Annals of Clinical and Analytical Medicine
Original Research

Analysis of navicular drop test values of patients with plantar fasciitis

Navicular drop test in plantar fasciitis

Rumeysa Dikici[1], İsmihan İlknur Uysal[2], Ali Yavuz Karahan[3], Zeliha Fazlıoğulları[4]
[1] Department of Anatomy, Faculty of Medicine, Alanya Alaaddin Keykubat University, Antalya
[2] Department of Anatomy, Faculty of Medicine, Necmettin Erbakan University, Konya
[3] Department of Physical Therapy and Rehabilitation, Faculty of Medicine, Uşak University, Uşak
[4] Department of Anatomy, Faculty of Medicine, Selçuk University, Konya, Turkey

Abstract
Aim: The aim of this study is to investigate the usability of navicular drop test (NDT) in the diagnosis of plantar fasciitis (PFs).
Material and Methods: Fifty patients aged 35-60 years who were diagnosed with PF in the physical therapy clinic and 50 healthy participants in the same age range were included in this study. Age, height, weight, dominant lower extremity of all participants were determined and body mass index was calculated. The navicular drop test measurements of all participants were performed. Data were compared between the two groups.
Results: The body mass index (BMI) in the PFs group was statistically significantly higher than in the control group ($p<0.05$). The right foot was dominant (93%) in both groups and PFs was more common on the right side in the patient group ($p<0,05$). The NDT data were statistically significantly higher in the PFs group on the right and left sides.
Discussion: Besides the fact that BMI is an important risk factor for the formation of PF, an increase in the amount of displacement in the navicular tubercle due to overloading of the extremity may further increase this risk. We believe that the diagnosis of PFs can be supported by NDT in physical examination.

Keywords
Navicular Drop Test, Plantar Fasciitis, Medial Longitudinal Arch, Foot Posture

DOI: 10.4328/ACAM.21253 Received: 2022-05-31 Accepted: 2022-07-15 Published Online: 2022-07-20 Printed: 2022-11-01 Ann Clin Anal Med 2022;13(11):1210-1213
Corresponding Author: Rumeysa Dikici, Department of Anatomy, Faculty of Medicine, Alanya Alaaddin Keykubat University, Antalya, Turkey.
E-mail: rumeysa.dikici@alanya.edu.tr P: +90 545 553 32 06
Corresponding Author ORCID ID: https://orcid.org/0000-0003-3144-8740

Introduction

The calcaneus and navicular bones are keystones in foot biomechanics. The tendon of the posterior tibial muscle, a dynamic stabilizer of the medial longitudinal arch, inserts into the navicular tuberosity [1,2]. The plantar fascia, which is a passive stabilizer that supports the arches of the feet, attaches to the medial tubercle of the calcaneus [3]. Repetitive stress/traction exerted by the plantar fascia on the calcaneus is hypothesized to be one of the possible causes of the calcaneal spur [4]. PFs is the most common cause of heel pain in adults [5]. This chronic degenerative process results from micro-tears in the calcaneal junction as a result of biomechanical overuse resulting from prolonged standing or running [6].

The relationship between the tension of the plantar fascia and the height of the arch of the foot is known. Therefore, it is recommended to investigate the relationship between PFs and the position of the navicular bone, which affects the medial longitudinal arch of the foot and thus the tension of the plantar fascia [5]. First described in 1982, NDT is the most widely used clinical test to examine the medial longitudinal arch [7]. This test is used to measure how much the navicular tuberosity height changes position with foot load. The difference between the navicular tubercle height, measured in the sitting position, and the navicular tubercle height measured when the foot is fully loaded on one leg is calculated [8].

This study aims to obtain the NDT data of patients with PFs and individuals who have no complaints in the foot region and to investigate the usability of this test in the diagnosis of PFs.

Material and Methods

This study is a master thesis project. The study protocol was made on the principles of the Declaration of Helsinki and was approved by the Selçuk University Clinical Research Ethics Committee (approval number, 2014/311). At the beginning of the study, all participants were informed and a consent form was filled out.

