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ARAŞTIRMA / RESEARCH

Ankle isokinetic muscle strength and navicular drop in athletes with medial tibial stress syndrome

Medial tibial stres sendromlu sporcularda ayak bileği izokinetik kas kuvveti ve naviküler çökme miktarı

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Abstract

Purpose: The purpose of this study is to compare some anatomical features and ankle isokinetic muscle strength of adolescent athletes with medial tibial stress syndrome (MTSS) and healthy control group and to examine the adequacy of 'tibial facial traction theory in the development of MTSS.

Materials and Methods: Adolescent athletes who had been diagnosed with MTSS during the season and healthy control group participants were included in the study. Demographic data and training details of the athletes were recorded. The MTSS score was used to determine the severity of the injury. The navicular drop test, lower extremity length measurement, and isokinetic muscle strength measurement were performed.

Results: The complaint duration of the patients with MTSS (n:21) was 1.8 ± 1.8 months and the MTSS score was 3.9 ± 2.2. The control group (n:12) and the athletes diagnosed with MTSS had similar demographic characteristics and training details. There was no difference between the groups in terms of navicular drop and lower extremity length. There was no 'lower extremity difference' for right and left extremities. According to the results of the isokinetic muscle strength test in plantarflexion and dorsiflexion direction, there was no difference between the groups in terms of muscle strength at both low and high angular speeds.

Conclusion: 'The tibial traction theory' does not sufficiently explain the pathogenesis of MTSS. Studies which evaluate isokinetic muscle strength and perform real-time dynamic analysis on the track are required to make recommendations for ideal protection and rehabilitation in cases of MTSS.

Keywords: Medial tibial stress syndrome, muscle strength, navicular drop.

Öz

Amaç: Bu çalışmanın amacı, medial tibial stres sendromu (MTSS) gelişen adolesan sporcular ile sağlıklı kontrol grubunun bazı anatomik özelliklerini ve ayak bileği izokinetik kas kuvvetini karşılaştırmaktır. MTSS gelişiminde 'Tibial fasial-traksiyon teorisi'nin yeterliliğini incelemektir.

Gereç ve Yöntem: Bir sezonluk süre içerisinde MTSS tanısı alan adolesan sporcular ve sağlıklı kontrol grubu araştırmaya alındı. Sporculara ait demografik veriler ve antrenman detayları kaydedildi. Hastalık şiddetini belirlemek için MTSS şiddet skoru kullanıldı. Sporculara naviküler çökme testi, alt ekstremite uzunluk ölçümü ve izokinetik kas kuvvet ölçümü yapıldı.

Bulgular: MTSS tanısı alan (n:21) hastaların şikayet süresi 1.8 ± 1.8 ay, MTSS şiddet skoru 3.9 ± 2.2 puandı. Kontrol grubu (n:12) ile MTSS tanısı alan sporcuların demografik verileri ve antrenman detayları benzerdi. Naviküler çökme miktarı ve alt ekstremite uzunluğu gruplar arasında fark oluşturmadı. Sağ ve sol ekstremite için 'alt ekstremite uzunluk farkı' yoktu. Plantarfleksiyon ve dorsifleksiyon yönündeki izokinetik kas kuvvet testinin sonuçlarına göre hem düşük açısal hızda hem de yüksek açısal hızda gruplar arasında kas kuvveti açısından fark belirlenmedi.

Sonuç: 'Tibial fasial-traksiyon teorisi' MTSS patogenezini açıklamakta yetersizdir. MTSS vakalarında, ideal düzeyde koruma ve rehabilitasyon önerilerde bulunmak için izokinetik kas kuvvetinin değerlendirildiği ve koşu alanında gerçek zamanlı dinamik analizlerin yapıldığı çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Medial tibial stress sendromu, kas kuvveti, naviküler çökme.

