JPOST Journal of Prosthetics Orthotics Science Technology
Volume 2, Number 1 Year 2023
ISSN (online): 2962-8016
DOI: 10.36082/jpost.v2i1.996

EFFECT OF METATARSAL PAD USE ON SPATIOTEMPORAL GAIT PARAMETERS ON FOREFOOT PAIN

Adisti Noer Sevina[1], Triyani[2], Suci Anatasia[2]
[1]Sevina P&O Clinic, Jakarta, Indonesia
[2]Prosthetics and Orthotics Department, Jakarta, Indonesia

Article History

Received date: 16-02-2023
Revised date: 18-02-2023
Accepted date: 01-03-2023

Keywords:
Forefoot, metatarsal pad, metatarsal head, spatiotemporal gait parameter, velocity, step length, stride length, stance phase duration

Abstract

Background: Wearing high heels above 2 – 2.5 cm can have an influence on increasing the risk of pain in the palm of the front brother. The pain of the front of the palm can be given a metatarsal pad. Orthotic filling can affect the spatiotemporal gait of a person's parameters. **Purpose:** Knowing the effect of the use of metatarsal pads on spatiotemporal gait parameters of a person who has pain in the soles of the front feet with the height of heels. **Method:** The research method and design uses a one-sample pre-test post-test type. A total of 30 participants aged 18 –20 years used a metatarsal pad for 2 weeks. The measurements taken are velocity, step length, stride length, and stance phase duration. **Result:** There is a change in the degree of pain before and after using the metatarsal pad. A total of 10 people felt less pain, 9 people felt more pain, and 11 people felt the same pain. However, the relationship between the degree of pain of the soles of the feet before and after using the metatarsal pad is insignificant. Changes also occur in the mean of each spatiotemporal variable gait parameter before and after using the metatarsal pad. The average velocity (0.718 km/h) is faster, the step length (14 mm) and stride length (3 mm) are shorter and the stance phase duration (0.314 seconds) is faster than before use. However, the entire variable result is insignificant (p-value>0.05). Velocity (p= 0.477), step length (p= 0.758) and stride length (p= 0.489), as well as accelerating the stance (p= 0.295). **Conclusion:** The use of a metatarsal pad reduces the degree of pain of a person with front foot pain. However, there is no connection between the degree of pain of the soles of the feet before and after using the metatarsal pad. In other aspect, there is a change in the spatiotemporal gait parameter in the use of metatarsal pads. This study shows the influence of the use of metatarsal pads on spatiotemporal gait parameters on velocity and stance phase duration. However, not at step length and stride length.

Author Correspondence:
Adisti Noer Sevina
Jakarta, Indonesia
Email: adistins@gmail.com

ISSN 2962-8016

Introduction

The foot has two main functions, namely as the foundation of the body (base of support) and leverage to advance the body while walking or running (Ozdinc et al., 2016). In activities, the legs are used to support the entire body weight. The amount of vertical force resulting from weight to the feet can increase pressure and cause a high risk of health problems in the legs. According to Mølgaard et al (2010), foot health problems that can affect spatiotemporal gait parameters are leg pain (55.9%) and deformities in the legs (17.9%) such as pes planus and pes cavus.

Pain in the soles of the forefoot can significantly alter a person's spatiotemporal gait parameters. This is evidenced by Rome et al, (2011) who evaluated significant changes in the comparison of spatiotemporal gait parameters between healthy people and people who have front foot pain. In this research, a person who has pain in the soles of the front feet walks with a slower velocity and a longer step length and stride length when compared to a healthy person. Factors that can result in changes in spatiotemporal gait parameters vary. According to Stewart et al (2016), pain can be associated with this. The compensatory mechanism of walking to avoid the onset of pain in the soles of the front feet makes changes in spatiotemporal gait parameters occur (Turner and Woodburn 2008).

