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Original Research

Effectiveness of Increasing the Angle of Lateral Wedge Insole on Spatiotemporal Gait Parameters in Patients with Medial Knee Osteoarthritis

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ABSTRACT

In previous studies, the effect of lateral wedge insole on gait variables in people with medial knee osteoarthritis has been studied. However, No study was found to examine the effect of insole slope. This study was sought to assess the effect of increasing the angle of lateral wedge insole on spatiotemporal gait parameters in patients with medial knee osteoarthritis. Ten individuals with medial knee osteoarthritis and 10 healthy subjects with similar age, height and mass were selected. The spatiotemporal gait parameters of subjects were calculated in four walking conditions (walking barefoot, walking while wearing shoes with 0°, 5°, 11° insoles). Repeated measures and *t*-test was used in case of intragroup comparison and MANOVA in case of intergroup comparison. The main effect of insole had a significant effect on walking speed ($p = 0.000$). Walking speed in wearing shoes with 0° and 5° insoles were significantly higher than other condition. The intragroup analysis showed that walking speed, Double Support time, percent of foot off, and stride and step length in walking barefoot were significantly less than walking while using insoles in both groups. The speed of walking, stride and step length in barefoot conditions showed a significant difference between the two groups ($p<0.05$). These findings imply that the use of insole was a similar effect in affected and non- affected limb. To increase the efficiency of gait, according to the results, recommended using laterally wedged insoles in people with medial knee OA.

Keywords: Knee, Osteoarthritis, Insoles, Gait, Spatiotemporal parameters.

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Introduction

Medial knee osteoarthritis (OA) is caused by disproportionate load distribution in the knee medial compartment. It is one of the most common types of arthritis characterized by destructive changes in the synovial joint structure and function (1). The symptoms include joint pain, joint stiffness, motor dysfunction, limited range of motion, weakness of the quadriceps, and difficulty in standing up, walking and climbing stairs (2, 3). Disproportionate load distribution in the medial knee compartment is one of the characteristics of medial compartment OA since the force vector passes medially to the knee joint center, increases the external knee adduction moment (EKAM), and consequently increases joint load on the medial compartment (4).

Lateral wedge insole (LWI) is one the non-surgical treatments for medial compartment OA. LWI produces EKAM and reduces loading on the medial compartment (5, 6). LWI transfers loading from the medial to the lateral knee compartment, reduces loading on the knee medial compartment, and consequently reduce knee pain (7-9). Several researchers have assessed different aspects of using LWI in this type of knee injury. Hunt *et al.* (2006) showed that insoles reduced the EKAM in patients with medial knee OA compared to healthy individuals (10). Kerrigan *et al.* (2002) showed that 5° and 10° LWIs reduced the peak knee varus torque values (11).

According to the pathophysiological mechanism, LWIs are used to shift loadings from the medial to the lateral knee compartment (12-15). Evidence shows an increasing amount of data about changes in gait pattern of OA patients in recent decades (2, 16-18). Various studies have shown a decrease in walking speed, cadence, and stride length as well as an increase in stride width in OA patients (19-21). A specific training or treatment protocol can be designed by increasing data on effective factors on mechanism of action of medial compartment OA and efficacy of LWI on gait parameters. The present study aimed to assess the efficacy of 0°, 5°, and 11° LWIs on spatiotemporal parameters in patients with medial knee OA. It assumed that the use of LWI due to effects on the medial knee compartment improve gait symmetry and spatiotemporal parameters in patients with medial knee OA.

