ORIGINAL RESEARCH PAPER
Volume - 10 | Issue - 09 | September - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EFFECT OF DIABETES ON ENERGY EXPENDITURE IN PATIENTS OF SAME AGE USING UNILATERAL TRANSTIBIAL PROSTHESIS

Transtibial Prosthesis

Rishabh Gupta Subject Expert, Department of Prosthetics & Orthotics, Dr. Shakuntala Misra National Rehabilitation University, Lucknow.

Yamini Khanna* Prosthetist & Orthotist cum In-Charge Satellite Center Seemapuri, delhi.
*Corresponding Author

ABSTRACT

Background: The purpose of this study was to compare the Oxygen Uptake (Vo2), Heart rate (HR), and Energy Expenditure (EE) between diabetic and non-diabetic unilateral transtibial prosthetic users of same age walking with the self-selected speed in level surface to check the effect of diabetes. Two subjects male right side unilateral transtibial amputees of age 50 years were fitted with modular Patellar Tendon Bearing (PTB) prosthesis with Solid Ankle Cushion Heel (SACH) foot with cuff suspension and regularly used their prosthesis for longer than six months and were independent of any assistive ambulation devices. Thereafter, using the Cosmed® k4 b2 Respiratory Analyzer system, while ambulation with K4 b2 Oxygen uptake VO2, Heart rate (HR), and energy expenditure (EE) measured averaged across walking. Results showed that the transtibial prosthetic user having diabetes utilizes 26.5% more energy than non-diabetic subjects while walking on a level surface.The study concludes that an appropriate prosthetic fitment, follow-up and gait training make amputees walk with fewer energy demands.The non-diabetic amputee was walked with less energy than amputee associated with diabetes.

KEYWORDS

Amputee, Diabetes, Energy Expenditure, Prosthesis

INTRODUCTION

Diabetes mellitus is increasingly common with advancing age, rising with a prevalence of <10% below the age of 50 to 25% over the age of 70 [(1)]. In 2004, Wild et al. estimated that 4.4% of the population worldwide will have diabetes in 2030 (representing 366 million people) [(2)]. About 366 million people had diabetes and projected an increase to 552 million people by 2030 [(3)]. Despite advancements in medicine, lower limb amputation remains a major complication of diabetes.The main goal of treatment of diabetic amputees is ambulation with the least energy expenditure and it was observed that more than 90% below-knee unilateral cases achieved ambulation with a prosthesis after successful rehabilitation [(4)]. Previous works have concentrated on the energy expenditure and efficiency between amputees and normal population, no studies have compared the difference between amputees who have a vascular and non-vascular cause [(5) (7) (8) (9)]. This clinical report shows the two 50-year-old men presented (one amputee associated with diabetes and other healthy amputee both having unilateral transtibial amputation) for the rehabilitation of their limbs to the institute. This report emphasizes the effect of diabetes in below-knee amputee prosthetic rehabilitation combined with physical therapy during walking. However, it was interesting to study metabolic demands while using a transtibial prosthesis.

Table – 1 Physical Parameters Of The Diabetic And Non Diabetic Amputee

Subject	Age	Height (cm)	Weight (kg)	BMI
Diabetic	50	163	62	23.3
Non-Diabetic	50	165	67	24.6

METHODS

Two transtibial amputees approached at the same time to the rehabilitation team. The description of both cases is as follow

Case -1: A 50 years male with right unilateral transtibial amputation having height 163 cm, weight 62 kg, and stump length 10.8cm approached rehab clinic members. The past medical history of the patient confirmed that he is diabetic and has undergone a below-knee amputation due to RTA (road traffic accident) 6 years back. He lives alone and works as a lab attendant in a government institute in Kolkata. He started using his prosthesis after 1 year of amputation and walks for 5km per day. He reported with a damaged socket and suspension. On the basis of medical examination and assessment, the stump was found free from the adherent scar, abrasion, contracture, muscle pain, neuroma, and other deformities. The vitals were within normal range but little increase in heart rate value i.e. 92 was found. After necessary evaluation of the previous prosthesis, components of the prosthesis like Pylon, SACH foot, etc. were in good condition and need not change.The rehabilitation team concluded to fit the patient with a new PTB socket and cuff suspension with a modular prosthesis and SACH foot.

Case – 2 Another 50 years male right unilateral transtibial amputee, Height 165 cm, weight 67 kg, and stump length 15.2 cm approached to the rehabilitation team with a damaged prosthesis. He underwent a train accident 5 years back where he got and got amputated with the below knee level. He was running a small general store shop in his village. He lives with his wife and two children's all were dependent. After examining his previous reports and prescriptions it was found that he is non-diabetic and the residual stump was found to be free from any pain, deformity, and abnormality. The patient was an old prosthesis user and uses his prosthesis for more than 4 years. The Rehabilitation team decided to fit with a new PTB modular below-knee prosthesis with cuff suspension and SACH foot.

