up (T2).

Procedure

Each player received two 50-minute weekly sessions over a 4-week period. The interventions in each group were performed by the same physiotherapist, with experience in manual therapy, therapeutic exercise and kinesiotaping. The myofascial release on the subtalar joint and eccentric training using an isoinertial device were the interventions common to both study groups.

The duration of each myofascial release session lasted 10 minutes. The technique was performed by placing the patient in supine position, while the physiotherapist positioned the caudal hand on the subtalar region and the cranial hand mid-foot. With tibia-tarsus traction, taking the foot to eversion, a shearing motion was performed in the astragaline area, using a combined and slow technique [26].

The isoinertial eccentric training consisted of various exercises for 30 minutes. Each athlete performed a 10-minute warm-up on the treadmill, at a speed of 7 km/h without inclination. Strength training was performed on an isoinertial device (SpaceWheel model) with 20”/10 " interval methodology. Four set including three exercises were performed: *squat, lunges* and *deadlift*. Between sets, an active one-minute break on the treadmill was made, with a two-minute rest (passive) between exercises.

To ensure proper performance of the squat exercise, the physiotherapist who controlled the interventions told the athlete when he was parallel to the floor, to ensure thigh-level depth of the squat, parallel to the floor for all repetitions [27]. For the lunge exercise, the player was standing with feet hip-width apart, taking a large step forward with one leg, moving the weight forward, with the heel on the floor, and lowering the body until the thigh is parallel to the ground and the opposite leg perpendicular. Between each series of lunges a one-minute break was made, with active recovery on the treadmill [28]. Deadlift is used in resistance training, rehabilitation and weightlifting. The starting position for the deadlift was with the player squatting, arms straight and downward, and an alternating hand grip on a bar placed in front of the lifter's feet. The bar had to be lifted in a continuous motion, until the player was standing with his knees locked and his shoulders pushed back [29].

Players included in the experimental group were applied neuromuscular taping (Cure Tape, Aneid Italia Srl), according to the protocol described by Bellia and Selva [30] with the patient in supine position and the foot in dorsiflexion. Anchoring the strip below the sole of the foot without any tension, the tape was then tensed 50–70% to the medial and lateral malleolus, to finish without tension. Another strip was placed under the lateral malleolus following the astragalus with a tension of 50–70%, leaving the protrusion of the scaphoids free to surround the sole without stretch, leaving the 5th metatarsal free. Taping continued along the peroneal-astragaline ligament and the lateral malleolus with a tension of 50–70%, until insertion at the tendon without tension. Another strip was placed along the medial malleolus and the dorsal face of the foot to the fifth metatarsal on the sole of the foot without tension. Finally, running around the medial malleolus to the Achilles tendon ending in the lateral malleolus and the neck of the astragalus without any tension.

Outcome measures

The results were measured at baseline (T0), at the end of the 4-week intervention (T1), and after the 4-week follow-up period (T2). Four outcomes measures were evaluated in this study: range of motion, strength, stability and perceived pain in the ankle joint.

Ankle mobility, dorsiflexion and plantar flexion, was measured with a digital goniometer (*Get my R*om – IPhone 5-Interactive Medical Productions) [31]. Ankle isometric strength was measured with a digital dynamometer (*MicroFet ®* 2-Hoggan Health Industries) [32], evaluating dorsiflexion and plantar flexion movements, maintaining contraction 2–3 seconds. Each movement was repeated three times, resting one minute between repetitions, taking the highest value as reference. The stability assessment was performed using the *PWalk* platform (BTS, Bioengineering Corp). With the software used, measurements were made for 30 seconds with eyes open and closed, evaluating the movement with respect to the center of pressure in the frontal and sagittal plane (mm), the perimeter (mm), the area (mm2) and the average speed (mm / sec) [33].

Pain perception was assessed with the soccer player standing on the sprain-affected leg under load-bearing conditions, performing movements in the anteroposterior and mediolateral direction, evaluating the perceived pain through the visual analog scale (range 0–10).

