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Original Research

Effect Of Use Of Flexible Transfemoral Prosthesis On Dynamic Balance Of Transfemoral Amputee

Nur Rachmat[1*], Bambang Kuncoro[2]

[1] Departement of Prosthetic Orthotic, Poltekkes Kemenkes Surakarta, Indonesia
[2] Departement of Occupational Therapy, Poltekkes Kemenkes Surakarta, Indonesia

ABSTRACT

Background: *The flexible transfemoral prosthesis is known to improve the level of independence in performing the daily activities of transfemoral amputees. Dynamic balance is needed by transfemoral amputee patients to be able to move properly.*

Methods*: The research was conducted using a quasi-experimental research design with the post-test-only design method. A sample was obtained by the purposive sampling process. The Four Square Step Test (FSST) is used as an instrument to measure the dynamic balance. It was performed on 30 transfemoral amputee patients using axillary crutches, and then the patient wears a flexible prosthesis. The research was done at PT Kuspito Orthotic Prosthetics, and it was carried out from May to September 2022.*

Results: *The research subjects were transfemoral amputee patients who met the inclusion and exclusion criteria determined by the researcher, a total of 30 patients. The subjects in this study were mostly male: 23 patients (76.67%). The largest proportions of respondents are aged 26–45 years (adults), as many as 17 people (56.675). The data normality test was obtained from dynamic balance using the four-square step IP-value of 0.07, which indicates that the data is normally distributed. With a significance of 0.000 and an average time to perform the four square step of 12.54 seconds versus 22.45 seconds with axillary crutches, patients walking with flexible artificial limbs had more stable balance than patients walking with axillary crutches.*

Conclusion: *Patients with flexible artificial limbs are more balanced. It is recommended for transfemoral amputee patients to use a flexible prosthesis to improve dynamic balance when walking, so they can move better.*

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CONTACT
Nur Rachmat
✉
nurrachmat@gmail.com
Departement of Prosthetic Orthotic, Poltekkes Kemenkes Surakarta. Jln. Captain Adi Sumarmo, Tohudan, Colomadu Karanganyar, Central Java Indonesia.

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INTRODUCTION

Lower limb amputations hinder the patient's activities and make it difficult for the patient to socialize with the community (Ostler et al., 2022). Rehabilitation in post-amputation patients is to restore the patient's mobility and balance by using a transfemoral prosthesis (Hebenton et al., 2019). Approximately 37% of lower limb

amputees are done at the transfemoral level (above the knee), and most of them are prescribed prostheses for walking (Barr & Howe, 2018).

Balance is the relative ability to control the center of gravity (COG) or the center of mass of the body at the base of its support. The point where the mass of an object is concentrated by virtue of its gravitational pull is called the center of gravity. In normal humans, the center of gravity is approximately in the inferior abdomen and anterior to the knee joint. In order to maintain balance, the center of gravity must move to compensate for disturbances that can cause people to lose their balance (Zhang et al., 2019).

Balance involves various movements in every 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 center of mass of the body so that it is parallel and balanced with the fulcrum, and to stabilize the body parts when the other body parts move (Irfan, 2010). The ability to balance body mass with the fulcrum will enable humans to move effectively and efficiently (Yuliana et al., 2014).

In order to be balanced in a standing position, the central nervous system functions to maintain the center of body mass in a stable state with the fulcrum boundaries unchanged unless the body forms another fulcrum boundary, as seen in walking people (Adenikheir, 2019). Balance is the body's ability to react to any changes in body position in order to remain stable and dynamic. Balance means the ability to maintain or control the neuromuscular system to work efficiently both when the body is at rest or in motion (Ringhof & Stein, 2018). Balance plays an important role in everyday life, with a decrease in balance will result in disruption of mobility and daily activities (J.-H. Lee, 2016).

One of the medical interventions that can be given to patients with amputations is the prosthetic orthotic service. Prosthetic orthotics are health services provided by prosthetic orthotics in terms of medical aids in the form of orthoses or prostheses. The orthosis is a medical aid that functions for bracing, splinting, and supporting and is attached outside the body. It is intended for patients or clients in need. The prosthesis is a replacement device for limbs that are paired outside the body and intended for patients or clients in need (Permenkes No. 22, 2013).