Material and Methods

Subjects

This was a cross-sectional quasi-experimental study carried out in a sports biomechanics laboratory. The statistical population consisted of patients with medial knee OA who visited the medical clinics in Hamedan city and the peers who voluntarily participated in the study. The sample size was determined as 9 per group using G*Power by taking into account $\alpha=0.05$ and statistical power of 80% (22). However, 10 male patients with medial knee OA and ten peers were classified into the OA and control groups, respectively. The OA group filled out the Knee Injury and Osteoarthritis Outcome Score (KOOS) to assess pain, symptoms, knee-related quality of life, and daily activities. Those with lower extremity injuries (except for medial knee OA), neuromuscular diseases, and orthopedic disorders (fracture, tendonitis, sprain, strain, and joint replacement surgery) in the last six months were excluded from the study. The written consent forms were collected from the participants. Phases of the project, parameter measurements, and method of the study were thoroughly explained to the subjects. The project protocol was approved by the Ethics Committee of Hamedan University of Medical Sciences (ethics code IR.UMSHA.REC.1396.368, July 29, 2017).

Instruments and examination

The Vicon3D motion capture system (Vicon Peak, Oxford, UK) with six cameras of T20 series at a frequency of 100 Hz was used to track the markers attached to the lower limbs during walking. Spherical markers (diameter = 14 mm) were attached to anatomical landmarks (legs) with double-sided adhesive tapes according to Plug-In Gait Model (Gait Marker Set, Vicon Peak, Oxford, UK) (23, 24).

Raw data set was filtered using a fourth-order low-pass Butterworth filter with cutoff frequency of 20 Hz after initial processing and coordinate determination. Gait analysis could be carried out when all markers were visible in each gait cycle. Marker images were saved in a file in the computer. Each phase of gait cycle (the moment the heel contact, the moment the toe off, and the moment the heel contact the surface again) were stored in the file for both left and right legs. Then the cadence, walking speed, stride length, step length, strides and step time, stance, swing, single support and double support time, the opposite foot off, the opposite foot contact, and the toes off time were derived from the filtered data and expressed as the gait cycle percentage (Fig. 1). The swing time in each limb was

set to single support time by the opposite foot (25), which was derived from the Polygon software 3.5.1 (VICON, Oxford Metrics Ltd., Oxford, UK). Stance phase was calculated using formula 1.
Formula 1: Stance time $_x$ = double support time $_x$ + single support time x.

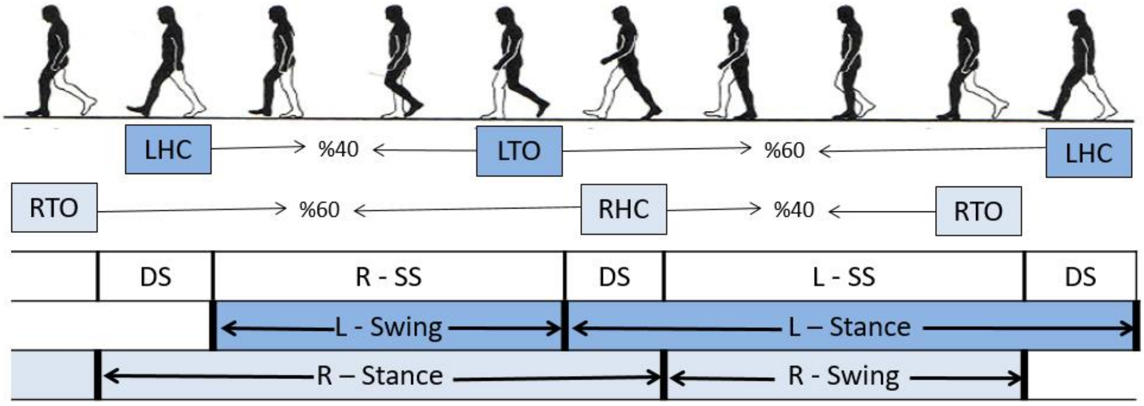

Figure 1. Sequence of gait cycle in each limb

Note: LHC: left heel contact, RTO: right toe off, RHC: right heel contact, LTO: left toe off

The participants walked on a certain track at their self-selected comfortable velocity. The starting place of the gait was determined by trial and error, so that each leg has a complete stride inside the calibrated space. The distance from the starting point to the calibrated space was such that, before entering the calibrated space, the subject took at least seven steps (26, 27), and the length of the 12-meter route made it possible after space was calibrated at least about seven steps were taken. With these conditions, the effects of starting and stopping of gait were eliminated.
Tasks in the laboratory were a) walking barefoot, b) walking wearing shoes with 0° insoles, c) walking wearing shoes with 5° insoles, and d) walking wearing shoes with 11° insoles. Each task was repeated three times for statistical analysis. All insoles were made of 70 shore ethylene vinyl acetate (EVA). The insole size were adjusted to fit each subject (fig. 2).