Three evaluations were carried out: prior to intervention (pre-treatment), at the end (post-treatment) and after 4 weeks (follow-up). All evaluations were performed by three blinded physiotherapists in terms of subject allocation.

Sample size

The magnitude of the sample has been considered through the calculation of the effect size, which was estimated at 1.14 based on the previous literature on the variable for ankle dorsiflexion in people with recurrent ankle sprains [34]. With an alpha level (type I error) of 0.05, a statistical power of 80% ($1-\beta = 0.80$) and a non-sphericity correction of 1, a representative sample size of 14 soccer players per group has been estimated.

Statistical analysis

A descriptive analysis was performed using SPSS statistical software, version 19.0, for Windows. By means of a descriptive analysis, the main statistics (mean and standard deviation) of the independent quantitative variables were calculated. The analysis of sample distribution was carried out using the Kolmogorov-Smirnov test.

The within-subject effect and group interaction were obtained by means of a repeated measures ANOVA. The error rate of the significance level was controlled using the Bonferroni correction. When Mauchly's sphericity test was significant, the Greenhouse-Geisser correction coefficient was used. The partial Eta squared value was calculated as an indicator of the effect size (classified as small 0.01, medium 0.06 and large 0.14) [35]. In this study, an analysis by intent-to-treat has been carried out. The significance level of the study was □ < 0.05.

Results

Between January and April 2020, 36 soccer players were evaluated for inclusion. Thirty-six males were included and randomized. Ninety-three percent of players completed a 4-week follow-up. Thirty-three males completed the study, although an intention-to-treat analysis was carried out for the 36 soccer players included in the study. For details, see flowchart (Fig. 1). Demographic and baseline characteristics were similar between the groups (Table 1).

Table 1
Descriptive analysis (mean and standard deviation) at baseline of the total sample, and according to the study group.

Variables	All sample	Experimental group	Control group	*P*-value [a]
Age (years)	26.09 (5.06)	26.41 (4.82)	25.75 (5.44)	.20
Weight (kg.)	73.52 (5.91)	73.29 (6.48)	73.75 (5.43)	.20
Height (cm.)	176 (7.35)	177 (7.3)	175 (7.4)	.20
Body mass index *	23.72 (2.50)	23.38 (2.24)	24.08 (2.77)	.01
Previous injuries (number) *	1.18 (0.46)	1.12 (0.33)	1.25 (0.57)	.00
[a] Kolmogorov-Smirnov test.				
*Significant difference (p < .05).				

The central trend (mean) and dispersion (standard deviation) statistics of the dependent variables were calculated in each evaluation (see Table 2).

Table 2
Descriptive statistics mean (and standard deviation), of the study variables at baseline, posttreatment and follow-up assessments.