A prosthetic intervention that can be given to patients with transfemoral amputations is the transfemoral prosthesis. A transfemoral prosthesis is a replacement tool for people with above-the-knee amputations, the main causes of which include diabetes, infection, and repeated total knee arthroplasty dislocation (Jamari & Ismawan, 2015). The use of the prosthesis is expected to complete the patient's limbs so that he can carry out his daily activities (Bactiar et al., 2014).

Another prosthetic orthotic intervention for patients with transfemoral amputations is the axillary crutch. An axillary crutch is a walking aid in the form of a stick with a handle in the middle so that it can be used as a handle by clamping the tool in the armpit (Silva et al., 2015). The use of an axillary crutch really helps people with disabilities to be more mobile. In addition to transfemoral amputation patients, the axillary crutch can be used for other conditions, namely paraplegia, fractures, ligament injuries, and others (Vetrayan et al., 2016).

The four-square-step exercise is an exercise technique used to increase the vestibular system. At the time of maintaining the balance of information received by the muscular, articular, and vestibular organs of the body. It will give information about

nerve impulses called sensory receptors that reach the brain (Syah & Olyverdi, 2021). Previous research shows that the functional independence of transfemoral amputees is strongly influenced by the use of a flexible prosthesis (Rachmat & Kuncoro, 2022). The study's goal is to determine the impact of flexible transfemoral prostheses on the dynamic balance of transfemoral amputees.

MATERIALS AND METHOD

This research was carried out from May to September 2022. This research was conducted to determine the effect of flexible artificial legs on balance in prosthesis users. The research was conducted using a quasi-experimental research design with the Post-test only design method. Research with a cross-sectional design is a research design in which measurements and observations are carried out simultaneously at one time.

The sample was obtained by purposive sampling process, the inclusion criteria: subjects are prosthesis users, good range of motion, and are in healthy condition. The exclusion criteria are: being a bilateral amputee, being pregnant, or not being willing to contribute to the research as the subject. The patient has signed the informed consent for the conduct of the study. Ethical clearance was obtained from Poltekkes Kemenkes Surakarta, No. LB.02.02/1.1/693.6/2022.

Figure 1. Flexible Transfemoral Prosthesis

Prior to data collection, samples were directed to wear a medical mask, check their temperature, and wash their hands with a hand sanitizer to maintain health protocols in order to prevent the spread of COVID-19. At the time this research period was conducted, COVID-19 was still a pandemic. People should monitor their temperatures and wash their hands with hand sanitizer to maintain health protocols in order to prevent the spread of COVID-19.

At the time this research period was conducted, COVID-19 was still a pandemic. This study begins with ascertaining the patient's general health condition, then explaining the research to be carried out to the sample by explaining the research objectives, the benefits of the research, and the stages of the research. Then, check the weight, and height.

Furthermore, distributing dynamic balance measurement questionnaires with the Four Square Step Test (FSST). The Four Square Step Test was performed on 30 transfemoral amputee patients using axillary crutches. Then the patient wears a flexible

artificial leg, as shown in Figure 1, and then measures dynamic balance with the Four Square Step Test.

The measuring tool used in this study is the four-square step test. It was used to measure the dynamic stability of the subject and to measure the ability to step forward, the ability to move sideways, and the ability to step backward (Shirley, 2021). The following is the implementation procedure: before beginning the test, site preparation was carried out by arranging several sticks to form four boxes, as shown in Figure 2.

The patient was shown a step-by-step demonstration by the researcher. Make sure the patient understands the instructions given. Instruct the patient to complete the steps on FSST as quickly and safely as possible without falling, and try to look forward during the process. It will be considered necessary to repeat the measurement if all steps are not completed or the patient loses balance or falls.

This measurement process is a modification of the existing FSST. Stage 1 measurement is the measurement of FSST in patients not using a flexible prosthesis. Transfemoral amputee patients are asked not to use a prosthesis but only to use axillary crutches. To start, the patient is asked to stand at the starting point, namely box A facing box B, then be asked to step to box B, then step to box C, then step to box D, then turn around to face box C, then step to box C, then step to box B, and finally step to box A. The faster you go, the better. Two patient trials were performed, and the fastest time was taken as the patient's FSST score using axillary crutches.

