Original Article

Effectiveness of Aerobic Training with Strengthening Exercise on Endurance in Patients with Below Knee Amputation: Experimental study

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Abstract

Background: Below-knee amputation (BKA) is a condition in which the limb is amputated in the transtibial level in which the distal tibia, fibula, whole of the ankle joint, and associated musculature and other components are removed.

Purpose: To determine the effect of aerobic training with strengthening exercise to increase endurance in patients with below knee amputation.

Materials and Methods: Total of 30 subjects with below knee amputation were selected based on the selection criteria. All the subjects were well elucidated about the objective of the study and the intervention and informed consent was obtained before participating in this study. The subjects received strengthening exercise and aerobic training for 4 weeks. The pretest values are taken with 6MWT and Borg scale; the same were recorded for post-test after 4 weeks of intervention. The entire process was performed from November 2022 to March 2023.

Result: Using a paired t-test to compare the pre and post-test results, the experiment revealed a significant difference in 6MWT and Borg scale. Independent sample t-test outcome at four weeks showed significant improvement in endurance.

Conclusion: The results and the data obtained from this research was statically classified and can be concluded that there was a definite and positive effect of aerobic training with strengthening exercise and increased endurance in patients with below knee amputation.

Keywords: aerobic exercise, strengthening exercise, 6MWT, Borg scale, below knee amputation

Introduction

An ankle joint, the distal tibia and fibula, as well as any related soft tissue components, are removed during a below-knee amputation (BKA), which is a transtibial amputation. A BKA is typically preferred over an above-knee amputation (AKA) because it provides better functional and rehabilitation results.[1] Lower extremity amputation is a necessary medical procedure. In more than 50% of instances, ischemia of the lower limbs, any peripheral artery disorders, and diabetes are thought to be the primary causes of amputation. The second most common reason for lower-extremity amputations is trauma.[2] An amputee

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who is able to use prosthesis to walk independently in the community has a higher aerobic potential to those who are receiving rehabilitation intervention, but they might not have postural control to walk easily on a treadmill. Hence, as opposed to the aforementioned conventional exercise tests, a field type of exercise test (such as a walk test) may more accurately contemplate the ability of amputees to exercise in the societal population. It is acknowledged that the residual component of the limb on the severed side of BK amputees performs daily activities like standing and walking with less activity (Isakov et al., 1996). Clinical professionals frequently employ manual muscle testing to evaluate the functionality of their patients. [3,4] Exercise is typically divided into power/strength and aerobic/endurance activities. Strength training is traditionally done with a relatively high load for a brief period of time, whereas endurance training is traditionally done with a relatively low load over a long period of time. Pure strength and endurance training, however, is uncommon. The majority of activities combine strength and endurance, and this sort of training is known as concurrent exercise.[5] Aerobic exercise, also referred to as endurance activities, cardio, or cardio respiratory exercise, is any exercise that predominantly uses the aerobic energy-generating process. The term "aerobic" refers to the use of oxygen to sufficiently satisfy the energy demands during activity. Through aerobic metabolism.[6] The word "aerobic" is defined as relating to, involving, or requiring oxygen". Cyclic sequences of light-to-mild intensity exercises over a sustained period of time is known as aerobic exercise. It may be more accurate to refer to aerobic activity as low-intensity exercise because this ensures that all carbs are produced in the mitochondria to produce ATP. Oxygen is required by mitochondria for the metabolism of carbohydrates, proteins and lipids.[7,8]

A valid and practical exercise test is necessary to evaluate exercise potential, recognize indicating signs and indicators of lack in exercise tolerance, and prescribe optimal or cautious exercise regimens in a societal environment when creating a fitness regimen program for patients with an amputation. Determining a person's ability to exercise after losing a lower limb has proven difficult.[9]

Aim

To investigate the effect of aerobic training with strengthening exercise on endurance in patients with below knee amputation.

Material and Method

The study was conducted as a Quasi Experimental study. The sample was collected at Kirubai Physio & Rehabilitation Centre. Depending on the inclusion and exclusion criteria a total of 30 subjects were selected and after describing the selection process. The safety and simplicity of the study was also explained. Materials used in this study were chair, stop watch, 30m walkway, pulse oximeter, two cones.

Study period: from November 2022 to March 2023.

Inclusion Criteria

- Below knee amputated patients
- Controlled medical conditions.
- Below the age of 55
- Patients using prostheses for 6 months.

