JPOST Journal of Prosthetics Orthotics Science Technology
Volume 2, Number 2 Year 2023
ISSN (online): 2962-8016
DOI: 10.36082/jpost.v2i2.1363

The Effect of Toe-Only Rocker Sole at 10-Degree's Extension on Dynamic Balance in Transtibial Prosthesis Users

Dody Suprayogi[1*], Agus Setyo Nugroho[1]
[1]Prosthetics and Orthotics Department, Polytechnic of Health Sciences Surakarta, Indonesia

Correspondence*:
Address: Prosthetics and Orthotics Department, Polytechnic of Health Sciences Surakarta, Indonesia | e-mail: dodysupraa@gmail.com

Abstract

Background: For transtibial amputees, the use of a transtibial prosthesis has an impact on balance during daily activities (Wang et al., 2015). Apart from the prosthesis which affect walking patterns and balance, the use of the shoes related to the patient's balance. Modifications to the shoes of transtibial prosthesis users to achieve the best balance with toe-only rocker sole are considered an option to improve balance (Preece et al., 2017).
Objective: To determine the effect of a 10-degree toe-only rocker sole on dynamic balance in transtibial prosthesis users.
Methods and Subjects: This research was conducted from May to June in APOC Boyolali, using a quantitative research method using a quasi-experimental one group pre-test and post-test design. The sampling technique used is purposive sampling. The subjects used were transtibial prosthesis users.
Results: A Statistical analysis with a p value of 0.000 less than 0.05 revealed that the use of a toe only rocker sole of 10 degrees had an impact on dynamic balance in transtibial prosthesis users.
Conclusion: There is an effect of using a 10-degree toe only rocker sole to improve the dynamic balance of transtibial prosthesis users, so that reducing the risk of falls when carrying out daily activities.

Keywords: Toe only rocker sole, dynamic balance, transtibial prosthesis

Article History

Received date: 13-09-2023
Revised date: 30-09-2023
Accepted date: 05-10-2023

Journal Prosthetics Orthotics and Science Technology (JPOST)
e-ISSN 2962-8016
Organized by Department of Prosthetics and Orthotics
Published by Poltekkes Kemenkes Jakarta I
email: jpost@poltekkesjakarta1.ac.id

Introduction

Balance is the relative ability to control the center of gravity or the body's center of mass relative to the base of support. The center of gravity is a point where the mass of an object is concentrated based on its gravitational pull. In order to maintain balance, the center of gravity must move to compensate for disturbances that can cause people to lose their balance (Giri & Borkar, 2021).

Balance involves various movements in each part of the body and is supported by the musculoskeletal system and fulcrum. The purpose of the body is to maintain balance, namely, to support the body against the force of gravity and other external factors, to maintain the body's center of mass so that it is parallel and balanced with the fulcrum, and to stabilize parts of the body when other bodies move. The ability to balance body mass with a fulcrum will enable humans to carry out activities effectively and efficiently (Marlian et al., 2020) (M. Haris Satria et al., 2023).

Factors that influence balance are center of gravity (COG), line of gravity (LOG) and base of support (BOS). The Center of Gravity (COG) is the main point on the body that distributes body mass evenly. If the body is always supported by this point, then the body is in balance. Balance disorders can occur due to changes in posture because of changes in the center of gravity. In humans, the center of gravity moves according to direction or changes in weight where the body can maintain balance without any change in support (M. Haris Satria et al., 2023).

Based on research conducted by (Sayyadfar et al., 2019), it was found that there was a significant increase in cadence and stride length when walking, and a significant reduction in various lower limb joint movements during walking between the use of shoes with toe only rocker sole compared to shoes with standard sole. Using shoes with toe only rocker soles can improve walking performance in patients with type 2 diabetes.

If someone has a transtibial amputation, they will need a replacement member that can replace the lost limb, such as a prosthesis. Where the role of a prosthesis is a tool to replace lost limbs and replace limbs according to missing or amputated limbs (Richardson & Dillon, 2017).

Transtibial prosthesis is an artificial leg that is used for people who have amputations below the knee. Toe-only rocker sole is the outsole part of the shoe that has a thicker sole than usual with a rounded forefoot. A transtibial prosthesis user needs balance when walking and carrying out daily activities. One of the benefits of using a toe only rocker sole is that it can improve gait parameters and dynamic balance when walking (Hashemi et al., 2021)

Based on preliminary studies conducted, it is known that one of the problems experienced by transtibial prosthesis users is that they are prone to falls. No previous studies have specifically examined the effect of using a toe only rocker sole on transtibial prosthesis users. This study aims to determine the effect of using shoes with a 10-degree toe only rocker sole on the dynamic balance of transtibial prosthesis users.