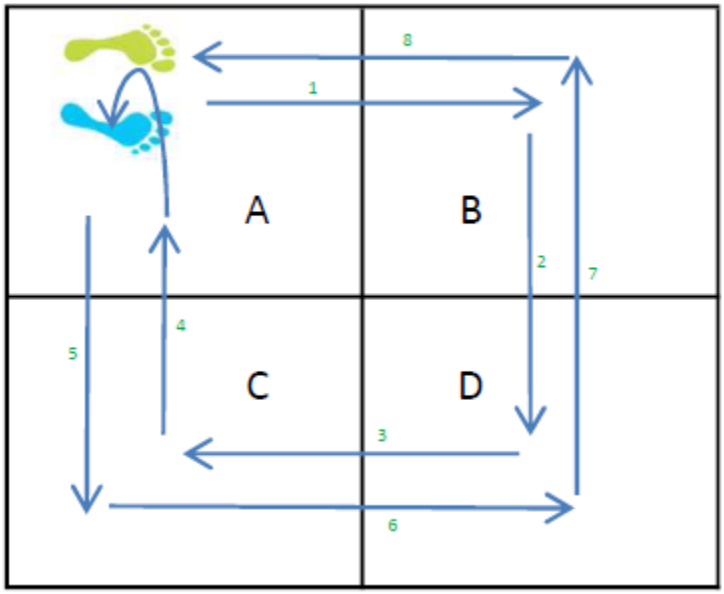

Figure 2. Four Square Step Test

Stage 2 measurements are carried out by instructing the patient to wear a flexible prosthesis, then having them perform the FSST in the same steps. The patient is asked to stand at the starting point, namely box A facing box B, then be asked to step to box B, then step to box C, then step to box D, then turn around to face city C, then step to box C, then step to box B, and final step to box A. The faster you go, the better. Two patient trials were carried out, and the fastest time was taken as the patient's FSST score using a transfemoral prosthesis.

Time measurement with a stopwatch on FSST begins when the respondent steps into box B and ends when the respondent steps back into box A. The score obtained is

in seconds. Any aids used during the test are properly recorded. The research results are presented in tabular form: frequency distribution data, descriptive analysis, normality test, and paired T-test.

RESULTS

The research subjects were transfemoral amputee patients who met the inclusion and exclusion criteria determined by the researcher. There were a total of 30 patients, and the subjects' ages ranged from 17 years to 60 years, as shown in Table 1 below.

Table 1. Characteristics of subjects

Description	Frequency	Percentage
Age of subjects		
17 – 25 (teenager)	10	33,33%
26 – 45 (maturely)	17	56,67%
46 – 65 (elderly)	3	10,00%
Gender of subject		
Male	23	76,67
Female	7	23,33
Amputation side		
Right	16	53,33%
Left	14	46,67%

The results of descriptive statistics show that the respondents in this study were more male, with 23 respondents (76.67%), than female respondents, with 7 respondents (23.33%). The largest proportion of respondents are aged 26-45 years (adults), with as many as 17 people (56.67%), aged 17-25 years (adolescents), with as many as 10 people (33.33%), and the least are the elderly, with as many as 3 people (10%). The characteristics of the respondents based on the side of the amputation on the right side of the amputation were 16 respondents (53.33%) and on the left side of the amputation were 14 respondents (46.67%). Descriptive statistics on the characteristics of the height and weight of the respondents can be seen in Table 2.

Table 2. Characteristics of the sample based on height and weight

Characteristic	f	Range	Min	Max	Mean	Std. Dev
Height	30	26	145	171	161.23	7.055
Weight	30	34	39	73	57.70	11.311

A flexible prosthesis function test was performed on 30 transfemoral amputee patients. The data normality test obtained from dynamic balance using Four Square Step obtained a p-value of 0.07, which indicates that the data is normally distributed. Because the data is normally distributed, the paired t-test is used. This test is carried out because it will be used to see the comparison of the two variables. The data used to carry out this test is quantitative, meaning that the data must have interval and ratio scales (Adiputra et al., 2021).

Results A comparison of walking balance test results between users of flexible prostheses and those using axial crutches was carried out using the paired T-Test, with the following results, as seen in Table 3.

Table 3. Dynamic Balance

Dynamic Balance	Mean	SD	SE	P value
Axial Crutch	22.45	10.248	1.872	0.000
Flexible Prosthesis	12.54	5.643	1.031	

The balance of patients using flexible artificial limbs was more stable than patients who walked using axillary crutches with a significance of 0.000, with an average time used to perform Four Square Step was 12.54 seconds and Axial Crutches was 22.45 seconds.

