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TRANSTIBIAL SQUATTING PROSTHETIC DESIGN

Transtibial Prosthesis

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ABSTRACT

Present Transtibial design is permitting the knee flexion hardly up to100-1100 . Hence tide over this problem, the double socket method is used to allow the required amount of knee flexion in such way that the remaining required 30-40 degrees of knee flexion took place between the inner and outer socket when amputee intends to squat. When amputee intended to walk the inner socket is fastened to outer socket securely by Velcro fasteners. Present Transtibial prosthetic systems do not permit the squatting activities as each one of them have their own limitations. Taking into consideration need, benefits and biomechanics of squatting, it was decided to design a Transtibial squatting prosthesis to suit the lifestyle of Indian amputees.

KEYWORDS

Squatting, benefits, low cost, sustainable

INTRODUCTION

Man like fellow primates has always used the squatting position for resting, working and performing body functions. India is an agriculture oriented country. About 80% of her population resides in rural area where basic facilities are not available to them. Majority of their day to day activities involve squatting and cross legged sitting almost all the time .E.g. working in the farm, cooking at the floor level, washing clothes, etc. Transtibial amputation is the amputation through a shaft of the tibia.

It occurs due to many reasons but trauma and diabetes are the major causes of amputations in India. Present Transtibial prosthetic systems do not permit the squatting activities as each one of the design has their own limitations. Taking into consideration need, benefits and biomechanics of squatting, it was decided to design a Transtibial squatting prosthesis to suit the lifestyle of Indian amputees.

Need Of The Study:

When Trans-Tibial amputee is fitted with currently available designs of the T.T. (Transtibial) prostheses, it permits the knee flexion only up to 100-110 degrees and no dorsiflexion is permitted in the commonly used SACH foot. With this design it is very difficult to squat because minimum of 135-140 degrees knee flexion and 10-15 degrees dorsiflexion is required for squatting. Hence to overcome this problem, the double socket method was used to allow the required amount of knee flexion, in such way that the remaining 30- 40 degrees of knee flexion took place between the inner and outer socket, when amputee intended to squat and the shank is made out of polypropylene copolymer (PPCP) sheet of 15 mm. thickness which has optimum combination of flexibility and rigidity which allows 10-15 degrees of overall dorsiflexion and structural stability to support the body weight.

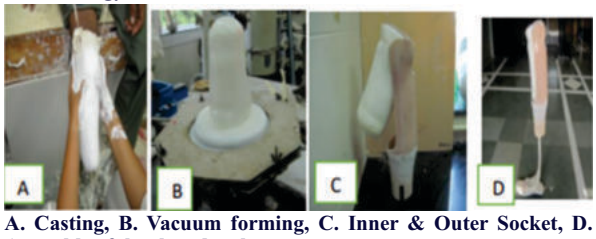
AIMS & OBJECTIVES:

To develop a suitable prosthetic design of Transtibial squatting prosthesis and test its efficacy to suit the lifestyle of Indian amputees.

Parameters Of Study:

- Weight distribution:- a)Standing b)Squatting
- Squatting endurance:- a)Static b)Dynamic
- Prosthesis evaluation questionnaire
- Angle of knee flexion in squatting
- Angle of dorsiflexion at ankle in squatting

Methodology:

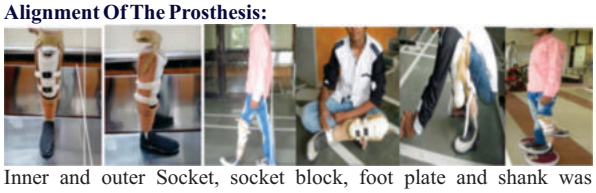


A. Casting, B. Vacuum forming, C. Inner & Outer Socket, D. Assembly of shank and socket

Patient Evaluation And Fabrication Of Prosthesis:

Ten subjects were recruited for the study using convenience sampling technique after the prescription from outdoor patient department of the Institute. Prosthetic designs were developed followed by fabrication and fitting of the patient with the prosthesis.

Alignment Of The Prosthesis:



Inner and outer Socket, socket block, foot plate and shank was fabricated then aligned by using standard alignment techniques.

Methods Of Data Collection:

The weight distribution in standing and squatting position were recorded at initial stage and follow up after one month with the design of squatting prosthesis.

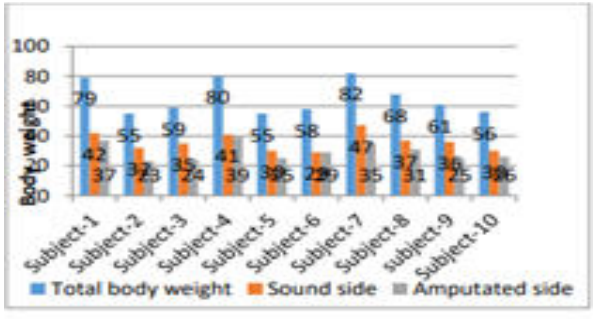
- The squatting endurance in static and dynamic position were recorded with the design of squatting prosthesis.
- Prosthetic Evaluation Questionnaire (PEQ) Scale: Prosthesis Evaluation Questionnaire score for utility scale, ambulation scale, satisfaction question were recorded with the designs of squatting prosthesis and regular patella tendon bearing prosthesis.
- Angle of dorsiflexion at ankle in squatting position was recorded.
- Angle of knee flexion in squatting position was recorded.