Exclusion Criteria

- Those who use assistive devices.
- Recent illness or hospitalized.
- Patient who are mentally unstable
- Patient with heart conditions.

Outcome Measures

Assessment was performed before and after four weeks of intervention. The 6-Minute Walk Test evaluates both aerobic capacity and endurance. The distance traveled over a 6-minute period is the metric used to compare shifts in performance capability. The goal of this test is to cover as much ground as you can in six minutes by walking as swiftly as you can. Participants can go at their own pace and take breaks as often as they choose. Borg rating of perceived exertion (RPE) is a scale used to determine the recommended exercise intensity. In cardiac patients as well as other patient populations undertaking rehabilitation and endurance training, it is utilized to assess exercise progress and mode. The aim of this test is to find out the breathlessness rate after the patient has completed the 6-minute walk test.

Procedure

The subjects of age group between 18 to 55 years of both genders with below knee amputation. Pre-test values were recorded using the outcome measure 6MWT and Borg scale. The subjects were prescribed treatment for a period of four weeks with 4 to 5 sessions per week. Following the training session, the post-test values were again recorded using the same outcome measures and the significant differences were noted.

Study Procedure: from October 2022 to July 2023

1. Hamstring Strengthening

- Subjects were asked to lie in prone position
- Raise their prosthetic leg
- Hold for 10 seconds
- Repetitions were gradually improved from 5-8 times and 3 sets

2. Quadriceps Strengthening

- Subjects were asked to sit with the elbow supporting their back in supine position.
- With the other knee slightly flexed subject is asked to raise their prosthetic leg
- Hold for 10 seconds.
- Repetitions were gradually improved from 5-8 times and 3 sets.

3. Abductor Strengthening

- Subjects were asked to lie on normal side
- Raise the prosthetic leg
- Hold for 10 seconds
- Repetitions were gradually improved from 5-8 times and 3 sets.

4. Adductor Strengthening

- Subjects were asked to lie on prosthetic side with normal leg placed in front of it
- And head supported by hand
- Raise the prosthetic leg
- Hold for 10 seconds
- Repetitions were gradually improved from 5-8 times and 3 sets

5. Squats

- Subjects were asked to stand tall with feet shoulder-width apart and toes pointing outwards and keep the prosthetic foot flat on the floor.
- They are asked to maintain an upright posture
- Start squatting by bending their hips and knees simultaneously.
- Lower their body until their thighs are parallel to the floor
- Hold for 10 seconds and they are asked to maintain balance.
- Support the patient on the wall and ask them to perform squats to improve sitting.

Aerobic Exercise

Walking

After completing strengthening exercise, the subjects were asked to walk for 8 to 10 minutes. It was gradually increased according to the subject. If they feel any discomfort, they are asked to sit on a chair and take rest at any time.

Data Analysis

Descriptive and inferential statistics were used to analyze the study's data. Standard deviation (SD) and mean were applied to all parameters. The significant variations in outcome measure were examined using a paired t-test.

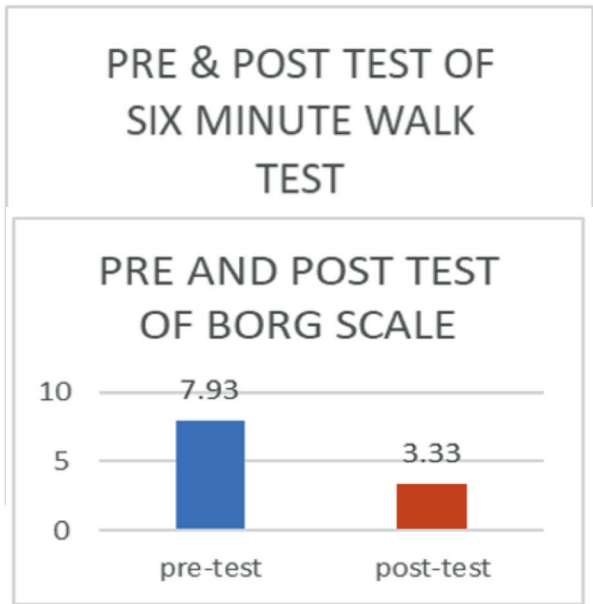

Fig-2 Pre & Post Test of Borg scale

Result

As needed descriptively, statistics, mean and SD were calculated. All the p values were considered as statistically significant using paired t-test.Subjects of 30 members with below knee amputation were assessed for pre and post-test using 6MWT and Borg scale. Fig 1 represents the comparison of the pre-tests and post -tests values of aerobic training with strengthening exercise using a 6-minute walk test. The mean value of the pre-test is 316.97 and the post-test is 336.6. Fig 2 represents the comparison of the pre-tests and post -tests values of aerobic training with strengthening exercise using Borg Scale. The mean value of pre-test is 7.93 and post-test is 3.33. As a result of statistical analysis, the values show that Aerobic training with strengthening exercise is effective in subjects with below knee amputation.

