JPOST Journal of Prosthetics Orthotics Science Technology
Volume 1, Number 1 Year 2022
ISSN (online): xxxx-xxxx DOI: 10.36082/jpost.v1i1.630

GAIT ANALYSIS: THE EFFECT OF SUSPENSION TYPE IN TRANSFEMORAL PATIENT

Linda Rahmawati[1], Olle Hjelmstrom[2], Ns. Widada[3], Burlian Mughnie[1]
[1]Prosthetics and Orthotics Department, Poltekkes Kemenkes Jakarta, Indonesia
[2]Exceed Worldwide, Sweden
[3]Faculty of Nursing and Midwifery, Universitas Binawan, Indonesia

Article Info

Article History:
Submitted: 01-07-2022
Revised: 01-07-2022
Accepted: 01-07-2022

Keywords:
gait analysis, silesian belt suspension, silicone liner with lanyard suspension, Transfemoral prosthesis.

Abstract

Background: common problems that occur in patients with transfemoral is the lack of stability during using the prosthesis and will result in gait deviation. One of the most important components in improving the stability of the patient is the selection of the type of suspension that appropriate to the patient's needs so as to improve gait. **Objective**: This study aimed to determine the difference cadence, walking speed and step length transfemoral patients when using different types of suspension. **Methods**: The study was conducted using the method of observation. Sample research is 4 transfemoral patients have an age of 26-60 years and male sex. Patients were asked to use Silesian Belt suspension and silicone liner with lanyard suspension respectively for 7 days. Observations using tape record. Differences cadence, walking speed and stride length calculated at the time when patient walks in the 10-meter walking test. Research carried out in clinical laboratories prosthetics and orthotics department.
Results: Results indicate that there are significant differences in the type of suspension against cadence, walking speed and stride length even though significant only on the difference cadence. Another factor studied in this research is the influence of age and the length of the patient's stump in cadence, walking speed and stride length. **Conclusion**: This research found that the cadence, walking speed and stride length of the transfemoral patients have differences when using two different types of suspension.

Author Correspondence:
Linda Rahmawati
Jl. Wijaya Kusuma Rya No.48, Cilandak, Jakarta Selatan, Indonesia
Email: linda.rah@jspo.ac.id

Introduction

Amputation is the removal of one or more body parts and can be the result of a catastrophe or natural disaster, unprecedented, such as accidents, earthquakes of strong intensity, terrorism and war, or carried out for medical reasons with a motive to improve the health and quality of life of the patient. This action is an action taken in the last condition when organ problems that occur in the extremities are impossible to fix using other techniques, or when the condition of the organs can endanger the safety of the patient's body as a whole or damage other organs (Demet et al., 2003).

Transfemoral is a lower limb amputation, that is, a level amputation above the knee. Transfemoral amputation is to cut part of the femur, which is the bone in the thigh (Myers & Chauvin, 2021). Amputation part of the femur can be done anywhere from the femur. Amputations over the knee are often caused by trauma, vascular disease, infections, tumors, and birth defects. Accidents and tumors are the most often cause people to be required to have amputations with an amputation level of the knee. Amputation over the knee is generally divided into three parts, namely 1/3 proximal to the femur, 2/3 proximal to the femur, and 3/3 proximal to the femur. Amputation over the knee can interfere the person with the amputation both psychologically and in daily activities, because the body part is large enough to make it difficult for the person with the amputation to stand or even walk.

To help overcome the limitation of activity that occurs in someone who has lost a leg due to an amputation, a prosthesis made by a prosthetist is used. With a prosthesis, it is hoped that the patient's limbs can be equipped so that he can carry out his daily activities (Fiedler et al., 2014).

The gait of a patient using a prosthesis is certainly not the same as the gait of a normal person, this is known as a gait deviation, which is a patient's gait deviation that is not the same as a person's normal gait or abnormal gait (Handžic & Reed, 2015). The patient's gait deviating from the normal gait is part of the gait analysis that is usually performed in amputated patients (Handžic & Reed, 2015). The gait analyzed included gait deviations, calculating cadence or the number of steps the patient took in one minute, calculating the patient's walking speed, and the patient's stride length (Rota et al., 2011).

In addition to correcting gait, the selection of the right components can help improve the gait of a patient with a prosthesis. The components of the transfemoral prosthesis include socket, shank, artificial knee joint, artificial leg and suspension system (Pitkin, 2016).

