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Research Article / Araştırma Makalesi

Efficacy of extracorporeal shock wave therapy and electrotherapy in medial tibial stress syndrome: a randomised study

Medial Tibial Stres Sendromunda ekstrakorporeal şok dalga tedavisi ve elektroterapinin etkinliği: Randomize bir çalışma

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ABSTRACT

Objective: Medial Tibial Stress Syndrome (MTSS) is a sports injury characterized by pain in the middle and lower parts of the tibia. This study aimed to evaluate the efficacy of extracorporeal shock wave therapy (ESWT) combined with exercise, compared to electrotherapy combined with exercise, in track and field athletes with MTSS

Materials and Methods: Track and field athletes diagnosed with MTSS were divided into two groups. The first group received ESWT, while the second group underwent electrotherapy. Both groups followed the same exercise program. Outcome measures, including the Visual Analogue Scale (VAS), Tegner Activity Score, Disablement in the Physically Active Scale Short Form-10 (DPA-SF-10), Lower Extremity Functional Scale (LEFS), Tampa Kinesiophobia Scale, and obstacle course completion times, were recorded at baseline and after 4 weeks.

Results: Fifty-six participants were enrolled in the study, with a mean age of 23.2 ± 4.8 years (range: 18-40) and a mean BMI of 23.2 ± 2.9 (range: 19-35). Both treatment approaches resulted in statistically significant improvements in participants' symptoms. However, no significant differences were observed between the two groups when comparing outcomes before and after treatment.

Conclusion: ESWT and electrotherapy combined with exercise were found to be similarly effective in the treatment of MTSS.

Keywords: *MTSS, ESWT, exercise, athlete*

ÖZ

Amaç: Medial Tibial Stres Sendromu (MTSS), tibianın orta ve alt kısmında ağrı ile karakterize bir spor yaralanması türüdür. Bu çalışmanın amacı, MTSS'den etkilenen atletlerde egzersiz ile birlikte uygulanan ESWT ve egzersiz ve elektroterapinin etkinliğini göstermektir.

Gereç ve Yöntem: MTSS tanısı alan atletizm sporcuları iki gruba ayrıldı. Birinci gruba ESWT tedavisi, ikinci gruba ise elektroterapi uygulandı. Her iki gruba da aynı egzersiz programı uygulandı. Başlangıçta ve 4 hafta sonunda Görsel Analog Skala, Tegner Aktivite Skoru, Fiziksel Olarak Aktif Olanlarda Engellilik Ölçeği Kısa Form-10, Alt Ekstremite Fonksiyonel Ölçeği, Tampa Kinezyofobi Ölçeği ve engelli parkuru tamamlama süreleri kaydedildi.

Bulgular: Çalışmaya toplam 56 katılımcı dâhil edilmiştir. Katılımcıların ortalama yaşı 23,2 ± 4,8 yıl (18-40 arası) ve ortalama VKİ'si 23,2 ± 2,9 (19-35 arası) olarak belirlenmiştir. Her iki tedavi yöntemi ile hastaların semptomlarında istatistiksel olarak anlamlı iyileşme kaydedilmiştir. Ancak, tedavi öncesi ve sonrası gruplar arasında anlamlı bir fark bulunmamıştır.

Sonuç: Egzersiz programına eklenen ESWT ve elektroterapi tedavileri MTSS tedavisindeki etkileri benzer bulunmuştur.

Anahtar Sözcükler: *MTSS, ESWT, egzersiz, sporcu*

INTRODUCTION

Medial Tibial Stress Syndrome (MTSS), also known as shin splints or tibial periostitis, is a sports injury characterized by pain in the mid and lower parts of the tibia (1-3). This pain commonly occurs during sports or physical activities (1). The diagnostic criteria for MTSS were defined by Yates and White (4). While MTSS generally has a favorable prognosis, it can progress to a chronic condition and lead to disability.

This injury is a frequent cause of leg pain in military personnel and athletes, with a prevalence ranging from 4% to 35% in these populations (5,6). Approximately 60-80% of cases are associated with musculoskeletal overload (3). Overtraining and lower-extremity physical activity contribute to stress reactions in bones, as confirmed by imaging studies. These stress reactions are considered precursors to stress fractures, which differ from MTSS by presenting with

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more localized pain on percussion and requiring distinct treatment and management strategies (1,5,7).