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INTRODUCTION

Medial tibial stress syndrome (MTSS) is most commonly seen in active individuals, athletes and military personnel[1]. While this condition mostly affects track and field athletes, athletes who practice sports that involve ballistic movements such as basketball, dance, or tennis are also under risk[2]. Patients complain about diffuse, activity-related pain at the border of posteromedial tibia[1]. Although the actual prevalence of MTSS is unknown, study results vary from 6% to 16%[3,4]. The incidence rate of MTSS among adolescent runners is 15.2% during the 13-week season and 43.6% within a three-year period[5]. It takes 44-78 days for athletes to return to their previous performance after the onset of complaints[5]. Considering the time lost during the season, this syndrome is a condition which needs to be treated and from which athletes should be protected[5].

Several studies in the literature have attempted to define intrinsic and extrinsic risk factors for the syndrome and suggest protection measures and treatments. Extrinsic risk factors include sports-related factors, equipment, training area, and weather conditions[3]. Intrinsic risk factors include age, sex, height, body weight, body fat ratio, physical defects/anatomical variation (femoral neck anteversion, genu valgum, pes cavus, hyperpronation, joint laxity, uneven leg length), physical fitness level (aerobic endurance, fatigue, flexor-extensor muscle strength and balance, muscle/joint flexibility, athletic ability/coordination), and physiological factors[3,4,6]. In spite of identified risk factors, there is insufficient knowledge about the pathogenesis of this condition[3,4].

One of the popular theories suggested for this condition is The tibial traction theory' which focuses on 'excessive navicular drop' and 'plantar flexor abnormality'. 'Excessive navicular drop' is believed to cause traction force while running and pose an intrinsic risk for the development of MTSS. In addition, muscle activation or muscle contraction in the plantarflexion direction provide a basis for the pronounced effect of traction forces on the connective tissue[7]. According to tibial traction theory, these two factors may cause traction force on the tibial periosteum[7]. Increased elongation stress at soleus, flexor digitorum longus and tibialis posterior tendons in cadaver studies supports this theory[8].

A small number of researchers in the literature have examined adolescent athletes diagnosed with MTSS[6,9,10] and used isokinetic muscle strength tests [11,12] which are the golden standard in assessment of muscle strength. The purpose of this study is to compare some anatomical features and ankle plantarflexion-dorsiflexion isokinetic muscle strength of adolescent athletes with MTSS and healthy control group.

MATERIALS AND METHODS

Athletes between the ages of 12-17 who applied to the sports medicine clinic with tibial pain were examined by a sports medicine specialist. Athletes with pain triggered by exercise in 2/3rd distal portion of the tibia, sensitivity to palpation in at least a 5 cm region 2/3rd distal portion of the posteromedial tibia, positive 'one leg hop' test, no trauma to the tibia within the last week, and no additional pathologies were diagnosed with MTSS [13]. Patients who had complaints related to medial tibial stress syndrome for at least a month, did not have any systemic disease, did not have a ligament pathology at the knee, did not undergo lower extremity surgery, did not have lower extremity fracture, and did not have any neurological and vascular pathologies were included in the study. Patients who received physical therapy within the last six months, used analgesics within the last month, had an inflammatory disease and back pain were excluded.

The control group consisted of athletes between the ages of 12-17, exercised regularly (at least 4,5 hours/week), had no active complaints, were not previously diagnosed with MTSS, did not have a history of lower extremity surgery, did not have a history of ligament injury or lower extremity fracture.

Demographic data and training details of the athletes were recorded. The medial tibial stress syndrome score was used to determine the severity of the injury for the athletes with MTSS. The navicular drop test, lower extremity length measurement, and isokinetic muscle strength measurement were performed.

Measures

Medial tibial stress syndrome score

The scoring system developed by Winters et al. was used to determine the severity of the medial tibial stress syndrome. The patients were asked to score their limitation in sporting activities (0-3 points), pain while performing sporting activities (0-3 points), pain while performing activities of daily living (0-2 points), and pain at rest (0-2 points). Patients with bilateral complaint were asked to perform the scoring for the extremity causing more complaints. The scoring was assessed out of 10 points in total [14].