Changes in spatiotemporal gait parameters in a person suffering from pain in the soles of the front feet can affect a decrease in the level of daily activity. In the study of Rome et al, (2010) a significant decrease in the level of activity occurred in a person with significant foot pain. The impact that can be felt by participants is the slowdown in velocity and the reduction of steps and stride lengths when walking. Based on the results of a preliminary study in December 2021, as many as 94.4% of the students of the Department of Midwifery, Poltekkes Jakarta 1 felt pain in the soles of the front feet when walking as a result of wearing heels of 2-3 cm. This pain occurs during the process of internal and external activities on campus. Teaching and learning activities and services that are calculated for more than 6 hours are the main factors that can interfere with productivity when carrying out activities.

The use of orthotic tools in dealing with foot pain can have an influence on spatiotemporal gait parameters. This research was proven by Othmane et al (2004), researchers compared the effect of the use of orthosis on 3 elements of spatiotemporal gait parameters, namely: velocity, cadence, and step length. In the study, it was produced that there was a change in velocity that was getting faster and the cadence was shrinking insignificantly. Unlike other variables, the step length variable when compared between the use of orthotics and without orthotics produces significant changes. This is shown by the use of orthotics which makes the step length wider than without the use of orthosis. Changes in spatiotemporal gait parameters were produced by both researchers from both front foot pain and the use of orthoses. In its development, the presence of the design of the front footwear varied. According to Lee P.Y, et al (2014), there are 3 types of metatarsal pads including: metatarsal dome, metatarsal bar, and plantar cover. A significant difference can be seen from the physical form, placement, and function in reducing pain when walking. In this research, a design that can reduce pain when used for activities and is easy for consumers to find is a metatarsal pad with a plantar cover type because of its wider shape to accommodate the shape of the soles of the front feet. When walking, the metatarsal head tends to widen to the sides. This study analyzed the differences in spatiotemporal parameters of participants with and without the use of a metatarsal pad and their effect on the pain of the front foot when walking.

ISSN 2962-8016

Methods

The design of this study uses an experimental type with a pre-treatment and post-treatment design (one-group pretest-posttest). This research has been carried out since December 2021 by conducting the initial stage of screening all students majoring in obstetrics Poltekkes Jakarta I as many as 114 people consisting of levels I, II, and III.

The procedure is carried out in collecting screening data using a google form that contains information on the degree of pain and duration of wearing heels and observation directly on the high heels of female students. The screening results were obtained by 66 female students who were able to enter the inclusion. However, due to the obstruction of permission from female students to get their willingness to become participants, as many as 36 people refused to be studied. Participants refused because there was no further news of 26 people and participants in levels 2 and 3 who often came to campus felt less objections because of the distance between home and the campus which was far away as many as 10 people. The study continued with 30 willing participants. Spatiotemporal gait parameter data collection uses a 1.5-meter foot scan with a crossing of 8 meters (2 meters acceleration, 4 meters of walking test, and 2 meters of deceleration) which can be called a 4 meter walking test (4MWT). The walking procedure uses two ways (pre test – post test), namely with shoes without a metatarsal pad and with shoes using a metatarsal pad. The data retrieval distance between before and after using the metatarsal pad lasted 2 weeks. Tests were carried out to examine velocity, step length, stride length, and stance phase duration. The next stage, when all the data has been collected, the researcher analyzes with the SPSS statistical test and can draw conclusions afterwards.

Results

Analyzes Univariat

The results of this study were obtained from 30 participants of the Midwifery Department of Poltekkes Jakarta 1. The screening process has been carried out since December 2021 – January 2022. Data collection activities are divided into two stages, namely pre-test and post-test. Data were obtained by filling out a questionnaire for the degree of pain and observing spatiotemporal gait parameters with a foot scan. The following is an overview of the distribution of participant characteristics in the form of a table.

Table 1. Frequency Distribution of Research Participant Characteristics based on the Age, Body Mass Index and Shoe Number

Characteristics of Research Participants	Range of Values	Frequency (n)	Average and Standard Deviation
Age (years)	18	15	18.67 ± 0.758
	19	10	
	20	5	
Total		30	
IMT	<18.50	4	23.3 ± 5.194
	18.50-22.90	11	
	23.00-24.90	11	
	>25.00	4	
Total		30	
Shoe Number	36-37	3	39.1 ± 1.269
	38-39	17	
	40-41	10	
Total		30	

The age frequency distribution was dominated by participants with the age of 18 years. In the frequency distribution of Body Mass Index (BMI) data, it is known that the most BMI groups are

ISSN 2962-8016

normal BMI and overweight BMI, which is 11 people with an average of 23.30. The data on the distribution of the most participant shoe numbers were numbers 38-39 with as many as 17 people.