Two groups were determined according to the physical examination and foot radiographs of the patients who applied to the physical therapy and rehabilitation outpatient clinic. Fifty patients aged 35-60 years who were diagnosed with PFs and 50 volunteers aged 35-60 years who applied with complaints related to upper extremities such as shoulders and elbows and had no complaints in the foot region were included in the study. The questionnaires and measurements applied to the participants were carried out by the same person in the same circumstances. Patients with ankylosing spondylitis and another known spondyloarthropathy, joint hypermobility syndrome (Beighton score 4 and above [9]), and pregnant women were excluded from the study. In addition, those who had lower extremity surgery, lower extremity length inequalities, and foot deformities such as tarsal coalition and hallux valgus were excluded from the study.

Gender, age, and foot dominance of the participants included in the study were recorded, height (meter, m), weight (kilogram, kg) measurements were made and body mass index (BMI= kg/m^2) was calculated [10].

Participants in the plantar fasciitis and control groups were divided into four groups according to body mass indexes (low<20; normal 20-25; overweight 25-30; obese 30-40). All measurements were repeated in both extremities for the patient and control groups. In the patient group, the extremities diagnosed as plantar fasciitis by the physical therapy and rehabilitation physician were also recorded as right, left, and bilateral.

For the NDT, participants were seated in a height-adjustable chair with their hips and knees at 90°. The ankle joint was fixed in the subtalar neutral position [10]. The foot was slowly turned outward until the talus was in a central position and the depressions felt under both toes were even. The navicular tuberosity was palpated approximately 2.5 cm anteroinferior to the medial malleolus tip and then marked with an erasable marker [7].

The navicular tuberosity was marked on a rigid measurement chart with the subtalar joint in neutral position. The map base was in full contact with the ground and the level where the point marked on the skin coincided with it was marked on the map. The distance from the ground to the navicular was measured by millimeters with a ruler [7].

The exact measurement was made while standing (Figure-1a), with an equal amount of body weight on each leg [10]. The navicular height difference in mm between the two points marked on the map between the sitting and standing positions represented the NDT [7,10] (Figure-1b).

This process was repeated 3 times for each participant. This method for measuring NDT has shown good reliability [7,10].

These calculated NDT values were divided into two groups as normal (10 mm ≤) and hyperpronation (>10 mm) [10].

Statistical Analysis:

Statistical analysis of the study was performed using the SPSS program, and a p-value of <0.05 was considered significant. Data were summarized as mean ± standard deviation and percentage, and the chi-square test was used to compare categorical data. Comparisons between the two groups were made using the Student's t-test (t-test for the independent group) when parametric conditions could be met, and the Mann-Whitney U test when they could not.

Results

The descriptive characteristics of the participants are given in Table-1 (Table-1). While there was no underweight person

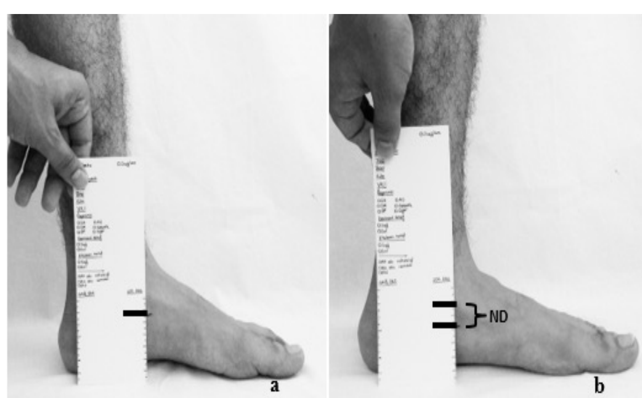

Figure 1. Measurement of navicular drop test (NDT) in the left extremity (a: measurement in the subtalar neutral position; b: standing position while weight bearing)

Table 1. Descriptive characteristics of the participants

		PFs Group	Control Group	Total	p-value
n		50	50	100	
Sex	Female	74% (37)	66% (33)	70% (70)	
	Male	26% (13)	34% (17)	30% (30)	
Age (years)		46±8 y	45±9 y	45,5±8 y	
Height (m)		1.64±0.1 m	1.64±0.1 m	1.64±0.1 m	
Weight (kg)*		79±12 kg	71±10 kg	75±12 kg	0.001
BMI*		29±4 kg/m²	27±5 kg/m²	28±5 kg/m²	0.008
Foot Dominance	Right	96% (48)	90% (45)	93% (93)	
	Left	4% (2)	10% (5)	7% (7)	
PFs sides	Right*	52% (26)			
	Left	18% (9)			0.012
	Bilateral	30% (15)			