'Navicular Drop Test'

Firstly, the most prominent aspect of the navicular tubercle was marked with a fine-tip pen in sitting position with the participant barefoot. Then, the participant was asked to stand up while maintaining the subtalar neutral position. The distance (mm) between the navicular tubercle and the floor was measured in both sitting and standing positions. The difference between the two measurements was recorded as the 'navicular drop' [2].

Lower Extremity Length Measurement

To measure the lower extremity length, the participant was asked to lie down in supine position with feet open at shoulder width. The distance (cm) between the most prominent points of the spina iliaca anterior superior and ipsilateral medial malleolus was measured with a measuring tape for both extremities. The difference between the right extremity and the left extremity was recorded as the lower extremity length difference [15].

Isokinetic test protocol

The muscle strength was measured after a 10-minute warm-up and stretching. The ankle muscle strength was measured with the participant in prone position after adjusting the angle according to the operating manual of the isokinetic dynamometer (ISOMED 2000, D & R Ferstl GmbH, Germany). The device was calibrated prior to each test. The test was performed in the plantarflexion-dorsiflexion direction and the concentric-concentric mode. Prior to the test, the participant was asked to perform two trials for both angular speeds to adapt to the device. The test protocol was applied at angular speeds of 60°/s (5 repetitions) - 120°/s (15 repetitions), [12]. The participant was verbally encouraged during the test. Parameters of peak torque, peak work, and total work were used in analysis.

This prospective study was approved by the Local Ethics Committee (with decision no. 2017/421 on 26 December 2017). The consent of the participants and their families was received after providing information about the study.

Statistical analysis

Statistical analysis was performed with SPSS for Windows version 22.0. The normality of distribution of continuous variables was tested by Shaphiro Wilk test. Mann Whitney U test was used to compare for non-normal data. Independent t-test was used to compare for normal data. Results for continuous variables were given as median ± standard error or mean ± standard deviation. P value < 0.05 was accepted as statistically significant.

RESULTS

21 (7 females, 14 males) patients were diagnosed with MTSS as a result of the one-season follow-up, 20 track and field athletes and 1 football player. The syndrome involved both extremities in 14 cases, the right extremity in 4 cases, and the left extremity in 3 cases. 26 (74%) athletes with MTSS were diagnosed for the first time. The complaint duration was found to be 1.8 ± 1.8 months and the MTSS score was 3.9 ± 2.2.

All of the 12 (2 females, 10 males) participants in the control group were track and field athletes. There was no difference between the groups in terms of demographic characteristics and training details (p> 0.05), (Table 1). There was no difference between the groups in terms of navicular drop and lower extremity length measured during the clinical examination (p> 0.05). Although a statistically significant difference was found between the groups in terms of 'lower extremity difference', it disappeared once the data of right and left extremities was analyzed separately (Table 2).

Table 1. Demographic data

	MTSS group (n=21)	Control group (n=12)	*p value*
Age (years)	17 ± 0.3	15 ± 0.3	0.06
Height (cm)	170.5 ± 7.6	167.9 ± 10.6	0.4
Body weight (kg)	57.6 ± 8	53.2 ± 9.5	0.2
Body mass index (kg/m^2)	19.8 ± 2.3	18.7 ± 1.6	0.1
Training time (years)	2.5 ± 0.4	2 ± 0.2	0.2
Yearly training sessions (months)	11 ± 0.4	11 ± 0.1	0.6
Weekly training sessions (hours)	12 ± 0.8	12 ± 0.4	0.3

Table 2. Clinical data

	MTSS group (n=35)	Control group (n=24)	*p value*
Shoe size	40.6 ± 2.1	40.1 ± 2.2	0.7
Navicular drop (mm)	5 ± 0.4	5 ± 0.4	0.4
Lower extremity length (cm)	89 ± 5.2	87.3 ± 4.3	0.5
Lower extremity length discrepancy (cm)	0.3 ± 0.1	0.1 ± 0.1	0.03*
Right (n=18; n=12)	0.3 ± 0.1	0.08 ± 0.08	0.2
Left (n=17; n=12)	0.2 ± 0.1	0.08 ± 0.08	0.4

*: statistically significant at level p< 0.05.