Methods

This research uses a quantitative method, quasi-experimental type, one group pre-test and post-test. The body balance was measured with the TUG test. The research was conducted in one group without a comparison group. The location of the research was APOC Boyolali. The study population was all patients who had a transtibial prosthesis made at APOC Boyolali. The sample was selected using a sampling technique using purposive sampling.

The classification of inclusion criteria in this study is subjects using unilateral transtibial prosthesis, subjects aged 17-65 years, subjects willing to carry out research procedures. The exclusion criteria in this study are subjects with bilateral prosthesis, subjects who are sick, subjects who are pregnant, subjects who are sports athletes. Data processing uses SPSS, normality test first then hypothesis test.

Results

The characteristics of continuous data research subjects in this study were age, body mass index, dynamic balance before treatment and after treatment. The descriptive statistical results of the characteristics of continuous data research subjects can be seen in Table 1 as follows:

Table 1. Characteristics of continuous data subjects

Variable	N	Min.	Max.	Mean
Usia	30	24	58	35.67
IMT	30	16.41	23.94	21.72
Pre test	30	8.64	12.60	11.19
Post test	30	8.05	11.82	10.09

Source: Primary data processed, 2023

The descriptive statistical results of the characteristics of continuous data research subjects show that the average value for age is 35.67 years, meaning that this age is productive age and is included in the adult category. The average BMI value is 21.72 which is included in the ideal category. The average result of dynamic balance measurements before intervention was 11.19 seconds, and the average result of dynamic balance measurements after intervention increased or was better to 10.09 seconds.

The characteristic of the categorical data research subjects in this study is gender. The descriptive statistical results of the characteristics of the categorical data research subjects can be seen in Table 2 and are as follows:

Table 2. Subject Characteristics Categorical data

Gender	N	frequency (%)
Male	19	63.3
Female	11	36.7
Total	30	100

Source: Primary data processed, 2023

The descriptive statistical results of the characteristics of the categorical data subjects show that of the total research subjects, namely 30 transtibial prosthesis users, the majority were male, namely 19 people (63.3%).

The normality test used was the Shapiro Wilk test because the sample in this study was a small sample (< 50). The purpose of the normality test is to find out what statistics will be used in data analysis, whether the type of statistics is parametric or non-parametric. The results of the data normality test can be seen in Table 3 as follows:

Table 3. Shapiro Wilk Test

Variabel	p value	Information
Pre test	0.021	Abnormal
Post test	0.334	Normal

Source: Primary data processed, 2023

The results of the normality test with the Shapiro Wilk test show that the pre-test variables are not normally distributed, and the post-test variables are normally distributed, so the hypothesis test uses a non-parametric statistical test, namely the Wilcoxon test.

Testing the hypothesis of the effect of a 10-degree toe-only rocker sole on dynamic balance in transtibial prosthesis users using the Wilcoxon test. The results of the hypothesis test can be seen in Table 4 as follows:

Table 4. Wilcoxon Test

Variabel	Mean	z	p value
Pre Test	11.19	-	0.000
Post Test	10.09	3.779	

Source: Primary data processed, 2023

The results of the hypothesis test on dynamic balance obtained a z value of -3.779 with a mean before and after treatment that increased by 1.1 seconds and a p value of 0.000, so it can be concluded that there is an influence of dynamic balance on transtibial prosthesis users before and after the intervention which is statistically significant.

Discussion

This study is the first study to examine the dynamic balance of transtibial prosthesis users using shoes with modified soles. Data on subjects who experienced transtibial amputations were data obtained from patients who had transtibial prostheses made at the APOC Boyolali clinic. From data on patients who came to the Boyolali APOC clinic, 30 patients who used transtibial prosthesis met the inclusion and exclusion criteria. The subjects' ages ranged from 24 years to 58 years. The results of this study are in accordance with research conducted by (Kolářová et al., 2021) which in this study used research subjects with ages ranging from 18 years to 70 years.

The criteria data for this research subject is primary data obtained from direct measurement results on research subjects. The research subjects were transtibial prosthesis users with an average body mass index value of 21.72, which means it is in the normal category, because dynamic balance is influenced by body mass index. In accordance with the results of research conducted by (Cancela Carral et al., 2019) which concluded that people with a body mass index in the obesity category have poor balance, people with obesity have a high risk of falling. Apart from that, the results of this study are also in accordance with research conducted by (Handayani et al., 2022), namely that subjects with body mass index influence postural balance which includes static balance and dynamic balance.