Figure 2. Insoles used in this study, a) 11° LWL insole, b) 5° LWL insole, c) 0° insole

Statistical analysis
Shapiro-Wilk test was used to test data normality and the possibility to use parametric tests. The project involved two intragroup factors; a) four walking conditions (walking barefoot, walking while wearing shoes with 0°, 5°, 11° insoles) and b) side of the body included the affected and non-affected limbs in the OA group. Another intergroup factor with two levels of OA group (patients with medial knee OA) and control group (healthy individuals) was taken into account. Repeated measures and *t*-test was used in case of intragroup comparison and MANOVA in case of intergroup comparison. Statistical analysis was performed in SPSS (version 16, SPSS Inc, Chicago, Il) at the significance level of $p<0.05$.

Results

The mean and standard deviation of participants' characteristics are presented in Table 1. As can be seen, the control group did not differ significantly in terms of demographic characteristics from the OA group.

Table 1. Mean and standard deviations of subjects' demographic variables in groups

	Groups		
Variables	OA	Control	Sig.
Age	51.70±5.70	50.75± 3.23	0.72
Height	1.70±0.72	1.73±0.31	0.18
Mass	74.10±14.66	82.34±5.79	0.12
BMI	26.72±5.21	27.34±1.69	0.72
Quality evaluation of koos			
Pain (0-100)	46.82±15.78	-	-
Symptoms of Disease (0-100)	53.20±16.35	-	-
Daily Living Activity (0-100)	47.78±17.19	-	-
Quality of life (0-100)	35.49±21.27	-	-

Note: abbreviations: SD: standard deviation, BMI (Body Mass Index, age in year, height in meters, mass in kilograms.

The results showed that the insole type had a significant effect on walking speed (Eta = 0.81, *p* = 0.000, F (3, 16) = 22.99). Paired comparison also showed that walking speed in wearing shoes with 0° and 5° insoles was significantly higher than walking barefoot and wearing shoes with 11° insoles. Also, the lowest walking speed belonged to walking barefoot (Table 2).

Table 2. Spatiotemporal variables in two groups. The data shown are the means (standard deviations).

	Gait conditions	Control group	OA group		P1	P2	P3
			Affected limb	Non-affected limb			
Speed	Barefoot	1.21 (0.81)	1.02 (0.12)	1.07 (0.11)	**0.00**	**0.00**	0.21
	0°	1.33 (0.89)	1.23 (0.12)	1.23 (0.15)	0.05	0.09	0.83
	5°	1.32 (0.07)	1.21 (0.16)	1.18 (0.15)	0.06	**0.02**	0.07
	11°	1.17 (0.16)	1.15 (0.15)	1.16 (0.16)	0.79	0.88	0.69
Cadence	Barefoot	114.81 (8.37)	113.89 (11.76)	113.42 (10.36)	0.84	0.74	0.84
	0°	113.91 (8.39)	115.22 (7.28)	114.30 (10.41)	0.71	0.92	0.59
	5°	115.18 (7.31)	114.03 (7.64)	115.18 (9.58)	0.87	1.00	0.65
	11°	113.17 (5.81)	113.07 (5.91)	112.20 (5.80)	0.97	0.71	0.56

Note: Walking barefoot: Walking without shoes; 0°, 5° and 11°: walking while wearing shoes with 0°, 5°, 11° insoles; P1 is the P-value for the intergroup comparison (Control group / Affected limb in OA group); P2 is the P-value for the intergroup comparison (Control group / Non-affected limb in OA group). P3 is the P-value for the intragroup comparison (Affected limb in OA group / Non-affected limb in OA group); Variables that were statistically significant are highlighted in bold.

