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Comparative Analysis of a Locally Fabricated SACH Foot and a Foreign SACH Foot

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Abstract

Background: The analysis of a locally fabricated SACH (Solid Ankle Cushion Heel) foot and a foreign SACH (Solid Ankle Cushion Heel) foot anchors on the performance of low-activity users and are of great interest to practitioners in amputee rehabilitation. **Aim:** The aim of this study is to compare these two prosthetic feet in terms of patient satisfaction, cardiovascular response and a few temporal gait parameters. **Methods:** For this purpose, a group of 10 hypomobile transtibial amputees (TTAs) had their usual foreign SACH foot replaced with a locally fabricated SACH foot, while also taking their cardiovascular response before and after the use of the foreign and locally fabricated SACH foot. Moreover, the patient satisfaction survey was performed using Prosthesis Evaluation Questionnaire (PEQ). **Results:** Results showed that participants had maintained the same level of stability and perceived safety, while presenting a significant albeit slight improvement in some important clinical aspects such as weight and overall mobility, balance, general comfort, and the perceived satisfaction with their own prosthesis. **Conclusion:** The findings demonstrate that a locally fabricated SACH foot represents a considerable alternative solution with respect to the foreign SACH foot in the prosthetic prescription for hypomobile transtibial amputees (TTAs).

Subject Areas

Nursing

Keywords

SACH Foot, Prosthesis, Hypomobile, Transtibial, Amputee

1. Introduction

The solid ankle cushion heel, or SACH foot has proved to be a valuable compo-

nent for lower-extremity prostheses; it can be used with all prostheses that require a full artificial foot. There is significantly less irritation of the amputation stump with use of the SACH foot, especially in below-the-knee amputees, because of the diminished torsion upon the stump and less jarring from heel impact. The degree of comfort for the amputee using an artificial lower limb with a SACH foot is increased as a result of the cushioned heel and smooth rocker action.

SACH Foot has a wooden keel which is long enough to restrict/limit movements in all directions and whatsoever movements take place, they occur at unnatural sites.

The SACH prosthetic design has many variations, but they are all based on a similar concept. A SACH foot is generally used when mid-stance stability is desired for the user [1]. The SACH foot has been considered the standard prosthetic foot prescribed to those with low function and activity levels. The SACH foot was the first prosthetic foot to exhibit roll-over shape [2]. The minimal parts allow for easier use and maintainability. The SACH foot is available at low cost because of the minimal parts needed and is the most prescribed prosthetic foot [1].

Several shortcomings of the SACH foot have been discovered in clinical trials and in human subject testing. A study completed at Northwestern indicated that the SACH foot often exhibits shortcomings in plantar flexion due to its rigid design [3]. This aspect of the foot also plays into its success because the rigidity in turn offers stability in the early phases of the gait cycle. The SACH foot also had issues with low energy return when compared to the Flex Foot [3]. It has also been found that the SACH foot has a shorter roll-over shape than a human foot and other prosthetic feet, such as the SR, which means that, at the toe region it is not as able to support weight [4].

2. Methodology

2.1. Research Design

The research design used for the purpose of this work was an experimental design which helped to compare both the locally fabricated SACH foot and the foreign SACH foot in terms of patient satisfaction and energy expenditure while using both feet.

The data were analyzed using various statistical means including; mean, standard deviation and Paired T-test.

2.2. Research Survey

This study adopted the survey research design. Survey design was explained by [5] as a procedure used in obtaining information from a sample or relevant population that is familiar with the ideas relating to the objectives of the study. In the opinion of [6] survey design is one which studies large or small population by selecting and analyzing (sample) data collected from the group through the

use of questionnaire, telephone or personal interview. The design is therefore appropriate for this study as it was used to obtain data from patients who have had amputation and are currently using a prosthetic lower limb in Port Harcourt.

2.3. Area of Study

The area of study is Port Harcourt; Port Harcourt is the capital city of Rivers State and a metropolitan city which is the fifth-largest city in Nigeria after Lagos, Kano, Ibadan and Benin City. It lies along the Bonny River and is located in the Niger Delta. As at 2016, the Port Harcourt urban area has an estimated population of 1,865,000 inhabitants, up from 1,382,592 as at 2006 [7].