Variables	Experimental group			Control group		
	T0	T1	T2	T0	T1	T2
Pain (0–10)	2.00 (0.86)	1.82 (0.88)	1.53 (0.62)	2.00 (0.89)	1.75 (0.85)	1.75 (0.68)
Plantar flexion (degrees)	32.41 (5.51)	33.76 (5.48)	33.35 (5.18)	32.19 (4.66)	34.44 (4.08)	34.19 (4.08)
Dorsal flexion (degrees)	15.35 (2.54)	16.76 (1.88)	16.82 (2.03)	16.31 (1.53)	17.00 (1.50)	17.06 (1.34)
Plantar flexion force (Newtons)	109.53 (30.25)	117.12 (28.61)	118.40 (31.74)	101.79 (26.08)	113.94 (31.42)	109.48 (25.85)
Dorsal flexion force (Newtons)	107.33 (22.75)	115.54 (22.01)	112.33 (21.46)	103.08 (35.99)	111.39 (33.71)	110.61 (29.39)
Anteroposterior center of pressure (OA) (mm)	0.31 (1.56)	0.63 (0.99)	0.10 (0.96)	0.08 (0.70)	0.00 (1.31)	0.16 (0.77)
Mid-lateral center of pressure (OA) (mm)	-0.14 (2.02)	-1.33 (1.88)	-0.53 (1.91)	-1.15 (1.38)	0.96 (5.85)	-0.50 (1.68)
Anterior-posterior and medial-lateral velocity (OA) (mm/seg)	5.53 (3.83)	14.36 (12.24)	13.21 (8.65)	7.14 (4.30)	14.83 (9.74)	10.72 (5.68)
Total load distribution with the left foot (OA) (%)	49.55 (5.29)	51.32 (3.68)	50.57 (2.91)	48.51 (3.75)	50.88 (2.73)	50.91 (2.42)
Total load distribution with the right foot (OA) (%)	50.44 (5.29)	48.67 (3.68)	49.42 (2.91)	51.48 (3.75)	49.11 (2.73)	49.08 (2.42)
Anteroposterior center of pressure (OC) (mm)	0.10 (1.20)	0.67 (0.70)	0.41 (0.87)	0.21 (0.90)	0.28 (0.98)	0.29 (1.07)
Mid-lateral center of pressure (OC) (mm)	0.12 (1.64)	-1.93 (1.90)	-0.41 (1.85)	-0.76 (1.50)	-0.25 (1.41)	-0.96 (2.00)
Anterior-posterior and medial-lateral velocity (OC) (mm/seg)	0.73 (0.85)	0.40 (0.36)	.1,02 (1.82)	0.50 (0.42)	0.60 (0.63)	0.93 (1.29)
Total load distribution with the left foot (OC) (%)	50.57 (5.16)	48.88 (3.60)	48.25 (2.14)	51.48 (3.75)	21.36 (4.57)	49.15 (3.83)
Total load distribution with the right foot (OC) (%)	50.44 (5.29)	48.67 (3.68)	49.42 (2.91)	51.48 (3.75)	49.11 (2.73)	49.08 (2.42)

Outcome measures at the baseline (T0), after the three-week period of experimental and control interventions (T1) and after further 4-weeks as follow-up (T2).

We found significant differences in range of motion in dorsiflexion ($F(1.48, 46.13) = 14$; $p < 0.001$; $n^2_p = 0.31$) and plantar flexion ($F(1.14, 35.58) = 9.64$; $p < 0.01$; $n^2_p = 0.23$) in the repeated measures analysis.

When assessing ankle strength, we also found differences depending on the moment in the strength in dorsiflexion ($F(2.62) = 7.63$; $p = 0.001$; $n^2_p = 0.19$) and plantar flexion ($F(2.62) = 12.94$; $p < 0.001$; $n^2_p = 0.29$). Finally, we found significant changes in the intra-subject effect, depending on the moment, in the variables perceived pain ($F(1.51, 46.86) = 4$; $p = 0.03$; $n^2_p = 0.11$) and the mean anteroposterior and mid-lateral velocity with eyes open ($F(2.62) = 10.38$; $p < 0.001$; $n^2_p = 0.25$). No significant changes in group interaction were found in any of the variables (see Table 3).

Table 3
Statistical analysis of repeated measures of the dependent variables in the three study assessments.