Use of insoles made significant changes in step length (Eta = 0.71, *p* = 0.000, F (3, 16) = 13.06). Paired comparison also showed the shortest step length in walking barefoot and the longest step length in wearing shoes with 0° insoles (Table 3). step length was significantly longer in wearing shoes with 0° insole compared to other walking styles ($p<0.05$).

Therefore, use of LWI made a significant change in stride length (Eta = 0.74, *p* = 0.000, F (3, 16) = 15.95). Paired comparison showed that the lowest stride length belonged to walking barefoot, which significantly differed from walking while wearing shoes with 0° and 5° insoles and the longest stride length in wearing shoes with 0° insoles (Table 3). There was also a significant interaction between insole and foot. Intragroup comparison showed a significant difference in stride length in walking barefoot between affected and non-affected limbs in OA group. Use of insoles significantly increased stride length in OA group.

Use of insoles made a significant change in the percent of gait cycle in the ipsilateral foot off (Eta = 0.51, p = 0.008, F (3, 16) = 5.58. Paired comparison showed that the lowest percentage of gait cycle belonged to walking barefoot and the highest percent pertained to walking while wearing shoes with 11° insoles, which significantly differed from other walking styles (Table 4). Factor analysis of gait cycle percent in the opposite foot off showed a significant interaction between the insole and the foot (p<0.05). Intragroup comparison showed a significant difference between walking barefoot and wearing shoes with 11° insoles. Therefore, a significant difference was found in gait cycle of the opposite foot off between affected and non-affected limbs in OA group in walking with and without insoles (Table 4).

Factor analysis also showed the significant effect of insole on single support time (Eta = 0.41, p = 0.032, F (3, 16) = 3.78). Paired comparison also showed that the single support time in walking barefoot was significantly higher than other walking styles. Therefore, use of insoles significantly reduced the single support time. All insoles had a similar effect on the single support time (Table 4).

The results also showed the significant effect of insoles on the Double Support time (Eta= 0.50), p = 0.01, F (3, 16) = 5.35). Paired comparison showed no significant difference in Double Support time in 0° and 5° insoles. However, significant differences were found in Double Support time between other walking styles. The lowest and highest Double Support time belonged to walking barefoot and walking while wearing shoes with 11° insoles, respectively. Gait analysis showed no significant difference between affected and non-affected limbs in the OA group. However, 11° insole significantly decreased the percent of opposite foot off in the non-affected leg and 5° insole significantly increased stride length of the affected limb in the OA group (Table 4).

ANOVA results showed that walking speed in the affected limb of OA group was significantly lower than the healthy individuals in walking barefoot (Table 2). Percent of foot off of the affected leg with 0° insole was higher in the OA group than other insoles. Stride and step length was longer in the healthy individuals compared to the affected leg of the OA group in walking barefoot. Walking speed in the control group was significantly higher than in the non-affected leg of the OA group in walking barefoot and with 5° insoles. Percent of the opposite foot off in walking while wearing shoes with 11° insoles was significantly lower in the control group compared to the non-affected leg of the OA group. Stride length in healthy individuals was significantly longer than the OA group in walking barefoot.

Table 3. Spatio variables in two groups. The data shown are the means (standard deviations).

	Gait conditions	Control group	OA group		P1	P2	P3
			Affected limb	Non-affected limb			
Step Length	Barefoot	0.61 (0.05)	0.54 (0.05)	0.55 (0.08)	**0.00**	0.08	0.65
	0°	0.70 (0.04)	0.65 (0.10)	0.66 (0.11)	0.10	0.27	0.68
	5°	0.68 (0.04)	0.63 (0.10)	0.62 (0.10)	0.12	0.07	0.47
	11°	0.63 (0.10)	0.62 (0.10)	0.61 (0.10)	0.90	0.67	0.38
Stride length	Barefoot	1.27 (0.10)	1.10 (.10)	1.13 (0.13)	**0.00**	**0.02**	0.09
	0°	1.40 (0.06)	1.30 (0.16)	1.30 (0.21)	**0.04**	0.18	0.52
	5°	1.40 (0.07)	1.30 (0.20)	1.25 (0.21)	0.15	0.08	**0.03**
	11°	1.25 (0.20)	1.23 (0.20)	1.25 (0.20)	0.82	1.00	0.48