According to Moen et al.'s bone stress reaction theory, bone marrow oedema indicates bone remodelling resulting from overload in individuals experiencing repetitive strain in the lower limb (8). Exceeding a certain threshold of load due to microscopic fatigue (micro lesions) can trigger clinical signs and symptoms (9).

Research on specific treatments for MTSS remains limited. In the acute phase, recommended treatments include rest, anti-inflammatory medications, analgesics, and various conservative approaches such as cryotherapy, electrotherapy, laser therapy, acupuncture, orthotics, foot orthoses, prolotherapy, compression, corticosteroid injections, and kinesio taping. Fasciotomy in the posterior superficial compartment of the leg has also been performed, but a definitive therapeutic approach remains undefined (5,10,11). Despite treatment, clinical courses often involve prolonged periods of relapse (5). Recovery time for recruits and recreational athletes has been reported to be 70-72 days (12).

Extracorporeal shock wave therapy (ESWT) is commonly used to treat sports injuries (13,14). FDA-approved for plantar fasciitis, it boasts an efficacy rate of over 90% and is also used for conditions such as lateral and medial epicondylopathies, Achilles tendinopathy, calcific tendinopathy, and calcaneal spurs (15,16). Although there are few studies on the effectiveness of ESWT for MTSS, some degree of controversy exists in the literature (5,6,17,18). Electrotherapy has also been documented as a conservative treatment for MTSS (19,20), but no original research has specifically addressed its use in this context. Although electrotherapy is widely used in clinical practice to alleviate pain and accelerate healing, evidence for its effectiveness in MTSS treatment remains scarce.

This study aims to evaluate the efficacy of ESWT combined with exercise and electrotherapy combined with exercise in track and field athletes with MTSS.

MATERIAL and METHODS

This study included track and field athletes diagnosed with MTSS at the Sports Medicine outpatient clinic. Participants were aged 18-40 years, male or female, with symptoms lasting at least three weeks and a diagnosis of MTSS within the preceding three months (from July 2023).

Exclusion criteria included: Current or previous radiological evidence of a stress fracture or other types of fractures, local infection or osteomyelitis, tumors in the affected area, compartment syndrome, previous surgery on the same leg, prior use of ESWT for MTSS, current rheumatic disease, coagulation disorders, and pregnancy.

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and was approved by the local clinical research ethics committee of Gulhane Education and Research Hospital (Date: 05/07/2023, Number: 2023/160). Written informed consent was obtained from all participants diagnosed with MTSS who agreed to participate.

Diagnostic Criteria:

The diagnosis of MTSS was based on the following criteria: patients presenting with crural pain and tenderness of at least 5 cm on palpation along the posteromedial border of the distal third of the tibia, with symptoms typically worsening during or immediately after exercise. Radiographic evidence was used to exclude stress fractures (21).

Participants were randomly assigned to two groups using stratified randomization. The first group received ESWT treatment, while the second group underwent electrotherapy. Both groups followed the same exercise program, with home exercises coordinated by an experienced physiotherapist. The home exercise program was scheduled once a week for two days.

ESWT was administered to one group using 1500 pulses at a dosage of 0.20 mJ/mm^2, once per week for four sessions, with the Storz Medical Duolith SD1 device. The other group received quadruple interferential current therapy twice per week for four sessions, using the Physiomed Ionoson-Expert device (22). Both treatments were performed by an experienced physiotherapist with the patients in the supine position and their legs externally rotated.

For ESWT, linear movements were applied along the posteromedial border of the tibia, moving both proximally to distally and distally to proximally. The interferential current therapy sessions followed a general treatment protocol: 10 minutes targeting analgesia and 20 minutes focusing on blood and lymphatic circulation, for a total session duration of 30 minutes.

On treatment days, patients also performed supervised exercises with a physiotherapist. Additionally, they were instructed to complete the same exercises at home twice per week. The home exercise program, based on the study by Gomez Garcia et al. (5), lasted 40 minutes per session and included stretching, resistance, and core exercises for the lower extremities. Patients were further advised to refrain from training for the first two weeks after diagnosis.