Of all the components, the type of suspension is one of the important components that will keep the socket on the stump and will also affect the way the transfemoral patient walks (Paternò et al., 2018). Each type of suspension still has drawbacks that will affect the outcome of the patient's transfemoral gait (Pitkin, 2016). The purpose of this study was to measure the effect of suspension type on differences in cadence, walking speed and stride length of Transfemoral patients in order to obtain a good suspension type to help improve the gait of transfemoral patients.

Methods

The type of research used is quantitative analysis by calculating the average cadence, walking speed and stride length. The research design was a quasi-experimental, time series design, with the characteristic that there was no control group and was given a pretest to ensure that the group was stable and consistent before the research was carried out. The research instruments used were a stopwatch, a 10-meter walking test, a pedometer and a video recorder to measure the speed and steps of the transfemoral patient. Types of prostheses used by patients in this study were transfemoral prosthesis with quadrilateral socket design criteria, Silesian Belt suspension, silicon liner suspension with lanyard and a combination of the two, IM-Limbs relief knee joint, endoskeletal shank, and the type of foot used dynamic foot. Cadence and walking speed are calculated when the patient is walking on a track with a length of 10 meters and the time will be calculated using a stopwatch. To calculate the length of the steps the patient walks as many as 10 steps and the distance will be measured using a meter. Then it will be divided by 10 to determine the average stride length.

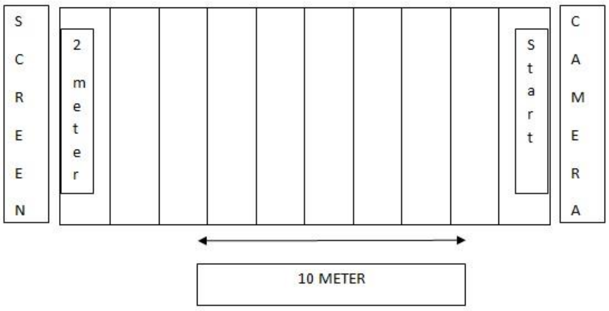

Figure 1. 10-meter walking test

Then do the processing and data analysis using univariate and bivariate analysis techniques. Univariate analysis yielded data on cadence, walking speed and stride length from 4 different patients when using lanyard and Silesian Belt suspension types. Bivariate analysis provides the measurement results of each variable with a different type of suspension.

Results

Cadence using Silesian Belt suspension was 88.79 steps / minute, while the average cadence using silicone liner with lanyard suspension was 83.65 steps / minute. Thus, it can be interpreted that there is an effect of differences in the features found in Silesian Belt suspension with a difference of 5.14 steps / minute more than the silicone liner with lanyard suspension. From the results of the independent t-test analysis, p-value 0.025 <0.05, which means that there is a significant difference in cadence when the patient uses Silesian belt suspension and silicone liner with lanyard suspension.

Tabel 1

Cadence measurements result using independent T-Test on Silesian belt and lanyard suspension

	Tipe alat	N	Mean	Std. Deviation	Std. Error Mean
Cadence	silesian	40	88.7915	7.45014	1.17797
	lanyard	40	83.6587	12.11856	1.91611

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
cadence	Equal variances assumed	8.664	.004	2.282	78	.025	5.13275	2.24924	.65485	9.61065
	Equal variances not assumed			2.282	64.795	.026	5.13275	2.24924	.64043	9.62507

Meanwhile, the results of the bivariate analysis of walking speed and stride length obtained p-value 0.025> 0.05, which means that there is no significant difference in walking speed and stride length when the patient uses Silesian Belt suspension and silicone liner with lanyard suspension.

Discussion

The results of testing on two different types of suspension, namely Silesian Belt suspension and silicone with lanyard suspension without any other factors affecting the data analysis system produced the following data:

In Cadence, the data obtained is in the form of the number of steps in 1 minute which is calculated from meter 1 to meter 10 on the 10-meter walking test. The mean cadence when patients walked using a transfemoral prosthesis with Silesian Belt suspension and silicone with lanyard suspension showed a significant difference. The cadence value was higher when the patient walked using Silesian Belt suspension, which was 88.79 steps / minute. Likewise, with walking speed, the patient has a walking speed of a difference of 0.0392 m / s faster than the silicone liner with lanyard suspension. Walking speed is measured from the 2nd meter to the 8th meter from the 10-meter walking test distance. The results obtained will be divided by 6, because the number of meters in the calculation is 6 meters. Then we get data that has units of meters per second. Then testing the stride length resulted in data that had a p-value of 0.167> 0.05, which means that there was no significant difference in stride length when the patient used Silesian Belt suspension and silicone liner with lanyard suspension.