Variable	Mauchly sphericity test		Box test	Intra-subject effect			Interaction		
	W	Sig.		F	Sig.	η^2_p	F	Sig.	η^2_p
Pain (0–10)	0.67	.00**	.50	4.00	.03*	0.11	0.71	.45	0.02
Plantar flexion (degrees)	0.25	.00**	.45	9.64	.00**	0.23	0.85	.37	0.02
Dorsal flexion (degrees)	0.65	.00**	.00	14.00	.00**	0.31	1.56	.22	0.04
Plantar flexion force (Newtons)	0.87	.12	.00	12.94	.00**	0.29	1.05	.35	0.03
Dorsal flexion force (Newtons)	0.89	.18	.14	7.63	.00**	0.19	0.21	.81	0.00
Anteroposterior center of pressure (OA) (mm)	0.87	.12	.11	0.24	.77	0.00	0.78	.46	0.02
Mid-lateral center of pressure (OA) (mm)	0.56	.00**	.00	0.25	.69	0.00	3.19	.06	0.09
Anterior-posterior and medial-lateral velocity (OA) (mm/seg)	0.86	.10	.67	10.38	.00**	0.25	0.65	.52	0.02
Total load distribution with the left foot (OA) (%)	0.90	.21	.00	2.93	.06	0.08	0.28	.75	0.00
Total load distribution with the right foot (OA) (%)	0.90	.21	.00	2.93	.06	0.08	0.28	.75	0.00
Anteroposterior center of pressure (OC) (mm)	0.97	.65	.76	0.81	.44	0.02	0.51	.59	0.08
Mid-lateral center of pressure (OC) (mm)	0.79	.03*	.90	1.81	.17	0.05	5.83	.07	0.15
Anterior-posterior and medial-lateral velocity (OC) (mm/seg)	0.57	.00**	.04	1.75	.19	0.05	0.35	.62	0.01
Total load distribution with the left foot (OC) (%)	0.01	.00**	.00	1.13	.29	0.03	1.03	.31	0.03

W: Mauchly Sphericity Test; Sig.: significance. η^2_p: effect size.

[a] The df corresponds to Greenhouse–Geisser test.

*Significant difference between improvements of the study groups (p < .05).

**Significant difference between improvements of the study groups (p < .001).

Variable	Mauchly sphericity test		Box test	Intra-subject effect			Interaction		
	W	Sig.		F	Sig.	η^2_p	F	Sig.	η^2_p
Total load distribution with the right foot (OC) (%)	0.90	.21	.00	2.93	.06	0.08	0.28	.75	0.09
W: Mauchly Sphericity Test; Sig.: significance. η^2_p: effect size.									
[a] The df corresponds to Greenhouse–Geisser test.									
*Significant difference between improvements of the study groups ($p < .05$).									
**Significant difference between improvements of the study groups ($p < .001$).									

The pairwise comparison analysis revealed changes in the T0 – T1 analysis for the variables of the range of motion in dorsiflexion and plantar flexion, and ankle strength. The analysis between the T0 - T2 measurements exhibited changes in the range of motion, ankle strength, and anteroposterior and mid-lateral velocity with eyes open. No changes were found in the measurement of T1-T2 assessments (see Table 4).

Table 4
Pairwise comparison analysis, means difference and (significance), between the three evaluations carried out in each study group.

Variables	**T0 - T1**	**T1 - T2**	**T0 – T2**
Pain (0–10)	0.21 (.05)	0.14 (.88)	0.36 (.06)
Plantar flexion (degrees)	-1.80 (.00) *	0.33 (.017)	-1.47 (.01) *
Dorsal flexion (degrees)	-1.05 (.00) *	-0.06 (1.00)	-1.11 (.00) *
Plantar flexion force (Newtons)	-9.86 (.00) **	1.58 (1.00)	-8.28 (.00) *
Dorsal flexion force (Newtons)	-8.26 (.00) *	1.99 (.87)	-6.26 (.05)
Anteroposterior center of pressure (OA) (mm)	-0.12 (1.00)	0.19 (1.00)	0.06 (1.00)
Mid-lateral center of pressure (OA) (mm)	.0.46 (1.00)	0.33 (1.00)	-0.13 (1.00)
Anterior-posterior and medial-lateral velocity (OA) (mm/seg)	-8.25 (.00) **	2.63 (.65)	-5.62 (.00) *
Total load distribution with the left foot (OA) (%)	-2.07 (.09)	0.36 (1.00)	-1.70 (.31)
Total load distribution with the right foot (OA) (%)	2.07 (.09)	-0.36 (1.00)	1.70 (.31)
Anteroposterior center of pressure (OC) (mm)	-0.31 (.52)	0.12 (1.00)	-0.19 (1.00)
Mid-lateral center of pressure (OC) (mm)	0.77 (.08)	-0.40 (1.00)	0.37 (.99)
Anterior-posterior and medial-lateral velocity (OC) (mm/seg)	0.11 (1.00)	-0.47 (.33)	-0.36 (.79)
Total load distribution with the left foot (OC) (%)	15.90 (.78)	-13.58 (1.00)	2.32 (.07)
Total load distribution with the right foot (OC) (%)	2.07 (.09)	-0.36 (1.00)	1.70 (.31)
T0 - T1: outcome measures between baseline to posttreatment assessments; T1 – T2: outcome measures between posttreatment to follow-up assessments: T0 - T2: outcome measures between baseline to follow-up assessments (T0); MD, mean difference.			
* Significant difference ($p < .05$).			
** Significant difference ($p < .001$).			