Outcome measures, including the Visual Analogue Scale (VAS), Tegner Activity Score, Disablement in the Physically Active Scale (DPA-TR) Short Form-10, Lower Extremity

Functional Scale, Tampa Kinesiophobia Scale, and obstacle course completion times, were recorded at baseline and after four weeks.

The **Visual Analogue Scale (VAS)** was employed to quantify subjective, non-numeric values by converting them into numerical form. The VAS consists of a 100 mm line with two extreme definitions of the parameter being assessed at either end. Patients were instructed to indicate their condition by drawing a line, placing a point, or physically pointing between the defined endpoints (23). VAS values were analyzed separately for rest, activity, and night.

The **Tegner Activity Score** was used to evaluate patients' activity levels. This scoring system ranges from 0 to 10, based on the patient's ability to perform daily life and sports activities. Scores range from 0, indicating cessation of activity due to injury or dysfunction, to 10, representing professional sports participation at the national team level (24).

The **Disablement in the Physically Active (DPA) Short Form-10** was used to assess physical activity limitations in patients post-injury. The Turkish validity and reliability of the scale have been established (DPA-TR Short Form-10) (25). This scale consists of ten questions divided into three sub-dimensions, with responses scored on a five-point Likert scale. The sub-dimension scores are summed to calculate the total score, which ranges from a minimum of 10 to a maximum of 50. Higher scores indicate greater physical activity limitation.

The Lower Extremity Functional Scale (LEFS) is a 20-item questionnaire designed to assess lower extremity function in patients. Each item is scored on a four-point Likert scale, with total scores ranging from 0 to 80. Higher scores indicate minimal difficulty with lower extremity activities, reflecting better functional status. The Turkish version of the scale has been validated and shown to be reliable (26).

The Tampa Kinesiophobia Scale (TKS) consists of 17 questions aimed at quantifying fear of movement or injury. It evaluates concerns related to injury/re-injury and fear-avoidance behaviors, particularly in work-related tasks. A higher score corresponds to greater fear of movement. The Turkish version of the scale has been validated for reliability (27).

The Obstacle Course is a standardized physical performance test commonly used in our country to assess the physical requirements for certain occupations. It evaluates agility, strength, and endurance through a series of tasks, which participants complete in sequence: Start; 2.5 m run, jump; 2 m double-foot jump onto a gymnastic board, run; 3 m, overrun; 2 m obstacle crossing, run; 3 m, weight carry; 16 m, run; 2.5 m, medicine ball touch; 9 m, completing three touches per lap, run; 2.5 m, somersault: 2 m, run: 4 m, slalom running; 6.5 m, run; 3 m, over and under obstacles; 8 m, run; 3.5 m and finish.

The Obstacle Course Completion Time serves as a performance measure. For healthy individuals, women are expected to complete the course within 50 seconds, and men within 48 seconds. Athletes with MTSS are typically unable to meet these benchmarks and require longer completion times.

Statistical Analysis

Data analysis was performed using SPSS version 23.0. Descriptive statistics were presented as frequencies and percentages for categorical variables, and as mean, standard deviation, minimum and maximum values for numerical variables. The independent samples t-test was used to compare two groups, and the paired t-test was used to compare pre- and post-treatment scores. Statistical significance was set at $p<0.05$.

RESULTS

A total of 56 participants were enrolled in the study. The mean age was 23.2±4.823.2±4.8 years (range: 18-40), and the mean BMI was 23.2±2.923.2±2.9 (range: 19-35). The demographics of the participants are summarized in **Table 1**. No significant differences were observed between the pre-treatment groups for any parameters except for the resting VAS. Statistically significant improvements were identified within both the ESWT and electrotherapy groups when comparing pre- and post-treatment outcomes. The parameter values within each group are presented in **Table 2**. However, no significant differences were noted in the comparison between the two groups after treatment. The inter-group parameter values are detailed in **Table 3**.