Table 2. Differences in Pain Degrees Before and After Using Metatarsal Pad

Variable	With	Sig. (2-tailed)
Degrees of pain before and after using *the metatarsal pad*	-0.426	0.67

Pain degrees were not significantly reduce pain, however, there were a differences in the degree of pain and after the use of metatarsal pads but not significantly.

Table 3. Differences in Pain Degrees Before and After Using Metatarsal Pad

Degrees of pain before and after using *the metatarsal pad*	**Asymptotic Sig.**
Pearson Chi-square	0.136
Odds Ratio	0.318

Table 3 shows a chi-square result of 0.136 and an odd ratio of 0.318 which exceeds the significant value of p-value.

Table 4. Effect of Metatarsal Pad Administration on Participants with Front Foot Sole Pain on Spatiotemporal Gait Parameters

Variable	Intervention	Mean (SD)	p-value
Velocity (km/hr)	Before	3.3817 ± 0.566	0.477
	After	3.4535 ± 0.444	
Step Length (mm)	Before	564 ± 58	0.758
	After	550 ± 119	
Stride Length (mm)	Before	1167 ± 202	0.489
	After	1164 ± 127	
Stance Phase Duration (second)	Before	0.7953 ± 0.0938	0.295
	After	0.7953 ± 0.0938	

The results of the study in table 4 did not show significant results (p-value < 0.05) on spatiotemporal gait parameters, namely velocity, step length, stride length, and stance phase duration. This shows that there is no significant difference in the overall of the spatiotemporal variable gait parameter. However, the table above shows that there are changes in the amount before and after the use of the metatarsal pad. Characterized by a faster stance phase duration of participants after the metatarsal pad with a difference of 0.314 seconds. In other variables such as: velocity, step length, and stride length. It was found that the average variable decreased on average compared to after using the metatarsal pad for 2 weeks. The difference in each average difference from the variables shows a slower velocity (0.718), a shortened step length (14 mm), and a shorter stride length (3mm) than before the use of a metatarsal pad.

Discussion

a. Difference in The Degree of Pain of the Front Soles of the Feet Before and After Using the Metatarsal Pad

The results of this study were obtained that there was a difference in the degree of pain in the soles of the front feet before and after using the metatarsal pad. It is characterized by a change in the degree of pain as many as 10 people reduced their pain, 9 people felt more painful, and 11 people felt the same pain. The results in this study are in line with (Kang et al., 2006 and Pelly et al., 2020) those that state that there are differences between before and after the use of metatarsal pads. The results of this study showed the use of metatarsal pads from participants who felt pain in the soles of the front feet caused by RA. base pressure can be generated by force and area. When standing or walking, the legs serve to support the weight

ISSN 2962-8016

and produce a vertical force towards the soles of the feet. Pressure can increase when there is a force that increases in size accompanied by a support area that increases smaller (Bachus et al., 2006). When walking or standing, pressure does not occur in the 2nd and 3rd metatarsal spheres but also in all metatarsal spheres while walking with metatarsal pads (Lai et al., 2013). Dilation of pain felt by participants can be at risk of occurring if not given a pad under the metatarsal ball.

b. Relationship of Degree of Front Foot Pain Before and After Using Metatarsal Pad