Discussion

This randomized clinical study aims to evaluate the effectiveness of myofascial release and eccentric training coupled with a stabilizing taping, in improving range of motion, strength, pain and ankle stability in footballers with recurrent ankle sprains. Although changes were reported in both study groups, we found no differences between the two interventions in improving the dependent variables studied. Ankle sprains represent in soccer practice one of the injuries leading to the greatest loss of training time. To reduce the risk of injury in an unstable ankle, as a result of restricted range of motion or poor stability, balance should be improved [17], attempting to reduce perceived pain by increasing strength [18].

Range of movement

Regardless of the administration of a stabilizing taping techniques, the combination of myofascial release and strength training achieved proper transmission of proprioceptive information. A significant increase in such transmission ability was noted in plantar flexion and dorsiflexion movements after the intervention and at follow-up. Our results are in line with those reported by Greig and McNaughton [8], who implemented an exercise protocol that replicated the activity profile of match play in 10 healthy footballers, observing improvement of active joint mobility, reducing in turn the risk of injury.

Our study has shown the effectiveness of myofascial release combined with muscle strength training in improving ankle range of motion. These changes may be due to facilitated sliding of the fascial plane, normalizing the mechanoreceptor activation threshold in the fascial tissue and to recruitment. The results obtained in the two groups included in this study are similar to those reported by Brandolini et al. [35] on the efficacy of myofascial release in improving ankle range of motion.

Stability

Fatigue affects balance in soccer players [8], so poor stability promotes the feeling of instability. The ankle retinaculum is a structure rich in proprioceptive receptors [26], whose damage can trigger undue proprioceptor activation, causing inaccurate proprioceptive afferent stimulus.

Our study noted improvements in the average speed in antero-posterior and mid-lateral movements, with visual support, and in the percentage of load distribution between left and right legs, in athletes treated with manual therapy and eccentric strength exercises. Similarly, those players who also used kinesiotaping exhibited changes in the mid-lateral pressure center with and without visual support. Although there was no specific proprioceptive exercise intervention, improvements in stability are similar to those found after implementing various approaches to balance training [17].

Kim and Cha [36] reported how the use of stretch bands increases the stability of the ankle allowing mobility within the elastic range, improving gait. A number of studies [37, 38] have reported the effect of adhesive taping on the ankle for improving dynamic balance and stability in young footballers with chronic ankle instability. Although Refshauge et al. [39] observed that the protective effect of taping did not improve proprioception in the plantar flexion and dorsiflexion plane, other authors [20] have reported an increase in the ability of stable gait after applying kinesiotaping in soccer players with lateral ankle sprains. However, although ankle stability improved in our study, we found no significant differences when comparing the stability assessment between footballers who used kinesiotaping (experimental group) and those who only performed the myofascial release and strength training intervention.