When carrying out activities, prosthesis users must have good dynamic balance, so they don't fall easily. One thing that can be done to improve dynamic balance is to make modifications to the shoes worn by transtibial prosthesis users. One shoe modification can be done to the shoe sole in the form of a toe only rocker sole. According to (López-Moral et al., 2019), using shoes with rocker soles can make it easier for users to carry out the push off phase which then becomes the swing phase in walking.

In this study, subjects who used transtibial prostheses were then given intervention by using shoes with toe only rocker soles. This intervention is provided in accordance with the results of research by (Hashemi et al., 2021) which states that the large angle of shoes with toe only rocker soles help increase ankle joint movement when used for walking, so that walking speed becomes better which results in increased balance and risk. fall becomes smaller.

From the research results, it was found that there was a statistically significant difference in dynamic balance before and after the intervention, namely (z = -3.779, mean difference 1.1 and p value = 0.000. This means that using shoes with a toe only rocker sole can reduce the risk of falling due to increased dynamic balance. The results of this study are in accordance with research conducted by (Sayyadfar et al., 2019) which concluded that the use of shoes with a toe only rocker sole affects walking speed. Shoes with a toe only rocker sole have a more extended sole surface in the forefoot area and cannot reduce pressure on the soles of the feet, especially in the forefoot area. Apart from that, the more extended shape of the forefoot sole area makes the push phase easier and faster.

The research results show that based on dynamic balance measurements using the TUG test, the use of shoe soles with a toe only rocker sole of 10 degrees increases dynamic balance. These results are in line with research conducted by (Gordahani & Arazpour, 2020) which shows that the use of shoes with a heel to toe rocker sole increases stride length. This is because apart from shoes with a heel to toe rocker sole type, this creates a phase from heel strike to toe phase. of when walking becomes faster. This means that increasing walking speed is associated with increased dynamic balance, so the risk of falling becomes smaller.

In accordance with the results of observations and interviews with subjects after using shoes with a modified toe only rocker sole of 10 degrees, the subject said that when using shoes with a rocker sole of 10 degrees, it felt easier to step, as if someone was helping to encourage the movement of the feet when walking. This is in accordance with research conducted by (Ghomian et al., 2019), that the use of shoes with toe only rocker soles with different degrees has the impact

of increasing stability in walking, apart from that the factor that influences stability in walking is the courage of the subject to walk using footwear that is are new or have never previously used footwear with a design such as a toe only rocker sole, so there is a fear of falling when walking. Apart from shoe factors, one of the factors that influences the results of dynamic balance examination in transtibial prosthesis users when collecting data is the subject's adaptability. One of these adaptation factors is influenced by self-confidence and courage to walk when wearing shoes. There were several subjects who, when using shoes with toe only rocker soles, said they were afraid of falling, so they needed a little education and motivation for the subjects to check their balance.

For transtibial prosthesis users, choosing footwear or shoes is important to help with daily activities. The choice of shoes or footwear is important because transtibial prosthesis users certainly have a higher risk of falling. According to the results of the assessment carried out by (Jellema et al., 2019), the conclusion was that choosing shoes is important and should not be ignored, shoes with special designs or according to conditions and needs are needed to provide stability during activities.

Shoes are a support for activities, including for transtibial prosthesis users. One of the good shoes has a sole made from a material with a texture that is not too hard with the aim of reducing pressure. In accordance with the results of research conducted (Kenny et al., 2019) which concluded that using shoes whose soles are made from textured material improves balance. This shows that the use of shoes with a non-hard textured sole material and modified with a toe only rocker sole can improve the balance of transtibial prosthesis users, thereby reducing the risk of falls.

Conclusion and Recommendation

The findings of this study provide conclusive evidence supporting the notion that incorporating shoes equipped with a specialized 10-degree toe-only rocker sole significantly enhances the dynamic balance of individuals utilizing transtibial prostheses. As a result, it is strongly recommended that individuals with transtibial prostheses consider integrating such footwear into their daily activities. This proactive measure is particularly pertinent as it has the potential to effectively mitigate the risk of falls during routine tasks and, consequently, enhance the overall safety and stability of individuals relying on transtibial prosthetic devices. Therefore, the adoption of shoes featuring a 10-degree toe-only rocker sole emerges as a valuable and practical recommendation for optimizing the functional mobility and reducing the likelihood of falls among transtibial prosthesis users in their everyday lives.