After fitment, and gait training both were able to ambulate without assistive devices. Fitted and rehabilitated amputees were called for follow up of prosthesis and stump condition after 6 months. During follow up the stump condition was re-examined physically by a qualified Prosthetist and Physiotherapist, the outcome of these results showed that ROM and muscle strength of stump are in normal range, and AMP (Amputee Mobility Predictor) tool, used to measure the functional status of lower limb amputees with a prosthesis (AMPPRO) was found above K3 level. The physical parameter of the subjects involved in the study is presented in Table 1. Both the participants were physically active and well balanced to complete the protocol. After detailed explanation of the procedure both were selected in this study with their consent. They were instructed to walk at a self-selected speed. Throughout this period, breath by breath analysis was carried out with Cosmed® k4 b2 Respiratory Analyzer system (COSMED Sr1- Italy) [(11)(12)] for the measurement of Oxygen Uptake (VO2), Heart Rate (HR), and Energy Expenditure per minute (EE) for both the subjects. They were given sufficient time to become accustomed to the respiratory analyzer system before any testing. At the time of the test FBG (Fasting Blood Glucose) was measured normal. Resting heart rate was measured before testing and was found 85 and 78 beats/minutes for diabetic and non-diabetic prosthetic users.

Procedure: The physically fit diabetic and non-diabetic transtibial prosthesis users performs a gentle walking session with a prosthesis (Fig.2) consisting of easy 30 meters, with rest periods of 5 min (3-minute warm-up period to ensure that the muscles did not utilize anaerobic sources of energy, 1 minute to prime the airways, and 1 minute of the exhaled gas collection) separating each walk, on three separate occasions. During three identical sessions, a Cosmed® k4 b2 Respiratory Analyzer system was used.

Research Findings and Outcomes:

The summary of the results is presented in Table-2.. The measurement of HR shows 23.7 % more stability in non-diabetic amputees while walking on a level surface. The VO2 uptake was found at 1122.981 and 1008.643 for a diabetic and non-diabetic amputee. Diabetic amputee

utilizes 11.3% more oxygen uptake than non-diabetic amputee. The energy expenditure of diabetic and non-diabetic amputees shows diabetic amputees utilizes 26.5% more energy than non-diabetic subjects while walking in a level surface.

Table 2: Summary of results

Cause	Age	Sex	Oxygen Uptake (VO2)	Heart Rate (HR)	Energy Expenditure (EE)
Diabetic	50	M	1122.981	98.05	4.581265
Non-Diabetic	50	M	1008.643	79.21	1.254789

DISCUSSION:

The purpose of this study was to compare the Oxygen Uptake (VO2), Heart rate (HR), and Energy Expenditure (EE) between diabetic and non-diabetic unilateral transtibial prosthetic users of same age walking with the self-selected speed in level surface to check the effect of diabetes. Earlier reports have reported a significant decrease in VO2 uptake and gait efficiency with high maximal heart rate response during self-selected waking of amputees associated with vascular cause than non-amputees healthy subjects [5] [7] [8] [9] [10]. The results obtained from the Cosmed® k4 b2 Respiratory Analyzer system (COSMED Sr1- Italy) showed a 23.7% increase in Heart rate (HR) for diabetic unilateral transtibial prosthesis user than a non-diabetic prosthetic user in the level walking surface. The results support previous studies [5] [8] [9]. In comparison to the non-diabetic prosthesis, the user showed an 11.3% difference in VO2 uptake. The energy expenditure of diabetic prosthesis users and non-diabetic prosthesis users was 4.581265 and 1.254789. The diabetic prosthesis user showed 26.5% more energy demands as compared with non-diabetic prosthesis users. The findings of this study supported the results mentioned in the previous studies in terms of higher energy requirements by the persons associated with diabetes than healthy persons. that same energy requirements by amputees associated with medium stump length or leverage while walking in level surface and with below knee prosthesis. [10]. None of the studies compared the effect of diabetes on the amputee population compared with the same population with no pre-vascular issues. The major limitation of this study was that the outcome was based on single-subject analysis and it may vary individual basis. Using a case report it is difficult to justify these results but this pave way for future studies and a new hypothesis. However, concerning diabetes, there were no studies that compared the effect of vascularity in the amputee group. This study needs more additional research with a greater number of subjects including both sides with the control group to collaborate with the findings of this study.

CONCLUSION:

It is recommended that with good prosthetic fitment, proper training and follow up makes amputee more comfortable and walks with fewer energy requirements. Future studies should take care of Good quality, lightweight, and energy-saving prosthetic components that further reduces the energy demands of amputees having diabetes. Higher energy expenditure of transtibial prosthetic users associated with diabetes at self-ambulation pace was observed.

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