DISCUSSION

The aim of this research was to know the effect of the use of flexible transfemoral prostheses on the dynamic balance of transfemoral amputees. The subjects in this study were mostly male is 23 patients (76.67%), which is greater than the female subject with 7 patients (23.33%). The largest proportion of respondents are aged 26-45 years (adults), as many as 17 people (56.67%), aged 17–25 years (adolescents), as many as 10 people (33.33%), and the least are the elderly, as many as 3 people (10%). The characteristics of the respondents based on the side of the amputation on the right side of the amputation were 16 respondents (53.33%) and on the left side of the amputation were 14 respondents (46.67%).

A flexible prosthesis function test was performed on 30 transfemoral amputee patients. The data normality test obtained from dynamic balance using Four Square Step obtained a p-value of 0.07, which indicates that the data is normally distributed. The balance of patients using flexible artificial limbs was more stable than patients who walked using axillary crutches with a significance of 0.000, with an average time used to perform Four Square Steps being 12.54 seconds and Axial Crutches being 22.45 seconds.

Measurement of dynamic balance in this study was done using the Four Square Step Test. In addition to the FSST, dynamic balance measurements can also be done with the Timed Up and Go (TUG) test. The Timed Up and Go is a reliable and valid instrument to measure the dynamic balance of transfemoral amputees (Clemens et al., 2018).

The use of flexible transfemoral prostheses and axillary crutches has an influence on dynamic balance in post-transfemoral amputees. Amputees who use a flexible prosthesis or an axillary crutch have a larger base of support than those who do not. Because one of the factors that affects the balance is the base support. The results showed that post-transfemoral amputees using flexible transfemoral prostheses had better dynamic balance than post-transfemoral amputation patients using axillary crutches. Post-transfemoral amputation patients who use the transfemoral prosthesis have better dynamic balance because the transfemoral prosthesis has advantages in terms of comfort and convenience in carrying out activities and has a low risk of injury.

The balance of the subjects, who used the flexible artificial limbs, was significantly more stable than when walking using the axillary crutches. This is in line with research on the use of transtibial prostheses by Rachmat & Zubaidi, (2017) whose conclusions show there is a difference in the influence of an axial crutch and a transtibial prosthesis user in dynamic balance. It is necessary for a person to have a good balance to move and do activities (H. K. M. Lee & Scudds, 2003).

The subject's balance improves by wearing flexible artificial limbs, indicating that his cognitive function improves and his postural balance is increased. Cognitive

function is a with postural balance disorders in patients (Pramadita et al., 2019). There were 10% of the elderly in this study, the elderly who had amputations also needed to be trained in their balance. Square stepping Exercises can be used to increase stability in elderly people (Pramita & Susanto, 2018).

The flexible prosthetic leg used by amputee patients gives the patient confidence to walk faster because the flexible artificial leg provides stability. Some patients with lower balance feel an imbalance at more walking speeds, despite the external threat external to low balance (Kongsuk et al., 2019). The square steps exercise consists of several movements that improve balance. It can help to take faster steps under any conditions when slipping occurs to help maintain balance and prevent falls (Nokham & Kitisri, 2017).

The greater the value of hip abductor strength, the better the results of the time-up-go test will be in patients using unilateral transfemoral prostheses (Pauley et al., 2014). The use of a prosthesis can improve stability, and balance in amputees (Kahle et al., 2016). Alignment of the transfemoral prosthesis according to the patient's condition will improve the balance and confidence of the patient after transfemoral amputation (Fisher et al., 2013). The dynamic balance and walking pattern of post-transfemoral amputation patients improved with the use of a transfemoral prosthesis with passive mechanical and microprocessor-controlled prosthetic knees (Ramazanoğlu et al., 2013).

CONCLUSION

The balance of patients using flexible artificial limbs was more stable than that of patients walking using axillary crutches, with a significance level of 0.000. The average time used to perform FSST was 12.54 seconds, and axillary crutches were 22.45 seconds. So it can be concluded that patients with flexible artificial limbs are more balanced. It is recommended for transfemoral amputee patients to use a flexible prosthesis to improve dynamic balance when walking, so they can move better.

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