Accordingly, our findings are consistent with those described by Stecco et al. [40] who reported improved stability after administration of a fascial therapy intervention on the ankle retinaculum

Ankle muscle strength

The ability of the muscular system to generate strength is based on the combination of the neural impulse of the central nervous system and the peripheral contractile function. Changes in functional performance that occur after strenuous exercise are associated with changes in the central or peripheral systems [41]. Type II muscle fibers are more prone to muscle damage induced by exercise, suffering a high degree of remodeling that may temporarily affect the performance of explosive movements [42]. The symptoms of muscle damage are significantly reduced in trained athletes as a result of an adaptation known as the repeated bout effect [43]. This adaptation depends on the specific muscle group that is being used [44].

A protocol based on high-intensity squats, such as the one used in our study combined with an isoinertial device, causes a 48-hour drop in performance after exercise, although the isometric strength rapidly recovers. The drop in maximum strength caused by a maximum voluntary isometric contraction is used as a marker of exercise-induced muscle damage despite inter- and intra-subject variability in the response to exercise-induced muscle damage [45].

Fiber-specific remodeling, coupled with reduced neuronal impulse, promotes slower performance recovery, thereby improving the ability to exert force quickly [46]. The use of an isoinertial device together with the administration of myofascial release in our study has shown its effectiveness in improving ankle strength in dorsiflexion and plantar flexion movements. This improvement of eccentric muscle strength can have an impact on the training model and its functional asymmetries, with the aim of preventing injuries such as ankle sprains [9, 15].

Perceived pain

Poor coordination in the development of ankle movement can cause periarticular inflammation, in turn activating periarticular nociceptive receptors. The long-term effects of trauma to the lower limbs not only appear on the affected side and may cause alterations on the contralateral side.

The ankle retinaculum and deep fascia are highly innervated connective tissue structures that facilitate force transmission, motor coordination, and proprioception [40]. Improvements in perceived pain observed in both groups separately and the repeated-measures analysis have been previously reported in studies applying manual therapy to the fascial tissue [35]. In the same way, a protocol of exercises using stretch bands, weights, plyometric and proprioceptive exercises in people with chronic ankle instability has shown improvements in range of motion in ankle plantar flexion and dorsiflexion, reducing pain [18]. The decrease in pain under load-bearing conditions observed in our study allowed the footballers to increase their athletic performance.

Limitations

The main study limitation is the reduced sample size, a drawback we have attempted to minimize by performing an intent-to-treat analysis. Similarly, the use of more objective measuring instruments would have offered a more comprehensive analysis of the variables studied.

Conclusions

Myofascial release combined with strength training using an isoinertial device can improve ankle range of motion and strength, and stability in footballers with recurrent ankle sprains. Taping failed to provide a greater improvement of the study variables when combined with manual therapy and strength techniques. The improvement of ankle functionality in terms of mobility, strength and stability is similar in both study groups, regardless of the use of stabilizing taping.

Abbreviations

FIFA
Fédération Internationale de Football Association;
CONSORT
Consolidated Standards of Reporting Trials
ANOVA
Analysis of Variance

Declarations

Ethics approval and consent to participate: This study was carried out in accordance to the Declaration of Helsinki; prior to pre-tests, all the players were informed of the purpose of the study and its associated risks and benefits, before providing oral and written informed consent. This study approved by the Research Committee of the European University of Madrid (registration No: CIPI/18/084). It was registered in an international clinical trials registry (ClinicalTrials.gov ID: NCT04257916).

Consent for publication: Not Applicable.

Availability of data and materials: All data generated or analysed during this study are included in this published article.

Competing interests. The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Authors' contributions: RA, AN, AP and RCB conceived and designed the study. RA, AN and AP generated random allocation sequence. RA, AN and AP enrolled participants and assigned participants to interventions. RA, AN and AP carried out data collection. RCB performed the statistical analyses. RA, AN, AP and RCB participated in data interpretation and analysis. RCB was in charge of the writing process. RA, AN, AP and RCB participated in reviewing/editing the manuscript and all authors approved the final version of the manuscript.