Port Harcourt is a major industrial centre as it has a large number of multinational firms as well as other industrial concerns, particularly business related to the petroleum industry. It is the chief oil-refining city in Nigeria and has two main oil refineries located at Eleme. Rivers State is one of the wealthiest states in Nigeria in terms of gross domestic product and foreign exchange revenue from the oil industry, crude oil being its principal export earner [8].

Amputees from this part of the state prefer using prosthesis for daily activities so as to fit back into the society.

2.4. Research Instrument

The instrument for data collection was a structured questionnaire, which contains 25 items in all. These items were divided into four sections encompassing the four important research questions necessary for the study.

Patient Satisfaction Survey was employed for the purpose of this study to offer tested questions for measuring patient satisfaction individually after the use of both prosthetic foot (Locally fabricated SACH foot and foreign SACH foot). Users' satisfaction with the prosthesis was assessed by means of the prosthesis evaluation questionnaire (PEQ). The questionnaire consists of a series of items with a linear analogical scale response format, organized into six functional domain scales, widely used to analyze the impact and response on TTAs with the two different prosthetic feet (the local SACH foot and foreign SACH feet). The functional scales are: ambulation, size, appearance, comfort, change in heart beat, and wellbeing. The reliability and validity of this survey have previously been assessed.

2.5. Materials and Tools

2.5.1. Materials for Fabrication

- Core wood
- Ethylene vinyl acetate (rubber foam)
- Flexible tyre
- Gum
- Cooper nails
- Cosmetic leather

- Sand paper

2.5.2. Tools for Fabrication

- Grinding machine/filing machine
- Jig saw
- Drilling machine
- Hammer
- Scissors
- Bench vice
- Heating gun
- Handsaw
- Goniometer
- Chisel
- Hand file
- Meter rule
- Measuring tape
- Cardboard sheet

2.6. Method of Fabrication

- The impression of the foot to be fabricated was taken on a cardboard sheet and then it was divided into three (the hind, mid and fore foot). As shown in Figure 1.
- A core wood of length 26 cm and width 8 cm was cut out.
- 45˚ was measured using a goniometer at the hind foot part of wood which served as the heel of the foot.
- 15˚ was measured at the mid foot part, this degree gives the slope of the mid foot to the fore foot.
- 7˚ from the fore part of the wood to the plantar aspect was measured; this gives the toe clearance of the foot.
- With the aid of the hand saw, the measured and marked portions were chopped out and grinded using the grinding machine.
- The hand file was used to reduce size of the work piece and ensure all curves were visible before using the grinding machine to smoothen the work piece (foot).
- The drilling machine was also used to bore hole at the intersection point of the midline of the foot and the marked line which differentiated the hind and mid foot.
- At the plantar surface of the foot, a spiral drill bit was incorporated into the drilling machine and was used to bore a wide hole that was used as the locking device.
- Elastic rubber padded in ten layers was glued together and cut in a slant form and was used to form the heel of the foot.
- Appropriate smoothening was done round the foot as shown in Figure 2.
- A layer of thick ethylene vinyl acetate (EVA) form was heated in an industri-

al oven and then wrapped around the work piece to give it a cosmetic finishing as shown in Figure 3.

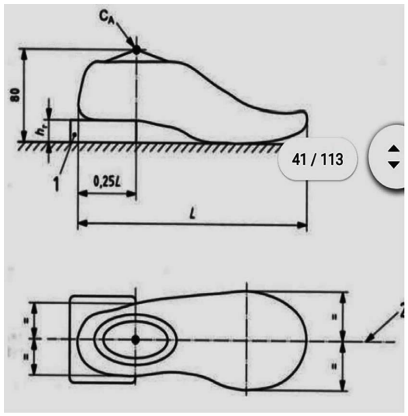

Figure 1. Impression of the foot to be fabricated.

Figure 2. A smoothened work piece.

Figure 3. A work piece with cosmetic finishing.