* p<0.05, Independent T-Test and Chi-Square Test

Table 2. Navicular drop test values and comparison of PFs group and control group (Student's t-test)

	Plantar Fasciitis (50 feet)			Control (50 feet)			p-value	
	Min	Max	Mean±SD	Min	Max	Mean±SD	t	p
Right side (mm)	5	18	10±3*	3	8	5±1	10.599	0.000
Left side (mm)	4	14	8,5±3*	2	8	4±1	10.161	0.000

*: p < 0.05, Independent T-test, (Min:minimum, Max:maximum)

according to BMI in the PFs group, there were 9 normal weight individuals (18%), 21 overweight individuals (42%), and 20 obese (40%) individuals. The control group consisted of 4 underweight individuals (8%), 19 normal weight individuals (38%), 18 overweight individuals (36%), and 9 obese individuals (18%).

According to the results we obtained, when the Students t-test was performed, the weight and BMI of the individuals in the PFs group were significantly higher than in the control group (p<0.05).

According to foot dominance, 48 people (96%) in the PFs group and 45 people (90%) in the control group were statistically right dominant (p<0.05). In total, 93% were right dominant and 7% left dominant. PFs was diagnosed at a statistically significant rate (52%) on the right side (Table-1).

NDT values were statistically significantly higher in the PFs group than in the control group (p<0.05) (Table-2). As a result of NDT, hyperpronation on the right side was 50% (25 feet) and 30% (15 feet) on the left side (ND>10 mm) in the PFs group. In the control group, all participants (100%) had normal (NDT≤10 mm) values on the right and left sides. In the control group, all participants (100%) had normal (NDT≤10 mm) values for the right and left sides.

Discussion

NDT values in the PFs group were found to be significantly higher than in the control group (p<0.05). This difference suggests that the displacement of the navicular tuberosity, which increases as a result of foot overload as a natural consequence of BMI, is associated with the formation of PFs. In the literature, studies are showing that a high BMI is effective in reducing foot arch and increasing foot pronation, thus increasing the risk of PFs [6,11,12].

Prichasuk and Subhadrabadandhu [12] argued that excessive weight gain, aging, and gender might be important factors that affected the fall of the foot arch and the increase in PFs formation, and also that these factors might lead to the development of plantar heel pain.

In contrast, Menz et al. [13]. reported that there was no relation between the navicular tuberosity height and the formation of PFs. Similarly, Gill [14] observed PFs development in increased arch height. Few studies were conducted to determine the relations between foot biomechanics and PFs. Tauntan et al. [15] argued reported that 19% of patients with PFsis had abnormal arch structure, conversely, Irving et al. [15] argued that chronic plantar heel pain was not associated with the height of the arch.

The rate of increased pronation in patients with PFs is not known completely. Werner et al. [16] found the rate of increased subtalar pronation (hyperpronation) as 53% with PFs. Çınar's study [17] with 73 PFs patients found that the hyperpronation rate measured by the NDT was 34%. In this study, the rate of hyperpronation (NDT>10 mm) in the right extremity in the PFs group was 50% in the right extremity and 30% in the left extremity. The hyperpronation rate in the control group was 0%.

Rathleff et al. [18] measured dynamic NDT in healthy people as 5±2 mm during running, and static ND as 3±0.5 mm before running. Bennet et al. [19] found mean static NDT measurements of 77 healthy athletes as 8.5±4 mm on the right and 8.7±4 mm on the left. Unver and Bek [20] found static NDT measurements of 12±2 on the right and 13±2 on the left in patients with increased pronation.

In this study, NDT was determined as 10±3 mm on the right and 8.5±3 mm on the left in the plantar fasciitis group. In our study, we determined static NDT as 5±1 mm on the right side and 4±1 mm on the left side in the control group.

In the study, subtalar joint pronation was examined by performing NDT. A significant correlation was found between increased subtalar joint pronation and the incidence of PFs. These data are similar to the results of studies on PFs and healthy groups in the literature. We think that increasing BMI will increase subtalar joint pronation. We believe that this study will contribute to the clinic in the field of foot anatomy and biomechanics.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

1. Prapto D, Dreyer MA. Anatomy, Bony Pelvis and Lower Limb, Navicular Bone. Treasure Island (FL): StatPearls Publishing; 2022. p.1-18.