Table 3. Isokinetic muscle strength test data

		MTSS group (n=35)	Control group (n=24)	*p value*
@ 60 °/sec	PF PT (Nm)	71.8 ± 27.8	68.4 ± 17.2	0.6
	PF PW (J)	40.9 ± 16.4	37.2 ± 10.6	0.3
	PF TW (J)	181.3 ± 77.6	166 ± 52	0.4
	DF PT (Nm)	24 ± 2.1	24.5 ± 1.8	0.8
	DF PW (J)	13 ± 1.5	13 ± 1.3	0.5
	DF TW (J)	64 ± 7.1	64.5 ± 6.2	0.5
	Ratio TWD DF/PF (%)	41 ± 4.1	34.5 ± 6.4	0.5
@ 120 °/sec	PF PT (Nm)	59.2 ± 24.4	63.1 ± 20.2	0.5
	PF PW (J)	35.1 ± 13.9	35.9 ± 11.5	0.8
	PF TW (J)	431.6 ± 181.1	452 ± 143.6	0.6
	DF PT (Nm)	21 ± 1.8	21 ± 1.6	0.6
	DF PW (J)	12 ± 1.3	12.5 ± 1.2	0.7
	DF TW (J)	144 ± 18.2	144.5 ± 16.5	0.8
	Ratio TWD DF/PF (%)	39 ± 4.8	28 ± 6.4	0.5

PF: Plantarflexion, DF: Dorsiflexion, PT: peak torque, PW: peak work, TW: total work, Nm: Newton metre, J: Joule, sec: second.

According to the results of the isokinetic muscle strength test in plantarflexion and dorsiflexion direction, there was no difference between the groups in terms of muscle strength at both low and high angular speeds (p> 0.05), (Table 3).

DISCUSSION

In this study, adolescent athletes with MTSS were found to have similar lower extremity length, navicular drop, and ankle isokinetic plantarflexion-dorsiflexion muscle strength with healthy athletes.

MTSS has been the subject of many studies since it was first described. Researchers have tried to identify factors associated with MTSS and normalization values of these factors. Studies have shown that ‘the variable drop test’, which evaluates the medial longitudinal arch function to determine navicular drop which is assumed to be involved in the development of MTSS, is not affected by variables such as age, sex, or body mass index. However, the usual navicular drop is approximately 5 mm and the increase in foot length has been found to cause increased navicular drop [16]. For this reason, we recorded shoe sizes of the athletes as an indirect indicator of the foot length. Similar to navicular drop, this parameter did not show a significant difference between the groups as a result of our analysis.

Studies in the literature have tried to clarify the causes of this sports injury with multiple factors. However, it is difficult to say that there is a consensus between researchers [3]. For example, Burne et al. followed military personnel for 1 year and found that 23 had ‘exercise-related medial tibial pain’ complaints. Those with and without ‘exercise-related medial tibial pain’ complaints were found to be similar in terms of demographic characteristics, body features (body weight, BMI), training level, lower extremity length difference, and ankle joint movement range. Although women are at greater risk of MTSS, female sex could not be described as an intrinsic risk factor. It has been found that men have greater hip rotation and lower lean calf girth, which is an indirect indication of lower leg muscle strength [15]. Garnock et al. reported that female sex, MTSS history, and increased external rotation of the hip caused increased risk of MTSS development, while navicular drop was not found to be related with MTSS risk for military personnel [17]. The small number of female participants in our study limited our opportunity to perform a group analysis by sex and evaluate the effect of sex. However, our results related to navicular drop were similar to those of both researchers mentioned above.