Note: Walking barefoot: Walking without shoes; 0°, 5° and 11°: walking while wearing shoes with 0°, 5°, 11° insoles; P1 is the P-value for the intergroup comparison (Control group / Affected limb in OA group); P2 is the P-value for the intergroup comparison (Control group / Non-affected limb in OA group). P3 is the P-value for the intragroup comparison (Affected limb in OA group / Non-affected limb in OA group); Variables that were statistically significant are highlighted in bold.

Table 4. Temporal variables in two groups. The data shown are the means (standard deviations).

	Gait conditions	Control group	OA group		P1	P2	P3
			Affected limb	Non-affected limb			
Double support time	Barefoot	0.24 (0.49)	0.25 (0.05)	0.24 (0.05)	0.52	1.00	0.49
	0°	0.27 (0.02)	0.27 (0.04)	0.28 (0.5)	0.57	0.59	0.87
	5°	0.27 (70.02)	0.27 (0.04)	0.27 (0.05)	0.70	0.80	0.93
	11°	0.29 (0.02)	0.29 (0.02)	0.31 (0.03)	0.93	0.15	0.06
Single support time	Barefoot	0.41 (0.01)	0.40 (0.03)	0.40 (04)	0.65	0.88	0.58
	0°	0.39 (0.02)	0.38 (0.03)	0.39 (0.03)	0.79	0.53	0.48
	5°	0.38 (0.03)	0.38 (0.02)	0.39 (0.03)	0.93	0.76	0.57
	11°	0.39 (0.03)	0.39 (0.02)	0.39 (0.03)	1.00	0.67	0.60
Foot off	Barefoot	62.47 (2.76)	61.70 (1.72)	61.10 (2.30)	0.45	0.24	0.34
	0°	62.60 (0.83)	63.70 (1.40)	62.50 (2.14)	**0.04**	0.89	0.13
	5°	62.84 (1.76)	63.02 (1.95)	63.30 (2.50)	0.83	0.64	0.74
	11°	63.77 (1.30)	63.80 (1.36)	64.73 (2.23)	0.96	0.25	0.18
Opposite.FC	Barefoot	51.22 (2.11)	50.55 (2.52)	49.30 (2.33)	0.52	0.06	0.36
	0°	49.50 (1.22)	50.23 (2.00)	48.70 (2.38)	0.33	0.36	0.22
	5°	50.21 (0.73)	50.16 (1.15)	49.82 (2.84)	0.91	0.67	0.74
	11°	49.67 (1.89)	49.71 (1.96)	50.95 (1.95)	0.96	0.15	0.27
Opposite.FO	Barefoot	12.00 (2.75)	12.77 (2.40)	11.00 (3.14)	0.49	0.46	0.21
	0°	12.36 (1.20)	13.15 (1.30)	12.62 (2.50)	0.17	0.77	0.43
	5°	13.37 (1.16)	13.43 (2.06)	13.03 (3.60)	0.93	0.76	0.71
	11°	13.22 (2.02)	13.30 (2.15)	15.20 (1.20)	0.93	**0.01**	**0.00**
Stance Time	Barefoot	0.65 (0.05)	0.66 (0.08)	0.65 (0.07)	0.77	0.94	0.57
	0°	0.66(0.05)	0.66 (0.06)	0.66 (0.04)	0.81	1.00	0.89
	5°	0.64 (0.05)	0.66 (0.06)	0.66 (0.05)	0.38	0.37	0.85
	11°	0.68 (0.04)	0.69 (0.04)	0.68 (0.04)	0.87	0.55	0.23
Step Time	Barefoot	0.51 (0.04)	0.53 (0.07)	0.54 (0.06)	0.51	0.25	0.63
	0°	0.53 (0.03)	0.52 (0.04)	0.54 (0.05)	0.43	0.72	0.19
	5°	0.52 (0.03)	0.52 (0.03)	0.52 (0.04)	0.84	0.76	0.84
	11°	0.53 (0.03)	0.53 (0.03)	0.52 (0.03)	1.00	0.59	0.55
Stride time	Barefoot	1.05 (0.07)	1.07 (0.12)	1.06 (0.10)	0.61	0.70	0.72
	0°	1.06 (0.08)	1.04 (0.07)	1.05 (0.09)	0.69	0.93	0.51
	5°	1.04 (0.06)	1.05 (0.09)	1.05 (0.06)	0.86	0.97	0.69
	11°	1.06 (0.05)	1.06 (0.05)	1.07 (0.05)	0.96	0.76	0.66
Sway time	Barefoot	0.40 (0.03)	0.41 (0.05)	0.41 (0.04)	0.44	0.29	0.72
	0°	0.40 (0.03)	0.40 (0.03)	0.40 (0.04)	0.25	0.84	0.25
	5°	0.40 (0.04)	0.40 (0.03)	0.40 (0.04)	0.29	0.21	0.57
	11°	0.40 (0.03)	0.40 (0.02)	0.40 (0.02)	0.73	0.70	0.27