The results of this study showed that there was no relationship between the degree of pain in the soles of the front feet before and after using the metatarsal pad. This result is not in line with the research of Kang et al (2006), in their research using a metatarsal pad design with dome types placed on the proximal spheres of the 2nd and 3rd metatarsal spheres. The relationship between the two conditions in this study refers to a theory that states that differences in the type of a tool can change the results of pressure that occurs when individuals wear it during activities (Lee P.Y et al., 2014). Metatarsal pad with plantar cover type can reduce pain in the soles of the front feet also due to differences in the width of the tool. The type of plantar cover in the shape of the upper surface cannot help support the transverse arch which can reduce the pressure on the metatarsal spheres. However, with this tool, it can cover the width of the soles of the front feet that are not supported by the transverse arch so that the metatarsal balls still get a reduction in pressure from the width of the tool. Coupled with the material that uses silicon studied, it can reduce excess pressure effectively and is greater when compared to other materials such as EVA and foam (Ghassemi et al, 2005).

c. Effect Before and After Metatarsal Pad Use on Spatiotemporal Gait Parameters On Front Foot Pain

The results of this study showed that there were changes in spatiotemporal gait parameters in the use of metatarsal pads for 2 weeks in participants who had insignificant foot pain in the front. Insignificant changes occurred as a result of p- value >0.05 covering velocity (p-value= 0.477), step length (p-value= 0.758), stride length (p-value= 0.489), and stance phase duration (p-value= 0.295). The results of this study are in line with the study of Othmane et al (2004), which compared spatiotemporal gait parameters before and after using orthoses. In this study, there were insignificant changes in velocity, step length, stride length, and stance phase duration (p-value >0.01). In this study, as many as 16 participants experienced pain in the soles of the front feet caused by RA with an average age of 52 years. The changes that occur in each variable of this study are in accordance with the research theory (O'Connell et al., 1998) which states that there is a change in spatiotemporal gait parameters when a person who has pain when walking. The difference in the duration of use of metatarsal pads in each study is different. Generally, the duration of the intervention to run for 1-2 years (Kang et al., 2006; His et al., 2006 and Li et al., 2011). The average study that provided conservative interventions such as metatarsal pads was carried out to a minimum for 3 months with time for adaptation to walk using metatarsal pads for 1-2 weeks (Rizzo et al., 2012). In this study, the duration of the study used a metatarsal pad for 2 weeks. This may increase the likelihood of differences in results on the influence of spatiotemporal gait parameters before and after using the metatarsal pad on front foot pain.

Conclusion

1. There were differences in participants' pain degrees before and after using the metatarsal pad.

ISSN 2962-8016

2. There is an insignificant association of the degree of pain in the soles of the front feet before and after using the metatarsal pad.

3. There are spatiotemporal gait differences in parameters before and after using the metatarsal pad on all its variables.

4. There is an influence on spatiotemporal gait parameters on velocity variables and stance phase duration before and after the use of metatarsal pads. However, there is no influence on the step length and stride length before and after the use of the metatarsal pad.

Recommendation

1. **For Participants and the Community**
   Participants or the public are advised to increase knowledge and increase awareness of front foot pain, the risks that can cause the pain, and complications that can occur if the pain is ignored.
2. **For Prosthetics and Orthotics Department**
   This research was obtained as additional information for the conservative treatment of front foot pain using a metatarsal pad to the academic community in other majors.
3. **For Professional Organizations**
   The results of this study can be used in the field of health services, especially in services in the field of orthotics for treating someone who has foot pain with providing metatarsal pad.
4. **For Future Researchers**
   This research is expected to be developed with a longer duration of metatarsal pad use, a larger number of participants, and providing other design comparisons.

References

Bachus, K. N., DeMarco, A. L., Judd, K. T., Horwitz, D. S., & Brodke, D. S. (2006). Measuring contact area, force, and pressure for bioengineering applications: using Fuji Film and TekScan systems. *Medical Engineering & Physics*, *28*(5), 483-488.

Chien, Hui-Lien, Tung-Wu Lu, and Ming-Wei Liu. "Control of the motion of the body's Center of Mass in relation to the center of pressure during highheeled gait." Gait & posture 38.3 (2013): 391-396.

D.E. Turner; P.S. Helliwell; K. Lohmann Siegel; J. Woodburn (2008). Biomechanics of the foot in rheumatoid arthritis: Identifying abnormal function and the factors associated with localised disease

Ghassemi, A., Mossayebi, A. R., Jamshidi, N., Naemi, R., & Karimi, M. T. (2015). Manufacturing and finite element assessment of a novel pressure reducing insole for Diabetic Neuropathic patients. *Australasian physical & engineering sciences in medicine*, *38*, 63-70.