Bennett et al. found that athletes with 'exercise-related leg pain' had higher navicular drop and the MTSS risk increased by 7-fold when the navicular drop was more than 10 mm. Bennett et al. assessed the ankle muscle strength endurance using 'the heel-rise test' and found no difference between the groups in terms of plantarflexion endurance [18]. Contrary to Bennett's findings, Madeley et al. reported lower isotonic plantarflexion endurance of the ankle joint in cases diagnosed with MTSS [19].

Bartosik et al. examined anatomical and biomechanical features of 14 MTSS cases using both static and dynamic measurement methods. With the exception of gait velocity, the researchers found no difference between the MTSS group and the control group in terms of other parameters such as activity level, leg length, foot arch height, and ankle joint movement range. In Bartosik's study, the lower extremity length difference was 0.09 cm for the control group, while it was found to be 0.25 cm for the MTSS group (p:0.51) [4]. Mitchell found a lower extremity length difference of more than 0.5 cm in 20% of adolescent track and field athletes; however, the author reported that a difference of this magnitude was not associated with running-related injuries [6]. Although there was a statistically significant difference between the groups in terms of lower extremity length difference, this difference disappeared once the data of right and left extremities was analyzed separately. The disappearance of the statistically significant difference may be related to the small number of participants. Therefore, it is difficult to say that lower extremity length difference causes a susceptibility to MTSS.

Hubbard et al. determined foot and ankle joint movement range, isometric ankle muscle strength (in flexion, extension, inversion, eversion directions) and navicular drop for athletes prior to the season and followed the participants throughout the season. No difference was found between 29 cases diagnosed with MTSS during the season and healthy athletes in terms of isometric ankle muscle strength and navicular drop [2]. Ghelnes et al. reported that cases with shin splint complaints experienced more angular displacement at the calcaneus and the midline of the lower leg while running. Also, cases diagnosed with shin splint were found to have higher isometric plantarflexion muscle strength than the control group. There was no difference in terms of dorsiflexion, inversion, and eversion muscle strength values [20]. Saeki et al. reported no difference between athletes with MTSS history and healthy athletes in terms of 2nd–5th metatarsophalangeal joint isometric plantarflexion muscle strength. However, athletes with MTSS history were found to have higher 1st metatarsophalangeal joint plantarflexion strength [5].

To the best of our knowledge, the only study in the literature that assesses the ankle muscle strength in cases diagnosed with MTSS with an isokinetic test system, which is the golden standard, belongs to Yuksel et al. According to the results of this study, the eversion concentric muscle strength and the inversion/eversion ratio were higher in the MTSS group. However, there was no difference between the groups in terms of medial longitudinal arch deformity and navicular drop [11].

Our limitations include the fact that our study covered only a season, included a small number of athletes, and was performed in a single center. Although a specific age group was evaluated and the muscle strength was measured with the isokinetic test method, our analysis was performed under clinical conditions and using static methods, which are other limitations of our study.

In conclusion, there is no consensus regarding the anatomical features and muscle strength of athletes diagnosed with MTSS. Our knowledge about adolescent athletes is even more limited. This research data that we obtained shows that 'The tibial traction theory' does not sufficiently explain the pathogenesis of MTSS. Studies which evaluate isokinetic muscle strength and perform real-time dynamic analysis on the track are required to explain the pathogenesis of MTSS make recommendations for ideal protection and rehabilitation.