Note: Walking barefoot: Walking without shoes; 0°, 5° and 11°: walking while wearing shoes with 0°, 5°, 11° insoles; P1 is the P-value for the intergroup comparison (Control group / Affected limb in OA group); P2 is the P-value for the intergroup comparison (Control group / Non-affected limb in OA group). P3 is the P-value for the intragroup comparison (Affected limb in OA group / Non-affected limb in OA group); Variables that were statistically significant are highlighted in bold.

Discussion

The present study aimed to assess and compare spatiotemporal gait parameters between patients with medial knee OA and healthy individuals. The participants were assessed in different walking styles (walking barefoot, and walking while wearing shoes with 0°, 5°, and 11° insoles). Intragroup comparison showed no significant difference in most of the parameters between the affected and non-affected limbs of the OA group. In addition, walking speed and stride length were significantly lower in the OA group compared to the control group in walking barefoot. Percent of the opposite foot off was higher in the OA group, especially when using the 11° insole.

Kiss *et al.* (2011) showed that walking speed did not significantly differed between patients with moderate knee OA and healthy individuals (28). Zeni and Higginson (2009) also confirmed these findings and attributed the negligible changes in walking speed in these patients to less knee pain and less decrease in knee muscles strength (29). However, walking speed in patients with severe knee OA significantly differed from the control group. OA group suffered from severe knee OA in the present study. Therefore, the results of this study were consistent with the findings of the above-mentioned studies. Naili *et al.* (2017) also showed that walking speed was lower and stride length was shorter in OA patients compared to healthy individuals (19). In the present study, walking speed was lower and stride length was shorter in the OA group compared to the control group in walking barefoot. Previous studies reported lower motion and flexibility in the knee (14, 30-33) and thigh (31, 34) of the affected leg compared to the normal leg. This lower function decreased stride length in OA patients and increased variability in order to reduce knee pain during walking (35).

Intragroup analysis showed that walking speed, Double Support time, percent of foot off, and stride and step length in walking barefoot were significantly less than walking while using insoles in both groups. The highest walking speed also belonged to walking while wearing 0° and 5° insoles. The highest stride and step length belonged to 0° insoles. The highest Double Support time was reported when using 11° insoles. In contrast to other gait parameters, the highest of single support time belonged to walking barefoot. Use of insoles significantly increased walking speed in the OA group. Gait speed is one of the measures of functional mobility. Various studies have shown that the use of insoles reduced loading on the medial compartment of the knee, reduced knee pain, and increased walking speed.

