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INTRA-RATER RELIABILITY OF USING THE NAVICULAR DROP TEST FOR MEASURING FOOT PRONATION

POUZDANOST NAVIKULARNOG DROP TESTA PRI MJERENJU PRONACIJE STOPALA

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SUMMARY

The navicular drop test was used as an indicator of foot pronation. It is defined as the distance between the original height of the navicular from the floor, with the foot on the floor in sitting in the subtalar neutral position, and the final weight-bearing position of the navicular in relaxed stance. This measurement is thought to represent the sagittal plane displacement of the navicular bone from a neutral position to a relaxed standing position. The purpose of this study was to test intra-rater reliability of a method for measuring the navicular drop. Fourteen healthy subjects, mean age 34.5±5.68 years, participated in the reliability study. Foot pronation was assessed using the navicular drop test. Measurements of the navicular drop were performed three times on each foot, one day apart and were averaged for statistical analysis. Statistical analysis was performed using SPSS (SPSS 10, for Windows). Intraclass correlation coefficients were 0.78 and 0.88 for the dominant and non- dominant leg respectively. The results demonstrated moderate to good intra-rater reliability for use of the navicular drop test for measuring foot pronation in clinical settings.

Key words: foot, morphology, pronation, navicular drop test, intraclass correlation coefficient.

SAŽETAK

Navicular drop test je upotrebljen kao indikator pronacije noge. Definira se kao razlika između visine navikularke od poda, u sjedećem položaju kad je noga na podlozi u subtalarnoj neutralnoj poziciji, i konačnom opterećenju navikularke u relaksiranom položaju. Mjerenje predstavlja pomak sagitalne ravnine navikularne kosti iz neutralne pozicije u stojeću neutralnu poziciju. Svrha studije je testiranje pouzdanosti intra-rater testa za mjerenje navikularnog pada. U studiji je sudjelovalo četrnaest zdravih osoba, prosječne starosti 34,5±5,68 godina. Pronacija noge je ocjenjena upotrebom navicular drop testa. Mjerenja navikularnog pada su izvršena tri puta na svakoj nozi, svaki drugi dan. Rezultati su bili statističko analizirani, upotrebom SPSS (SPSS 10, za Windowse).Koeficijent korelacije između različitih parametara je bio 0,78 i 0,88 za dominantnu odnosnu nedominantnu nogu. Rezultati pokazuju umjerenu do dobru intra-rater pouzdanost za upotrebu navikularnog drop testa za mjerenje pronacije noge u kliničkim okvirima.

Ključne riječi: noga, pronacija, navikularni drop test, test intra-rater pouzdanosti, korelacijski koeficijent

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INTRODUCTION

Navicular drop test addresses the plantar flexion component of talar motion and is used to assess the amount of subtalar pronation. Test was first described by Brody (3), who found it very helpful in evaluating the significance and amount of pronation in a runner's foot. Subtalar joint plays a significant role in force absorption and therefore, most of the studies looking at the dysfunction of the foot with increased pronation focused on the subtalar joint due to its significant role in force absorption.

The subtalar joint significantly affects the performance of the more proximal articulations such as the knee and modifies the force transfer (10,2). Abnormal pronation has a significant influence on knee joint when the leg is functioning in the closed kinetic chain. In normal conditions, the articulation of the talus causes the lower extremity to internally rotate with subtalar joint pronation and to externally rotate with subtalar joint supination (10). During increased foot pronation, excessive internal tibial rotation will transmit abnormal forces upward in the kinetic chain, causing vector changes of the quadriceps mechanism and lateral tracking of the patella (10). In addition, the anterior cruciate ligament tightens with internal tibial rotation and so increased internal tibial rotation increases the stress on the anterior cruciate ligament (ACL).

Beckett et al (2) investigated the prevalence of increased foot pronation in subjects who sustained an anterior cruciate ligament injury. They compared 50 subjects with an ACL injury and 50 uninjured subjects. They found that ACL-injured subjects had a greater score on the navicular drop test in uninjured foot, thus increased foot pronation, as compared to matched foot of uninjured subjects. They concluded that increased foot pronation might be associated with an increased risk for ACL injury. Several other studies have also reported a relationship between foot morphology and injury.

In a study of long distance runners, 77% of knee injuries were related to an abnormal foot position with 43% being defined as pronation-related and 34% being defined as cavus-related (5). Similarly, Dahle et al (4) studied the relationship between foot type and the occurrence of knee injury among athletes. A significant relationship was found between athletes who suffered knee pain and those who were classified with pronated or supinated foot types. In contrary, others reported no such relationship (11,12).

Taking into consideration the importance of the amount of foot pronation in lower limb biomechanics and lower limb pathologies, it is crucial to have a reliable technique to assess and evaluate the amount of foot pronation in the clinical settings. The purpose of this study was to investigate the intra-rater reliability of the navicular drop test. Navicular drop is defined as the distance between the original height of the navicular from the floor with the foot on the floor in sitting in the subtalar neutral position to the final weight-bearing position of the navicular in relaxed stance. This measurement is thought to represent the sagittal plane displacement of the navicular bone from a neutral position to a relaxed standing position.