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REFERENCES

1. Reinking MF, Austin TM, Richter RR, Krieger MM. Medial tibial stress syndrome in active individuals: a systematic review and meta-analysis of risk factors. Sports Health. 2017;9:252-61.
2. Hubbard TJ, Carpenter EM, Cordova ML. Contributing factors to medial tibial stress syndrome: a prospective investigation. Med Sci Sports Exerc. 2009;41:490-6.
3. Thacker SB, Gilchrist J, Stroup DF, Kimsey CD. The prevention of shin splints in sports: a systematic review of literature. Med Sci Sports Exerc. 2002;34:32-40.
4. Bartosik KE, Sitler M, Hillstrom HJ, Palamarchuk H, Huxel K, Kim E. Anatomical and biomechanical assessments of medial tibial stress syndrome. J Am Podiatr Med Assoc. 2010;100:121-32.
5. Saeki J, Nakamura M, Nakao S, Fujita K, Yanase K, Morishita K, et al. Ankle and toe muscle strength characteristics in runners with a history of medial tibial stress syndrome. J Foot Ankle Res. 2017;10:16.
6. Rauh MJ. Leg-length inequality and running-related injury among high school runners. Int J Sports Phys Ther. 2018;13:643-51.
7. Noh B. Medial tibial stress syndrome: focused on tibial fascial-traction theory and prevention strategies. Asian J Kinesiol. 2018;20:38-42.
8. Bouche RT, Johnson CH. Medial tibial stress syndrome (Tibial fasciitis) A proposed pathomechanical model involving fascial traction. J Am Podiatr Med Assoc. 2007;97:31-6.
9. Luedke LE, Heiderscheit BC, Williams DB, Rauh MJ. Association of isometric strength of hip and knee muscles with injury risk in high school cross country runners. Int J Sports Phys Ther. 2015;10:868.
10. Lachniet PB, Taylor-Haas JA, Paterno MV, DiCesare CA, Ford KR. Altered sagittal plane hip biomechanics in adolescent male distance runners with a history of lower extremity injury. Int J Sports Phys Ther. 2018;13:441.
11. Yüksel O, Özgürbüz C, Ergün M, İşlegen Ç, Taskiran E, Denerel N, et al. Inversion/eversion strength dysbalance in patients with medial tibial stress syndrome. J Sports Sci Med. 2011;10:737.
12. Fourchet F, Kelly L, Horobeanu C, Loepelt H, Taiar R, Millet G. High-intensity running and plantar-flexor fatigability and plantar-pressure distribution in adolescent runners. J Athl Train. 2015;50:117-25.
13. Verrelst R, Willems TM, De Clercq D, Roosen P, Goossens L, Witvrouw E. The role of hip abductor and external rotator muscle strength in the development of exertional medial tibial pain: a prospective study. Br J Sports Med. 2014;48:1564-9.
14. Winters M, Moen MH, Zimmermann WO, Lindeboom R, Weir A, Backx FJ et al. The medial tibial stress syndrome score: a new patient-reported outcome measure. Br J Sports Med. 2016;50:1192–9.
15. Burne SG, Khan KM, Boudville PB, Mallet RJ, Newman PM, Steinman LJ, et al. Risk factors associated with exertional medial tibial pain: a 12 month prospective clinical study. Br J Sports Med. 2004;38:441-5.
16. Nielsen RG, Rathleff MS, Simonsen OH, Langberg H. Determination of normal values for navicular drop during walking: a new model correcting for foot length and gender. J Foot Ankle Res. 2009;2:12.
17. Garnock C, Witchalls J, Newman P. Predicting individual risk for medial tibial stress syndrome in navy recruits. J Sci Med Sport. 2018;21:586-90.
18. Bennett JE, Reinking MF, Rauh MJ. The relationship between isotonic plantar flexor endurance, navicular drop, and exercise-related leg pain in a cohort of collegiate cross-country runners. Int J Sports Phys Ther. 2012;7:267-78.
19. Madeley LT, Munteanu SE, Bonanno DR. Endurance of the ankle joint plantar flexor muscles in athletes with medial tibial stress syndrome: a case-control study. J Sci Med Sport. 2007;10:356-62.
20. Gehlsen GM, Seger A. Selected measures of angular displacement, strength, and flexibility in subjects with and without shin splints. Res Q Exerc Sport. 1980;51:478-85.