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Figures

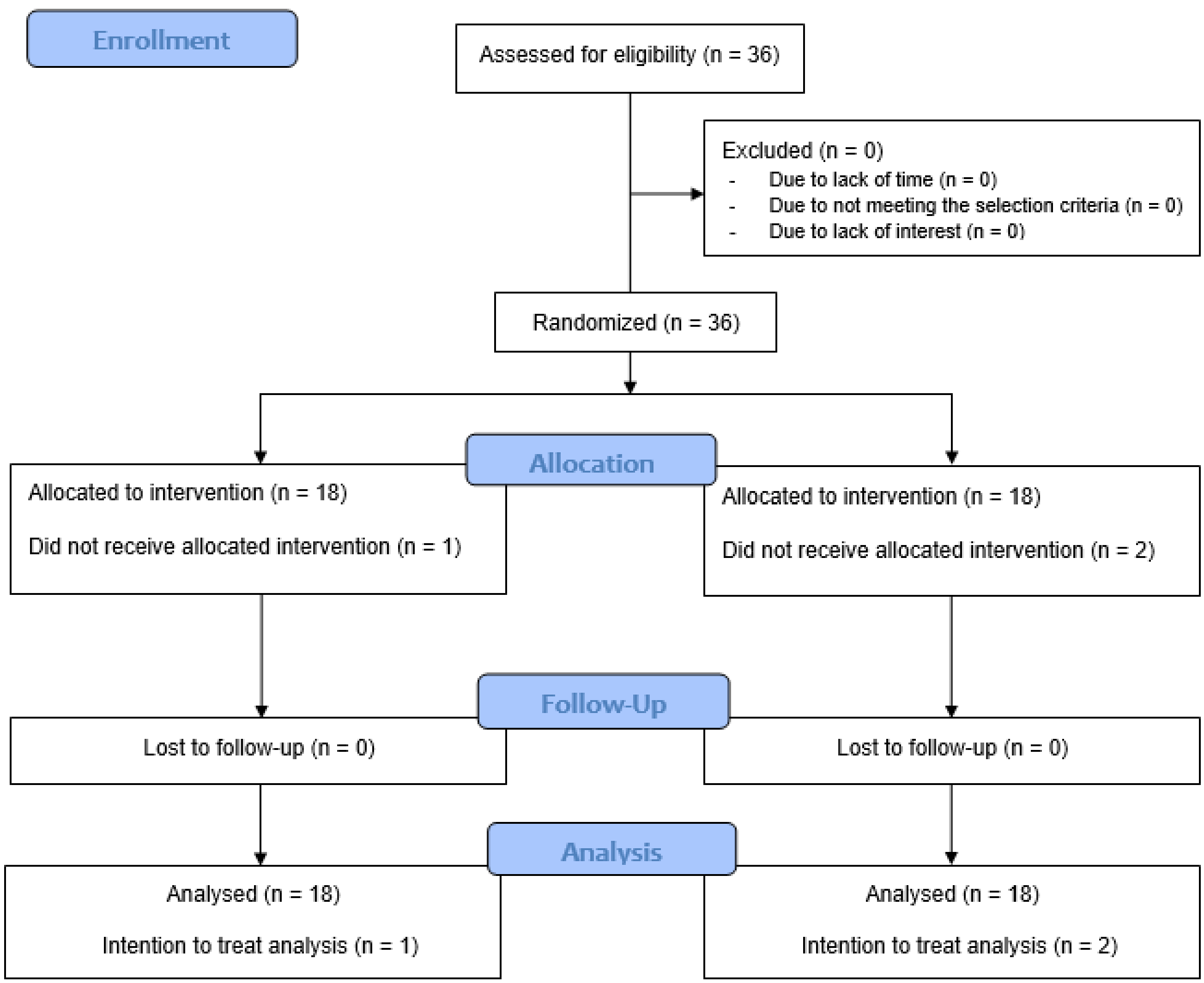

Figure 1

Flow Diagram of the study.

Supplementary Files

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