Table 1. Demographics of the patients

		All N	All %	ESWTGroup N	ElectrotherapyGroup N	*P*Value
Groups	ESWT Group	31	55.4	31	-	
	ElectrotherapyGroup	25	44.6	-	25	
Age		23.2±4.8		23.3±4.7	23.0±5.0	0.768
BMI		23.2±2.9		24.1±3.3	22.9±2.1	0.116
Injured side	Right	26	46.4	15	11	0.743
	Left	30	53.6	16	14	
Dominant side	Right	48	85.7	28	20	0.272
	Left	8	14.3	3	5	
Gender	Male	33	58.9	20	13	0.344
	Female	23	41.1	11	12	
Duration of complaints (week)		20.2±25.8		17.5±18.7	23.6±32.6	0.385
Tegner		7.3±1.5		7.5±1.4	7.2±1.6	0.511

Table 2. The values of the parameters in groups

	ESWT Group		*P*Value	Electrotherapy Group		*P*Value
	Before	After		Before	After	
OCT	46.3±3.6	43.9±2.8	<0.001	47.1±3.5	45.4±3.3	<0.001
Rest VAS	2.6±2.7	0.2±0.9	<0.001	4.2±2.6	0.3±0.6	<0.001
Activity VAS	7.6±1.6	2.9±1.8	<0.001	7.7±1.9	3.3±2.0	<0.001
Night VAS	1.5±2.3	0.2±0.8	<0.001	1.5±2.6	0.3±0.9	0.010
LEFS	52.5±14.0	69.1±10.2	<0.001	51.2±11.7	68.8±9.2	<0.001
DPA-TR	33.0±13.8	20.4±9.1	<0.001	32.8±10.0	23.5±8.3	<0.001
Tampa	40.3±6.4	36.6±7.9	0.003	41.5±5.5	40.0±5.6	0.151

OCT: Obstacle course completion times; VAS: Visual Analogue Scale; LEFS: Lower Extremity Functional Scale; DPA-TR: Disablement in the Physically Active Scale Short Form-10; Tampa: Tampa Kinesiophobia Scale

Table 3. The values of the parameters between the groups

Parameters	Treatment Time	All	ESWT Group	Electrotherapy Group	*P*Value
OCT	Before	46.7±3.5	46.3±3.6	47.1±3.5	0.428
	After	44.6±3.1	43.9±2.8	45.4±3.3	0.075
Rest VAS	Before	3.3±2.8	2.6±2.7	4.2±2.6	0.034*
	After	0.3±0.8	0.2±0.9	0.3±0.6	0.896
Activity VAS	Before	7.6±1.7	7.6±1.6	7.7±1.9	0.876
	After	3.1±1.9	2.9±1.8	3.3±2.0	0.473
Night VAS	Before	1.5±2.4	1.5±2.3	1.5±2.6	0.976
	After	0.3±0.8	0.2±0.8	0.3±0.9	0.765
LEFS	Before	51.9±13.0	52.5±14.0	51.2±11.7	0.704
	After	69.0±9.7	69.1±10.2	68.8±9.2	0.915
DPA-TR	Before	32.9±12.2	33.0±13.8	32.8±10.0	0.956
	After	21.8±8.8	20.4±9.1	23.5±8.3	0.196
Tampa	Before	40.8±6.0	40.3±6.4	41.5±5.5	0.490
	After	38.1±7.1	36.6±7.9	40.0±5.6	0.740

OCT: Obstacle course completion times; VAS: Visual Analogue Scale; LEFS: Lower Extremity Functional Scale; DPA-TR: Disablement in the Physically Active Scale Short Form-10; Tampa: Tampa Kinesiophobia Scale. p value refers to the data analysis between the groups. * is used to show that it is statistically significant.

DISCUSSION

This study demonstrated the efficacy of two different conservative treatments for medial tibial stress syndrome (MTSS) in two groups of patients with comparable baseline characteristics. The findings indicated that both extracorporeal shockwave therapy (ESWT) and electrotherapy, combined with an exercise program, resulted in similar levels of improvement.

Extracorporeal shockwave therapy (ESWT) is a conservative approach for managing MTSS, though it is not typically considered a primary treatment option. A study by Gomez Garcia et al. evaluated the effectiveness of ESWT in reducing pain and accelerating recovery in MTSS (5). In this study, 42 military students with MTSS were randomly assigned to two groups. Both groups followed the same exercise program, but one group (n=23) received focused electromagnetic ESWT in a single session. Outcomes were measured using asymptomatic running test time, post-run VAS scores, and modified Roles and Maudsley scores, assessed four weeks after baseline. The results demonstrated that a single ESWT session, when combined with an exercise program, expedited both clinical and functional recovery. In contrast, the present study applied radial ESWT over four sessions and compared its effects with those of electrotherapy. Consistency in the exercise program and ESWT dose planning was maintained throughout the study.