References

1. Cancela Carral, J. M., Ayán, C., Sturzinger, L., & Gonzalez, G. (2019). Relationships Between Body Mass Index and Static and Dynamic Balance in Active and Inactive Older Adults. *Journal of Geriatric Physical Therapy*, *42*(4), E85–E90. https://doi.org/10.1519/JPT.0000000000000195
2. Giri, H. S., & Borkar, P. (2021). Effects of sensory stimulation on balance and postural control in diabetic neuropathy: systematic review. *International Journal of Research in Medical Sciences*, *9*(7), 2090. https://doi.org/10.18203/2320-6012.ijrms20212531
3. Gordahani, S. A. A., & Arazpour, M. (2020). The Effect of a Heel to Toe Rocker Sole on Walking in Patients with Type 2 Diabetes. *Journal of Clinical Physiotherapy Reseach*, *5*(3).
4. Handayani, M., Sayuti, M., & Nadira, S. (2022). RELATIONSHIP BETWEEN BODY MASS INDEX AND POSTURAL BALANCE AMONG STUDENTS OF THE MARTIAL ARTS CLUB MALIKUSSALEH UNIVERSITY. *Jurnal Kedokteran Diponegoro*, *11*(3), 131–137. http://ejournal3.undip.ac.id/index.php/medico

5. Hashemi, H., Bahramizadeh, M., Arazpour, M., & Aboutorabi, A. (2021). Effect of Toe Only Rocker at 10 and 15 Degrees on Balance and Walking Speed in Elderly Adults. *Journal of Rehabilitation*, *22*(2), 168–181. https://doi.org/10.32598/RJ.22.2.2883.2
6. Jellema, A. H., Huysmans, T., Hartholt, K., & van der Cammen, T. J. M. (2019). Shoe design for older adults: Evidence from a systematic review on the elements of optimal footwear. In *Maturitas* (Vol. 127, pp. 64–81). Elsevier Ireland Ltd. https://doi.org/10.1016/j.maturitas.2019.06.002
7. Kenny, R. P. W., Atkinson, G., Eaves, D. L., Martin, D., Burn, N., & Dixon, J. (2019). The effects of textured materials on static balance in healthy young and older adults: A systematic review with meta-analysis. In *Gait and Posture* (Vol. 71, pp. 79–86). Elsevier B.V. https://doi.org/10.1016/j.gaitpost.2019.04.017
8. Kolářová, B., Janura, M., Svoboda, Z., Kolář, P., Tečová, D., & Elfmark, M. (2021). Postural control strategies and balance-related factors in individuals with traumatic transtibial amputations. *Sensors*, *21*(21). https://doi.org/10.3390/s21217284
9. López-Moral, M., Lázaro-Martínez, J. L., García-Morales, E., García-Álvarez, Y., JavierÁlvaro-Afonso, F., & Molines-Barroso, R. J. (2019). Clinical efficacy of therapeutic footwear with a rigid rocker sole in the prevention of recurrence in patients with diabetes mellitus and diabetic polineuropathy: A randomized clinical trial. *PLoS ONE*, *14*(7). https://doi.org/10.1371/journal.pone.0219537
10. M. Haris Satria, Kesumawati, S. A., Desi Arisandy, & Mutiara Karama. (2023). Balance Board Sensory to Increase Body Balance's Children with Special Needs. *Kinestetik : Jurnal Ilmiah Pendidikan Jasmani*, *7*(1), 205–211. https://doi.org/10.33369/jk.v7i1.26704
11. Marlian, N., Program, Y., Profesi, S. P., Fakultas, F., Kesehatan, I., Program, M. A., Muhammadiyah, U., Safun, M., Program, R., Susanti, S., Studi, P., Profesi, P., & Septyorini, M. (2020). GAMBARAN AKTIVITAS FISIK BERKORELASI DENGAN KESEIMBANGAN DINAMIS LANSIA. *Jurnal Sport Science*, *10*(2).
12. Preece, S. J., Chapman, J. D., Braunstein, B., Brüggemann, G. P., & Nester, C. J. (2017). Optimisation of rocker sole footwear for prevention of first plantar ulcer: Comparison of group-optimised and individually-selected footwear designs. *Journal of Foot and Ankle Research*, *10*(1). https://doi.org/10.1186/s13047-017-0208-3
13. Richardson, A., & Dillon, M. P. (2017). User experience of transtibial prosthetic liners: A systematic review. In *Prosthetics and Orthotics International* (Vol. 41, Issue 1, pp. 6–18). SAGE Publications Inc. https://doi.org/10.1177/0309364616631343
14. Sayyadfar, M., Arazpour, M., Bahramizadeh, M., & Bani, M. A. (2019). *The Immediate Effect of the Toe only Rocker on Walking Parameters in the Patients with Type 2 Diabetes. Journal of Clinical*.
15. Wang, Q., Yuan, K., Zhu, J., & Wang, L. (2015). Walk the walk: A lightweight active transtibial prosthesis. *IEEE Robotics and Automation Magazine*, *22*(4), 80–89. https://doi.org/10.1109/MRA.2015.24087