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Comparison of Navicular Drop and Hallux Deviation in Women with Different Knee Osteoarthritis Radiographic Grades

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ABSTRACT

Aims Knee osteoarthritis is the most common joint disease. It has more prevalence and severity in women than in men. The aim of this research was to compare the navicular drop (ND) and hallux deviation (HD) in women with different knee osteoarthritis (OA) based on the radiographic grades of 1 to 4.

Instruments & Methods The present research was a descriptive cross-sectional and causal-comparative study. The study population included women with knee osteoarthritis in Tehran. The statistical sample included 87 female patients with knee osteoarthritis, who were selected based on the simple purposive and non-probability sampling method from patients referring to specialized clinics and Akhtar Hospital in 2015. The number of knees with knee OA was 168, which were divided into 4 groups based on the Kellgren-Lawrence grading scale. One-way analysis of variance was used to compare the difference between the groups in terms of the amount of navicular drop and the hallux deviation, and for significant results, Tukey's post hoc test was applied.

Findings There was a significant difference between the first and second groups regarding the extent of ND, which was mostly observed in Group 2. It was non-significantly higher in Group 4 in comparison with Group 3 and higher in Group 3 than in Group 1. The mean of HD increased from Group 1 to 4 but not significantly.

Conclusion Higher drop in navicular is a risk factor for the development of knee osteoarthritis radiographic grades.

Keywords Knee Osteoarthritis; Postures; Ergonomic

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Introduction

Osteoarthritis is a type of disorder in moving joints, which is characterized clinically with pain and functional limitations, in terms of radiography with osteophytes and joint space narrowing, and in terms of tissue pathology with alteration in the cartilage and the underlying bone [1].

Osteoarthritis is at the head of the causes of inability in elderly. In Iran, in general, of every 10 patients aged 30 to 35 years with main complaints of knee, waist, and neck pain, 9 people are suffering from osteoarthritis [2].

The annual cost of osteoarthritis treatment is more than 7 times of the cost of rheumatoid arthritis treatment [3]. Knee osteoarthritis is the most common articular disorder characterized by abnormal conditions of articular cartilage and underlying bone in thigh-tibia cartilage [4].

Many factors contribute to the development of knee osteoarthritis. In many cases, osteoarthritis is believed to be as the result of local mechanical factors that cause tissue damage [5-7].

Malalignment is a known risk factor for osteoarthritis. In theoretical sciences, any change or shift from a neutral or straight direction in the hip, knee, and ankle joints affects the distribution of load on the knees [8].

Previous studies have proven that malalignment is a strong predictor for the progression of the disease in patients with osteoarthritis [9]. Lower extremity malalignment in hip, knee, and ankle joints have been suggested as risk factors for a wide range of lower extremity injuries, such as osteoarthritis. Clinically, the biomechanical role of foot abnormality is important in the development of knee pathology in order to prevent and treat injury. The early stages of the disease process are clinically silent, making clear the cause of high prevalence of radiographic and pathological symptoms of osteoarthritis in patients without clinical symptoms. Even in the final stages of osteoarthritis, there is a weak correlation between clinical signs and marked changes in the cartilage and bone integrity [1]; therefore, radiographic features are the best and most accurate methods for categorizing the severity of osteoarthritis.

The Kellgren-Lawrence grading system is a gold standard in the classification of osteoarthritis [10], which combines significant radiographic features of osteoarthritis (osteophyte formation and joint space narrowing) within an intensification scale and divide them into grades from 1 (mild) to 4 (very severe) [11].

A study conducted by by Amini Aghdam and Daneshmandi, which compared the rate of navicular drop and back knee angle in athletes with and without a history of anterior cruciate ligament injury, showed that the rate of navicular drop in injured group was higher than that of the healthy group; also, there was no significant difference between the values of back knee angle in the two groups [12].

Amiri and Davoodi investigated navicular drop and tibia torsion in active female students suffering from patellofemoral pain syndrome and healthy ones. The results did not show significant difference between both healthy and infected groups regarding the variables of navicular drop and tibia torsion [13].

Levinger *et al*. examined the foot posture in people with knee osteoarthritis and healthy ones. According to their findings, the patient group showed significantly higher scores in terms of foot posture index, navicular drop, and foot arch index in comparison with the healthy group. There was no significant difference regarding the vertical height of navicular bone [14].

Avani *et al*. compared the ankle and foot indices in healthy people and patients with knee osteoarthritis, showing that there was a significant difference between the two groups in terms of foot posture index scores, navicular drop, heel deviation angle, the motion range of foot ankle bending, and the opening of the first foot sole-finger joint; also, the patients' feet have more inner rotation compared to the healthy group. In patient group, the motion range of foot ankle bending and the opening of the first foot sole-finger joint was lower [15].