Previous studies, including those by Rompe et al. and Moen et al., have also reported positive outcomes with ESWT for MTSS, though findings have been inconsistent across the literature. For instance, Rompe et al. investigated low-energy radial ESWT in 47 patients with MTSS, comparing it to exercise-only treatment in another 47 patients. Improvements were assessed using a six-point Likert scale. The results indicated that radial ESWT combined with exercise was an effective treatment for MTSS (18). Similarly, Moen et al. evaluated the effectiveness of focused ESWT in a cohort of 22 patients with MTSS, compared to 20 patients who followed a graded running program alone. ESWT was administered over five sessions across nine weeks, with progressively increasing dosages. The study concluded that ESWT provided additional benefits when combined with the running program. However, contrasting findings have also been reported. Newman et al.'s study on ESWT concluded that it did not demonstrate significant benefits for MTSS (6,17).

The results demonstrated that the group receiving ESWT achieved faster complete recovery compared to the electrotherapy group (17). In Newman et al.'s study, one group (n=12) received the standard ESWT dose used in Moen et al.'s research, while another group (n=12) received a low-dose ESWT as a control. Both groups exhibited similar outcomes in terms of pain and running distance, leading the authors to conclude that ESWT was ineffective for treating MTSS (6). However, it could be argued that using low-dose ESWT as the control treatment might have served as a sham intervention. Notably, this trial did not include an exercise program for participants. Studies demonstrating the effectiveness of ESWT, including ours, consistently incorporated exercise programs alongside ESWT. This suggests that ESWT alone may not be sufficient for treating MTSS; its efficacy appears to be enhanced when combined with exercise.

While multiple sessions of ESWT have shown efficacy in several studies, other research suggests that even a single ESWT session, when combined with an exercise program, can accelerate recovery from MTSS (5). Healing and regeneration rates are influenced by numerous factors and can vary significantly among individuals (15). In Garcia et al.'s study, the mean participant age was 20.0±0.220.0±0.2 years, which may have contributed to the positive outcomes from a single-dose ESWT treatment (5). Additionally, the variability in individual healing responses makes achieving standardization for ESWT challenging.

MTSS often results from overuse, improper training techniques, foot structure changes, or inadequate sports footwear. Managing the condition may require reducing training intensity, adjusting training methods, and, in some cases, advising rest. Addressing these underlying causes and implementing appropriate modifications are crucial for effective management (2,12). Moreover, patient compliance and engagement are as vital as the treatment itself in achieving successful outcomes.

This study had certain limitations. One limitation was the absence of a validated Turkish version of the MTSS-specific questionnaire. As a result, alternative lower extremity questionnaires were utilized. Additionally, while the Tegner Activity Level Scale was employed to measure activity levels, its Turkish validity and reliability have not been established, though it remains widely used in research. The lack of a stand-alone exercise group in the study design could also be considered a limitation. However, similar exercise-only interventions have been reported in the literature. A key strength of this study was the large cohort of MTSS patients recruited from the same obstacle course activity, which enabled the use of obstacle course completion time as an objective and standardized performance measure. Furthermore, patient compliance and engagement were high, driven by the participants' urgent need for a swift recovery.

CONCLUSION

ESWT and electrotherapy, when combined with exercise, were found to have similar effectiveness in the treatment of MTSS. However, further research involving larger patient cohorts is required to confirm these findings and explore potential differences.

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Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from local clinical research ethics committee of Gulhane Education and Research Hospital, Ankara, Türkiye (Date: 05/07/2023, Number: 2023/160).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Consept- AO; Design - AO; Supervison –GB; Materials–AO,BA,TK Data Collection and/or Processing – HG,BK,TK,BA; Analysis and İnterpretation – GB; Literature Review – HG,BK; Writing manuscript – AO ; Critical Reviews – HG,BK. All authors contributed to the final version of the manuscript and discussed the results and contributed to the final manuscript.

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