2.7. Tools/Instrument for Data Collection

- Automated sphygmomanometer
- Thermometer
- Marker
- Black trampoline
- Powdered chalk/white powder
- Measuring tape
- Stopwatch
- Pen and paper
- Questionnaire

2.8. Inclusion and Exclusion Criteria

- Patients resident in Rivers State were included in the survey; for easy access.
- Patients' having unilateral transtibial amputation that has used prosthesis before were included; to avoid fall and other arising problems as a result of the use of the prosthesis.
- Patients without known peripheral vascular disease, whose skin is free from abrasion and blisters which may interfere with gait pattern were included.
- Patients with known gait and cardiovascular abnormalities were excluded from participation.
- Patients with bilateral lower limb amputation were also excluded.
- Patients who are using the wheelchair and other assess instruments were not allowed to participate in the study.

2.9. Materials/Instruments

- White Paint
- Measuring tape
- Polyethylene
- Rag
- Record book and pen
- Stop watch
- Walking lawn
- Omron Automatic Blood Pressure Monitor (Model HEM-7322)

2.10. Procedure

- Participants' cardiovascular response was measured before the start of the process.
- A 12" horizontal line was measured using a measuring tape and points were marked.
- The centre of the horizontal line at the 6" mark was marked and a vertical line of 240" was measured which gave the line of progression (*i.e.* the patients direction during data collection).
- Participant wore both SACH foots (locally fabricated foot and foreign SACH

foot) at interval with a polyethylene and their feet were immersed into a white paint.

- Participant stood at their comfortable position and their base of support was measured.
- Participant was asked to walk a distance of 240" and the stop watch was used to record the corresponding time spent.
- Time taken in seconds was recorded and the gait parameters were recorded by measuring the foot prints of the participants.
- Participants' cardiovascular response was measured at the end of the process.
- The above processes were repeated for other participants.

3. Discussion

To design a good, functional, efficient and safe substitute to a foreign foot using locally sourced materials, it is important to study the effects of different SACH foot on a specific category of amputees.

This research work fills an important gap in the literature as, to the best of my knowledge; there are no similar studies about the considered prosthetic feet for low-activity users with so wide, a range of clinical evaluations.

4. Result

After the replacement of the foreign SACH foot with a locally fabricated SACH foot, patients have maintained the same level of stability and perceived safety, while presenting a significant albeit slight improvement in some important clinical aspects such as, the weight and overall mobility, balance, general comfort, and the perceived satisfaction with their own prosthesis.

5. Conclusions

The findings demonstrate that a locally fabricated SACH foot represents an alternative solution with respect to the foreign SACH foot in the prescription of prosthetic foot for hypomobile TTAs.

Thus, the range of prosthetic devices available to practitioners involved in amputee rehabilitation is increased, therefore allowing them to select the most appropriate solution for each specific subject based on their clinical experience and patient financial status.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Supan, T.J. (2005) Clinical Perspectives on Prosthetic Ankle-Foot Designs. *Journal of Prosthetics and Orthotics*, **17**, s33-s34. https://doi.org/10.1097/00008526-200510001-00011

[2] Hansen, A.H. (2005) Scientific Methods to Determine Functional Performance of Prosthetic Ankle Foot Systems. *Journal of Prosthetics and Orthotics*, **17**, s23-s29.

https://doi.org/10.1097/00008526-200510001-00008

[3] Stark, G. (2005) Perspectives on How and Why Feet Are Prescribed. *Journal of Prosthetics and Orthotics*, **17**, s18-s22. https://doi.org/10.1097/00008526-200510001-00007

[4] Sam, M., Childress, D., Hansen, A., *et al.* (2004) The 'Shape&Roll' Prosthetic Foot: I. Design and Development of Appropriate Technology for Low-Income Countries. *Medicine, Conflict and Survival*, **20**, 294-306. https://doi.org/10.1080/1362369042000285937

[5] Nwogu, B.G. (2001) Educational Research: Basic Issues and Methodology. Wisdom Publishers Ltd., Ibadan.

[6] Ali, A. and Olaitan, S. (2000) Writing a Research Article for Publication. In: Olaitan, S.O., Ali, A., Eyoh, E.O. and Sowande, G., Eds., *Research Skills in Education and Social Sciences*, Cape Publisher International Ltd., Onitsha.

[7] Wolpe, H. (1974) Urban Politics in Nigeria: A Study of Port Harcourt. University of California Press, Berkeley, 268.

[8] Archibong, M. (2004) Port Harcourt: Garden City with Few Flowers. The Sun Publishing Limited, Lagos.