Other studies have also showed that two-week utilization of insoles significantly increased walking speed in OA patients. Insoles also reduced the peak EKAM (18, 36, 37). Use of insoles had a realignment effect on the medial tibiofemoral compartment (17). Biomechanical study also showed that the use of insoles can immediately reduce the peak EKAM by 5% to 10% (5) and can effects on gait coordination (38). Jones *et al.* (2013) also showed that the use of supported and unsupported insoles improved gait speed in healthy people. Those who used insoles reported walking more comfortably than those who did not (39). Studies on spatiotemporal parameters also showed that brace wearing had positive effects on gait parameters (40, 41). However, there are a limited studies on effect of insoles on spatiotemporal parameters.

One limitation of this study was small sample size (n=10). Further studies with larger samples would help to increase credibility of findings of this study. Another limitation of this study was reluctance of women with medial compartment OA to participate in the study.

Conclusion

Use of insoles decreased the difference in gait parameters between control and OA groups. This strategy also decreased the difference between the affected and non-affected limbs of the OA group. The results also showed that use of 0° and 5° insoles had higher effects on gait parameters compared to 11° insoles To increase the efficiency of gait, according to the results, recommended using laterally wedged insoles in people with medial knee OA. We hope that our current findings will be useful for changing appropriate clinical outcomes.

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چکیده فارسی

اثر افزایش زاویه کفی کفش با لبه خارجی بر پارامترهای فضایی- زمانی راه رفتن بیماران مبتلا به استئوآرتریت داخلی زانو

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در مطالعات قبلی، تأثیر کفی کفش با گوه خارجی بر متغیرهای راه رفتن در افراد مبتلا به استئوآرتریت داخلی زانو بررسی شده است. با این حال، هیچ مطالعه‌ای به بررسی اثر شیب کفی کفش نپرداخته است. این مطالعه به منظور بررسی تأثیر افزایش زاویه کفی کفش با گوه خارجی بر پارامترهای فضایی-زمانی راه رفتن در بیماران مبتلا به استئوآرتریت داخلی زانو انجام شد. ده فرد مبتلا به استئوآرتریت داخلی زانو و ۱۰ فرد سالم با سن، قد و جرم مشابه انتخاب شدند. پارامترهای فضایی- زمانی راه رفتن افراد در چهار شرایط راه رفتن (راه رفتن با پای برهنه، راه رفتن در حالی که کفش‌هایی با کفی‌های ۰ درجه، ۵ درجه، ۱۱ درجه می‌پوشید) محاسبه شد. از آزمون آنووا ویژه داده‌های تکراری و آزمون t وابسته برای مقایسه درون گروهی و از MANOVA برای مقایسه بین گروهی استفاده شد. عامل کفی تأثیر معنی‌داری بر سرعت راه رفتن داشت ($p = ۰/۰۰۰$). سرعت راه رفتن در پوشیدن کفش‌های با کفی ۰ و ۵ درجه به طور قابل توجهی بالاتر از شرایط دیگر بود. تجزیه و تحلیل درون گروهی نشان داد که سرعت راه رفتن، زمان حمایت دوگانه، درصد لحظه جدا شدن پا و طول گام و قدم در راه رفتن با پای برهنه به طور قابل توجهی کمتر از راه رفتن هنگام استفاده از کفی در هر دو گروه بود. سرعت راه رفتن، طول گام و طول قدم در شرایط پابرهنه تفاوت معنی‌داری را بین دو گروه نشان داد ($p < ۰/۰۵$). این یافته‌ها حاکی از آن است که استفاده از کفی در اندام آسیب‌دیده و غیر آسیب‌دیده اثر مشابهی داشته است. برای افزایش کارایی راه رفتن، با توجه به نتایج، توصیه می‌شود از کفی‌های با لبه خارجی در افراد با استئوآرتریت داخلی زانو استفاده شود.

واژه‌های کلیدی: زانو، استئوآرتریت، کفی، راه رفتن، متغیرهای فضایی زمانی