Many factors can influence cadence, walking speed and stride length for transfemoral patients (Batten et al., 2019). Psychological factor is one of the influencing factors. Patient confidence and confidence in the prosthesis were associated with factors affecting cadence, walking speed and stride length (Espy et al., 2010).

Based on the value of Cadence, walking speed and stride length of the transfemoral patient, the authors can draw a conclusion that the Silesian Belt suspension gives a result that is close to the normal value of gait in transfemoral patients. This is because the patient's stability is maintained when using a Silesian Belt suspension. The advantage of using a Silesian Belt suspension is that it is easy to use and can be used for all types of stump lengths (Paikray et al., 2021). The use of a cylindrical belt can also improve patient comfort in using a prosthesis. This is based on the suspension system which is directly in contact with the patient's body and also the patient can adjust the degree of tightness of the cylindrical belt himself.

Conclusion

In testing, it was found that there was an effect of different types of suspension on cadence, running speed, and stride length, although only the difference in cadence was significant. Cadence decreased by 5.14 steps / minute while the patient was using silicone with lanyard suspension. The walking speed and stride length were closer to normal values when the patient walked using a Silesian Belt suspension than when the patient used silicone with lanyard suspension. However, the statistical test values of walking speed and stride length did not show a significant difference.

Due to several obstacles in this study, it is hoped that in future studies to increase the number of respondents in order to support the accuracy of the research results. Limitation of internal and external factors that can influence gait can reduce bias in results.

References

Batten, H. R., McPhail, S. M., Mandrusiak, A. M., Varghese, P. N., & Kuys, S. S. (2019). Gait speed as an indicator of prosthetic walking potential following lower limb amputation. *Prosthetics and Orthotics International*, *43*(2), 196–203. https://doi.org/10.1177/0309364618792723

Demet, K., Martinet, N., Guillemin, F., Paysant, J., & Andre, J.-M. (2003). Health related quality of life and related factors in 539 persons with amputation of upper and lower limb. *Disability and Rehabilitation*, *25*(9), 480–486. https://doi.org/10.1080/0963828031000090434

Espy, D. D., Yang, F., Bhatt, T., & Pai, Y. C. (2010). Independent influence of gait speed and step length on stability and fall risk. *Gait and Posture*, *32*(3), 378–382. https://doi.org/10.1016/j.gaitpost.2010.06.013

Fiedler, G., Akins, J., Cooper, R., Munoz, S., & Cooper, R. A. (2014). Rehabilitation of People with Lower-Limb Amputations. *Current Physical Medicine and Rehabilitation Reports*, *2*(4), 263–272. https://doi.org/10.1007/s40141-014-0068-8

Handžic, I., & Reed, K. B. (2015). Perception of gait patterns that deviate from normal and symmetric biped locomotion. *Frontiers in Psychology*, *6*(FEB), 1–14. https://doi.org/10.3389/fpsyg.2015.00199

Myers, M., & Chauvin, B. J. (2021). Above the Knee Amputations. In *StatPearls Publishing, Treasure Island (FL)*. StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK544350/?report=reader#_NBK544350_pubdet_

Paikray, S., Raihan, H. M. A., & Das, D. S. (2021). Comparative Effect between Silesian Suspension and Total Elastic Suspension on GRF Loading in Subjects with Trans-Femoral Prosthesis: A Biomechanical Study.

International Journal of Health Sciences and Research, *11*(7), 171–178. https://doi.org/10.52403/ijhsr.20210725

Paternò, L., Ibrahimi, M., Gruppioni, E., Menciassi, A., & Ricotti, L. (2018). Sockets for limb prostheses: A review of existing technologies and open challenges. *IEEE Transactions on Biomedical Engineering*, *65*(9), 1996–2010. https://doi.org/10.1109/TBME.2017.2775100

Pitkin, M. R. (2016). Effects of Design Variants in Lower-Limb Prostheses on Gait Synergy. *Physiology & Behavior*, *176*(1), 139–148.

Rota, V., Perucca, L., Simone, A., & Tesio, L. (2011). Walk ratio (step length/cadence) as a summary index of neuromotor control of gait: Application to multiple sclerosis. *International Journal of Rehabilitation Research*, *34*(3), 265–269. https://doi.org/10.1097/MRR.0b013e328347be02

Jl. Wijaya Kusuma No. 48 Cilandak Jakarta Selatan, Indonesia
email: jpost@poltekkesjakarta1.ac.id