Hastario T. Dicky. (2019). Quasi-Experimental Design His J, Alex M.J, Aaron S.P, Eden K, (2011) Optimum Position of Metatarsal pad in Metatarsalgia for Pressure Relief

Kang JH, Chen MD, Chen SC, Hsi WL. Correlations between subjective treatment responses and plantar pressure parameters of metatarsal pad treatment in metatarsalgia patients: a prospective study. BMC Musculoskelet Disord. 2006 Dec 5;7:95. doi: 10.1186/1471-2474-7-95. PMID: 17147793; PMCID: PMC1712337.

Kang Moung Jo, Park Bo Yong, Lee Min Syik, (2006). Correlations between subjective treatment responses and plantar pressure parameters of metatarsal pad treatment in metatarsalgia patients: a prospective study

Keizer, M. N., Otten, E., Beijersbergen, C. M., Brouwer, R. W., & Hijmans, J. M. (2021). Copers and noncopers use different landing techniques to limit anterior tibial translation after anterior cruciate ligament reconstruction. *Orthopaedic journal of sports medicine*, *9*(4), 2325967121998061.

ISSN 2962-8016

Lee, P. Y., Landorf, K. B., Bonanno, D. R., & Menz, H. B. (2014). Comparison of the pressure-relieving properties of various types of forefoot pads in older people with forefoot pain. *Journal of foot and ankle research*, *7*(1), 1-8.

Manupibul, U., Charoensuk, W., & Kaimuk, P. (2014). Design and development of SMART insole system for plantar pressure measurement in imbalance human body and heavyactivities.

Mølgaard, C., Lundbye-Christensen, S., & Simonsen, O. (2010). High prevalence of foot problems in the Danish population: a survey of causes and associations. *The foot*, *20*(1), 7-11.

Othmane Mejjad, Olivier Vittecoq, Sophie Pouplin, Léocadie Grassin-Delyle, Jacques Weber, Xavier Le Loët, Foot orthotics decrease pain but do not improve gait in rheumatoid arthritis patients, Joint Bone Spine, Volume 71, Issue 6, 2004, Pages 542-545

Ozdinc, S. A., & Turan, F. N. (2016). Effects of ballet training of children in Turkey on foot anthropometric measurements and medial longitudinal arc development. *J. Pak. Med. Assoc*, *66*(7), 869-874.

Pelly, T., Holme, T., Tahir, M. A., & Kunasingam, K. (2020). Forefoot pain. *bmj*, *371*.

Platto MJ, O'Connell PG, Hicks JE, Gerber LH. The relationship of pain and deformity of the rheumatoid foot to gait and an index of functional ambulation. The Journal of Rheumatology. 1991 Jan;18(1):38-43. PMID: 2023197.

Rizzo, L., Tedeschi, A., Fallani, E., Coppelli, A., Vallini, V., Iacopi, E., & Piaggesi, A. (2012). Custom-made orthesis and shoes in a structured follow-up program reduces the incidence of neuropathic ulcers in high-risk diabetic foot patients. *The international journal of lower extremity wounds*, *11*(1), 59-64.

Rome, K., Survepalli, D., Sanders, A., Lobo, M., McQueen, F. M., McNair, P., & Dalbeth, N. (2011). Functional and biomechanical characteristics of foot disease in chronic gout: a case-control study. *Clinical biomechanics*, *26*(1), 90-94.

Stewart, Sarah; Morpeth, Trish; Dalbeth, Nicola; Vandal, Alain C.; Carroll, Matthew; Davidtz, Lisa; Mawston, Grant; Otter, Simon; Rome, Keith (2016). Foot-related pain and disability and spatiotemporal parameters of gait during self-selected and fast walking speeds in people with gout: A two-arm cross sectional study. Gait & Posture, 44(), 18–22. doi:10.1016/j.gaitpost.2015.11.004

ISSN 2962-8016