In many cases, the hallux valgus is accompanied by flat foot sole, and these two factors in relation to osteoarthritis require more investigations; on the other hand, it has not yet been determined whether there is a relationship between disease progression and malalignment. Despite the research done, lower extremity malalignment, especially foot malalignment, has not yet been studied in patients with osteoarthritis with different radiographic grades.

Also, due to the fact that in osteoarthritis, women are more at risk (4.9%) than men (2.6%) [16], this study was conducted with the aim of investigating and comparing lower limb postural malalignments including navicular drop and hallux deviation in women with different knee osteoarthritis (OA) based on the radiographic grades of 1 to 4.

Instrument and Methods

The present research was a descriptive cross-sectional and causal-comparative study. The study population included women with knee osteoarthritis in Tehran. The statistical sample included 87 female patients with knee osteoarthritis who were selected based on the simple purposive and non-probability sampling method from patients referring to specialized clinics and Akhtar Hospital in 2015.

The number of knees with knee OA was 168, which were divided into 4 group based on the Kellgren-Lawrence grading scale (Group 1: 46 knees with Grade 1, Group 2: 51 knees with Grade 2, Group 3: 49 knees with Grade 3, and Group 4: 22 knees with Grade 4). Knee osteoarthritis was diagnosed by a specialist with the help of American College of Rheumatology (ACR) criteria, including clinical and radiological information, and radiologic grades were determined and approved by Kellgren-Lawrence grading scale. Inclusion criteria in the study were as follow: having knee OA, being female, and having more than 40 years old. Exclusion criteria were as follow: having osteoarthritis of other lower limb joints or having a history of knee injury or fracture, knee joint surgery, intra-articular injection in the last 6 months, arthritis, rheumatism, and acute synovitis in the lower extremity.

After completing the consent form, the subjects' individual information including age, height, weight, history of injury, surgery, and knee injections, and other articular diseases in lower extremity was recorded in the demographic characteristics questionnaire prepared by the researcher. Subsequently, the rate of nasvicular drop and hallux deviation was evaluated in the groups.

To measure the navicular bone drop, the examiner initially measured the height of the navicular bone from the ground floor in a sitting position so that the bone was in a neutral position and, then, measured the height of the bone in a standing position, using a hard ruler (Fig. 1) [17].

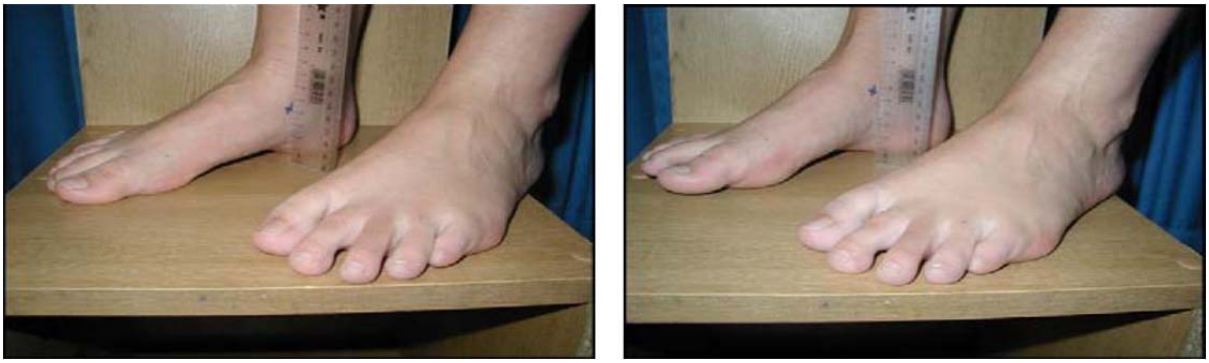

Figure 1) Measurement of navicular drop based on the study by Schwellnus

The difference between these two values is called the navicular bone drop and indicates the amount of foot inner rotation [18]. During the measurement, the subject was asked in the sitting position to place thigh and knee in a position of 90 degrees, foot sole on the ground, subtalar in neutral position, and feet in a non-weight bearing condition, and in the standing position to open the legs as wide as the shoulder width and evenly distribute the weight of the body on the two feet in a weight bearing condition [19].

The angle between the axis of the first foot sole bone and the axis of the first hallux knuckle is defined as hallux deviation angle [20]. To measure the hallux deviation angle, the directions of the first foot sole bone and the first hallux knuckle were determined with the help of a digital image taken from the top of the feet. The patient was asked to place the foot sole on the floor, open the legs as wide as the shoulder width, and evenly distribute the weight of the body on the two feet. Next, this image was taken directly from the top of the foot so that the first foot sole-finger joint was located at the center of the photo (Fig. 2). In the next step, this photo was copied to Autocat software. Then, the center of the joint was marked on the photo, and a line was drawn along the first foot sole bone, and the other line was drawn along the first hallux knuckle, and to determine the degree of hallux deviation, the angle between these two lines was measured and recorded.