SUBJECTS AND METHODS

Intra-rater reliability of the navicular drop test was tested on 14 healthy women by 1 examiner. Fourteen subjects were considered sufficient conditions with adequate power (90% at $p<0.05$) (1). None of the subjects had a recent (last six months) history of lower leg injury that required medical attention or they had any previous surgery of lower leg. Physical characteristics of the subjects are reported in Table 1.

All subjects were required to give informed written consent for participating in the study. Committee for Medical Ethics at University of Ljubljana and Ethics Committee at King's College London approved the

Table 1. Anthropometric characteristics of the subjects, means, standard deviations and ICC's of navicular drop measurements (N=14)
Tablica 1. Antropometrijske karakteristike ispitanika i rezultati navikularnog drop testa s korelacijskim koeficijentima

	Mean		**Standard Deviation**		**Range**	
Age	34.5		5.68		26-47	
Body mass (kg)	63.9		10.02		54-88	
Height (cm)	168.5		5.07		164-178	
BMI (kg/m2)	18.92		2.58		16.27-25.14	
Right leg						
	Mean 1	SD 1	Range 1	Mean 2	SD 2	Range 2
NDT (cm)	0.5	0.11	0.3-0.7	0.6	0.12	0.4-0.8
Left leg						
	Mean 1	SD 1	Range 1	Mean 2	SD 2	Range 2
NDT (cm)	0.6	0.14	0.3-0.8	0.6	0.13	0.4-0.8
	ICC right leg			**ICC left leg**		
NDT (cm)	0.78			0.88		

Key: BMI -body mass index; NDT -navicular drop test; ICC -inter class correlation coefficient;

proposed study. Navicular drop was measured as described by Brody (3). The subjects were placed in a sitting position with their feet flat on a firm surface and with the knee flexed to 90° and ankle joint in neutral position. The most prominent point of the navicular tubercle while maintaining subtalar neutral position was identified and marked.

Subtalar neutral position was established when medial and lateral talar depressions were equal. Then an index card was placed on the inner aspect of the hindfoot and the level of the navicular bone was marked on the card. The individual was then asked to stand without changing the position of her feet and while distributing equal weight on both feet. In the standing position, the navicular bone position relative to the floor was again identified and marked on the card. Finally, the difference between the original height of the navicular bone in the sitting position and weight bearing positions was assessed with a tape measure rendering the navicular drop amount (cm). The navicular drop test was performed three times for each leg. Intraclass correlation coefficient (ICC) was used to assess the reliability of the proposed test for measuring foot pronation. Statistical analysis was performed using the statistical package SPSS (SPSS 10, for Windows).

RESULTS

Anthropometric characteristics of the subjects, means standard deviations and ICC's of navicular drop measurements are summarised in Table 1. Intraclass correlation coefficients are lower than 0.90, which is considered indicative of moderate reliable clinical measurement protocols (8).

DISCUSSION

Navicular drop test indicated moderate to good reliability, with ICC of 0.78 and 0.88 for right and left knee, respectively. These reliability data are partly comparable to other studies (6,7). Picciano et al. (7) reported poor to moderate intratester and poor intertester reliability. Examiners used in the study by Picciano et al (7) were relatively inexperienced physiotherapists and they only undertook a 2 hour training session prior to main data collection. In addition, they examined 15 subjects and treated each foot independently, therefore, analysing data from right and left foot together. This might cause differences in the reliability results between their and the present study.

In the present study, examiner was regularly using navicular drop test in the clinical setting and data were analysed separately for right and left foot. Muller et al (6) reported good reliability of using navicular drop test for measuring foot pronation. Similar results were reported by Sell et al (9). They evaluated the reliability of measuring navicular drop in 30 healthy subjects and reported a mean value of 0.6 cm and high ICC for intra and inter-rater reliability of 0.73 and 0.83, respectively. Their mean values of foot pronation are in agreement with the results of the present study, were mean values of 0.5 and 0.6 cm were reported for right and left foot, respectively, while on the other hand, intra-rater reliability reported in the present study is higher with 0.78 for the right foot and 0.88 for the left foot.

Navicular drop is considered as a measure of pronation since both rearfoot and forefoot abnormalities may influence it. The major limitation of navicular drop test is the capability of measuring displacement only in the sagittal plane, while in actual fact motions of the navicular bone actually take place in all three planes simultaneously (6). In addition, placing the subtalar joint in the neutral position is another source of error.

The results of this reliability study indicate that navicular drop test, having moderate to good reliability can be used in the clinical setting for foot and ankle diagnostic as well as preventive evaluations. However, if considered navicular drop test as evaluating tool in research setting, higher reliability should be achieved before using it for the research purposes.

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