Statistical Analysis:

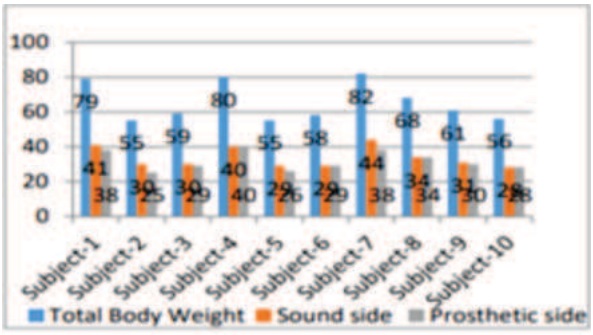
In this study a paired t-test was applied, because samples are randomly selected and sample size was ten. Quantitative data have been collected initial stage and one month after initial fitting with the squatting prosthesis. Find out the statistical analysis i.e. mean, SD (Standard Deviation), SE (Standard Error), t value for the parameters.

Graph No. 1

A) Weight distribution in standing position at initial stage:
B) Weight distribution in standing position follow-up after one month:



Graph no.1 (A)

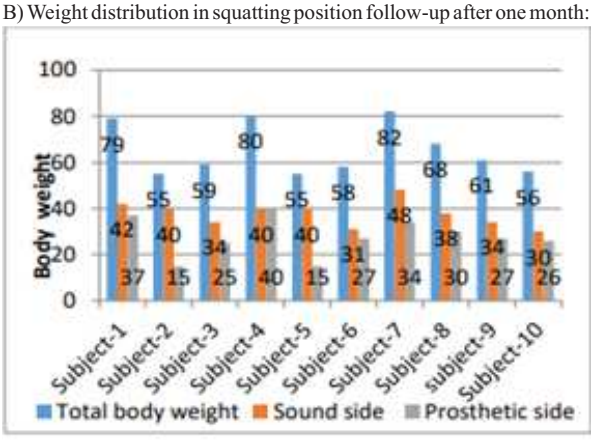


Graph no.1 (B)

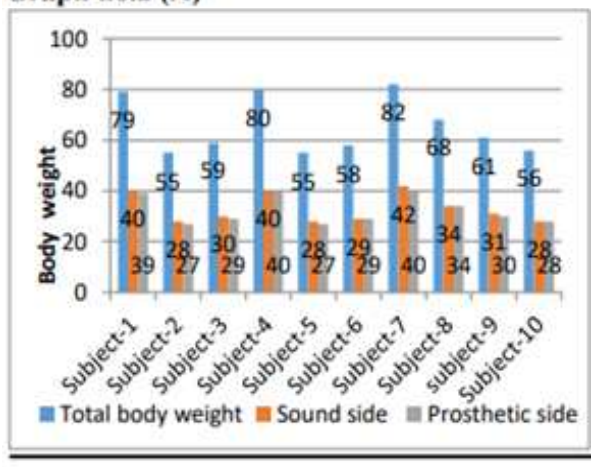
Graph No.2:

A) Weight distribution in squatting position at initial stage:

B) Weight distribution in squatting position follow-up after one month:



Graph no.2 (A)



Graph no.2 (B)

RESULTS:

- Patient can maintain the squatting position at least 30 minutes.
- This design allows the patient from squat to stand up to 20 to 25 times at a stretch and cross legged sitting.
- This design allows the few degree of inversion and eversion so patient can walk on uneven terrain without any difficulty.
- Squatting endurance is good in static position as well as dynamic position (Squat to stand).
- Weight distribution in squatting and standing position with the new developed design found almost equal.
- Mechanical testing of this foot was done at Micro, Small and Medium Enterprises (MSME),
- Government of India, Mumbai for fatigue test and it was found there no signs of stresses developed around the ankle area after 5000 cycles of cyclic loading (fatigue loading).
- This design allows 10 to 15 degree dorsiflexion while squatting.

DISCUSSION

In this study, the newly developed trans-tibial prosthetic design has been used for the prosthetic fitting of 10 trans-tibial amputees. Present design of the trans-tibial prosthesis design copied from western countries permits the knee flexion hardly up to 100-110 degrees and with this design it is very difficult to squat as minimum of 135-140 degree knee flexion is essential for squatting. The newly developed design consists of double socket that is inner socket and outer socket, so the remaining 30-40 degree of flexion essential for squatting was supplemented by double socket design. This design permits the squatting position without any difficulty. User can maintain the squatting position for at least 20 to 30 minutes. Squatting endurance depends upon the age and physique of the subject. Patient can walk on uneven terrain; can climb up the slopes, ramps and stairs easily due to flexibility in the material (PPCP). This prosthesis also facilitates cross legged sitting. The foot design allows few degrees of dorsiflexion (10-15 degrees) to permit the squatting position. As per the cyclic test report this material can withstand more than 80 kg weight and amputee can walk more than 4 hours at a stretch without causing any damage to the structure.

CONCLUSION:

The squatting offered many physiological benefits to the patient like better adaptation, shock absorption and enhanced pressure on the bowel while squatting which allows easy clearance of the bowel squatting prosthesis became an integral part of the daily life style of average Indian amputees. In short the transtibial squatting prosthesis was found suitable to the lifestyle of average Indian amputees coming from rural and urban areas.

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