One-way analysis of variance was used to compare the difference between the groups in terms of the amount of navicular drop and the hallux deviation, and for significant results, Tukey's post hoc test was applied.

Figure 2) Drawing the hallux deviation angle based on the photos taken by the researcher

Findings

The mean age of participants was 55.03±8.84 years and the mean of BMI was 30.66±4.45kg/m^2 (Table 1).

Table 1) The mean of age and BMI in studied groups

Groups	**Age** (years)	**BMI** (kg/m²)
1	50.35±7.55	29.12±5.15
2	55.35±9.11	30.47±3.22
3	57.82±8.08	30.44±3.24
4	58.09±7.69	34.27±4.01

There was no significant difference in the hallux deviation angle among the 4 groups, but there was a significant difference in the navicular drop (Table 2).

Table 2) The result of comparing the degree of hallux deviation and navicular drop in the four groups of patients with knee osteoarthritis (using ANOVA)

Groups	Mean±SD	F	p value
Degree of hallux deviation			
1	12.87±8.08	1.28	0.28
2	14.29±9.62		
3	16.18±10.39		
4	16.54±9.74		
Navicular drop			
1	6.35±3.11	2.67	0.049*
2	8.26±3.19		
3	7.42±3.69		
4	7.70±3.54		

*It is significant at p≤0.05

The mean of the navicular drop had a significant difference between the Groups 1 and 2, but there was no significant difference between the other groups (Table 3).

Table 3) The changes of the mean of navicular drop in four groups of patients with knee osteoarthritis

Groups	Mean Difference Tukey's Post hoc Test		p value
1	Group 2	-1.92	0.03*
	Group 3	-1.07	0.41
	Group 4	-1.36	0.41
2	Group 1	1.92	0.03*
	Group 3	0.85	0.59
	Group 4	0.56	0.91
3	Group 1	1.07	0.41
	Group 2	-0.85	0.59
	Group 4	-0.29	0.99
4	Group 1	1.36	0.41
	Group 2	-0.56	0.91
	Group 3	0.29	0.99

*It is significant at p≤.05

Discussion

The results of this study showed that the amount of navicular bone drop in the second group (patients with Grade 2 knee osteoarthritis) was more than the other groups. But, this increase was only significant in relation to the Group 1, and there was no significant difference between the Group 2 and the Group 3 and 4. Navicular drop was non-significantly higher in Group 4 compared to Group 3 and in Group 3 compared to Group 1.

In their recent study, Karen *et al*. reported the amount of navicular drop between 5mm to 9mm as normal [19].

In the present study, the navicular drop mean in all 4 groups was in the normal range; however, with the disease development from Grade 1 to 2, the rate of navicular drop significantly increased. The results of this study can suggest that navicular drop is as a risk factor for the progression of radiology grade. In contrast to the current study, Levinger *et al*. reported that navicular drop was significantly more in patients with knee osteoarthritis than in healthy ones [14].

Avani *et al*. also showed that the navicular drop at the foot of patient group was significantly higher than the healthy group [15]. The results of these two studies suggest that navicular drop is as a risk factor for knee osteoarthritis.

But, no study was found in the previous research comparing navicular drop among different grades of osteoarthritis.

The results of the present study in relation to the foot static postural malalignment, that is, hallux deviation showed that the mean of hallux deviation angle was increased in Groups 1 to 4, respectively, but this increase was not significant.

In Orthopedic Physical Assessment book, Maggie reported the normal range of the hallux deviation angle from 8 to 20 degrees [20]; therefore, in this study, the mean of hallux deviation angle in all 4 groups was in the normal range. In previous research, the hallux deviation has not been compared and investigated among the different grades of knee osteoarthritis. The findings can be used as a starting point for further research on risk factors such as lower limb malalignment in the development and progression of knee osteoarthritis.

In the present study, in 53.57% of the feet, the navicular bone drop in the lower limbs with knee osteoarthritis was in an abnormal range, while the hallux deviation in 48.81% of the cases was abnormal.

The ministry of sports is suggested to prevent from the progression of knee osteoarthritis as much as possible by setting up and implementing comprehensive prevention plans to improve and correct lower limb malformation with the help of therapeutic exercises and corrective movements.

Based on the obtained results performing corrective exercises necessary for improving the structural and biomechanical aspects of the limb can help prevent from rapid progression of the disease.

Limitations of the study were the small society and not cooperating with other agencies.

Conclusion

Higher drop in navicular is a risk factor for the development of knee osteoarthritis radiographic grades.

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