2. Marshall D, MacFarlane RJ, Molloy A, Mason L. A review of the management and outcomes of tarsal navicular fracture. Foot Ankle Surg. 2020; 26(5):480-6.

3. Held R, Blankstein A. Plantar Fasciitis: A Novel Crowdsourcing Approach to Data Collection and Analysis. J Musculoskeletal Res. 2021; 24(4):21-3.

4. Koh DTS, Yeo W, Koo Thein KO. Radiofrequency Plantar Fascia Coblation With and Without Gastrocnemius Recession in the Management of Recalcitrant Plantar Fasciitis Foot Ankle Int. 2022;1-7.

5. Buchanan BK, Kushner D. Plantar Fasciitis. Treasure Island (FL): StatPearls Publishing; 2022. p.1-12.

6. Marszalek R, Simon JE, Wayner R. The Effects of a 6-Week Intrinsic Foot Morphology, Kinematics, and Kinetics in Individuals with Pes Planus. J Sports Med Health Sci. 2022; 8(1):4.

7. Zuil-Escobar JC, Martínez-Cepa CB, Martín-Urrialde JA, Gómez-Conesa A. Medial Longitudinal Arch: Accuracy, Reliability, and Correlation Between Navicular Drop Test and Footprint Parameters. J Manipulative Physiol Ther. 2018; 41(8):672-9

8. Spörndly-Nees S, Dåsberg B, Nielsen RO, Boesen MI, Langberg H. The navicular position test - a reliable measure of the navicular bone position during rest and loading. Int J Sports Phys Ther. 2011; 6(3):199-205.

9. Evans AM, Rome K, Peet L. The foot posture index, ankle lunge test, Beighton scale and the lower limb assessment score in healthy children: a reliability study. J Foot Ankle Res. 2012; 5(1):1.

10. Pabón-Carrasco M, Castro-Méndez A, Vilar-Palomo S, Jiménez-Cebrián AM, García-Paya I, Palomo-Toucedo IC. Randomized Clinical Trial: The Effect of Exercise of the Intrinsic Muscle on Foot Pronation. Int J Environ Res Public Health. 2020; 7;17(13):4882.

11. Park DJ, Lee KS, Park SY. Effects of Two Foot-Ankle Interventions on Foot Structure, Function, and Balance Ability in Obese People with Pes Planus. Healthcare (Basel). 2021; 9(6):667.

12. Prichasuk S, Subhadrabandhu T. The relationship of pes planus and calcaneal spur to plantar heel pain. Clin Orthop Relat Res. 1994; (306):192-6.

13. Menz HB, Zammit GV, Landorf KB, Munteanu SE. Plantar calcaneal spurs in older people: longitudinal traction or vertical compression? J Foot Ankle Res. 2008; 1(1):7.

14. Gill LH. Plantar Fasciitis: Diagnosis and Conservative Management. J Am Acad Orthop Surg. 1997; 5(2):109-17.

15. Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD. A retrospective case-control analysis of 2002 running injuries. Br J Sports Med. 2002; 36(2):95-101.

16. Werner RA, Gell N, Hartigan A, Wiggerman N, Keyserling WM. Risk factors for plantar fasciitis among assembly plant workers. PM&R. 2010; 2(2):110-67.

17. Cinar E, Saxena S, Akkurt H, Uygur F. Extracorporeal shockwave therapy in the management of plantar fasciitis: A randomized controlled trial. The Foot. 2020; 44.

18. Rathleff MS, Nielsen RG, Kersting UG. Navicula drop test ad modum Brody: does it show how the foot moves under dynamic conditions? J Am Podiatr Med Assoc. 2012; 102(1):34-8.

19. 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(3):267-78.

20. Unver B, Bek N. Tabanlık Kullanımının Plantar Temas Alanları ve Basınç Dağılımına Etkisi (Effect of Insoles Use on Plantar Contact Areas and Pressure Distribution). Turk J Physiother Rehabil. 2014; 25(2):86-92.

How to cite this article:

Rumeysa Dikici, İsmihan İlknur Uysal, Ali Yavuz Karahan, Zeliha Fazlıoğulları. *Analysis of navicular drop test values of patients with plantar fasciitis. Ann Clin Anal Med 2022;13(11):1210-1213*