Discussion

The study was directed to show the efficacy of strengthening exercise with aerobic training to improve endurance in subjects with below knee amputation. An ankle joint, the distal tibia and fibula, as well as any related soft tissue components, are removed during a below-knee amputation (BKA), which is a transtibial amputation.[6] In more than 50% of instances, ischemia of the lower limbs, any peripheral artery disorders, and diabetes are thought to be the primary causes of amputation. The second most common reason for lower-extremity amputations is trauma.[2] Therefore, focusing on exercise is an important way to improve health status. I.Moirenfeld (2000) in his study concluded that Long-term transtibial (TT) amputees frequently have muscle wasting of the thigh muscles in the limb that is amputated. Proprioceptive feedback is lost after TT amputation, primarily from the articular surfaces of the ankle and associated musculature.[5]K H Pitetti (1987) et al, conducted study and concluded that aerobic conditioning has been found to boost walking efficiency in those who had lower limb amputations, as well as cardiovascular fitness.[10] Lin S-J, BOSE (2007) demonstrates that the 6MWT, which involves a moderate degree of exercise intensity and has some correlation to postural control skills in individuals with transtibial amputation, might be used as a reliable predictor of functional ability.[1] According to Darter BJ study domestic treadmill walking is an efficient technique to enhance gait performance in people with transfemoral amputation, according to research on the use of treadmill training to help people with chronic amputations of the femur.[9] Aerobic exercise and endurance: enhancing fitness for health advantages, according to Wilmore JH TFA found that patients who are active as children will be active as adults and will lessen the natural losses of strength, endurance, and flexibility that come with aging and sedentary lifestyles, maintaining independence throughout life.[3] According to Wezenberg D study on Relation between VO_{2max} and ambulation in older adults with a lower-limb amputation, concluded that especially in people with a vascular amputation, the VO_{2max} is an important determinant for ambulation. The information offers quantitative forecasts on how aerobic exercise will affect health.[11] Enright PL (1998) in his study concluded that High correlations between workloads, heart rate, and SaO2 as well as the dyspnea responses when compared to treadmill and bicycle ergometry exercise tests have proven the validity of the 6-min walk test. In addition to aerobic training, strengthening exercise has beneficial effects on below knee amputation.[12] With the conclusion of all the above-mentioned studies, we designed a protocol involving strengthening exercise along with aerobic training for the patients with below knee amputation to improve endurance and muscle strength. With this attempt, the pre- and post-tests measures were analyzed and tabulated in the result column. Thus, the results could be that strengthening exercise combined with aerobic training is effective in improving endurance and muscle strength in patients with below knee amputation. The patients who use assistive devices were not included in the recruitment of participants, which was the best way to enhance sample size. Future studies may concentrate on the long-term impact of these interventions, as this study only did a four-week follow-up. However, the six-minute walk test score and Borg score indicated a substantial change. A statistically significant difference is seen in statistical analysis of quantitative data of pre and post-test values of 6-minute walk test and Borg scale. The mean value of 316.97in the pre-test and 336.6 in the post-test by using a 6-minute walk test and 7.93 in pretest and 3.33 in post-test

by using Borg scale. The present study concluded that strengthening exercise combined with aerobic training were effective for below knee amputees.

Conclusion

The aim of the study was to estimate the effectiveness of aerobic training with strengthening exercise in subjects with below knee amputation. From the collected data it has been proved that aerobic training is effective and increases endurance in subjects with below knee amputation.

Ethical clearance: The ISRB committee of a private hospital and institution in Chennai has provided its clearance for the conduct of human research that complies with all applicable national laws, institutional regulations. (Application Number 03/077/2022/ISRB/SR/SCPT).

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Conflict of interest: The authors state that there is no conflict of interest**.**

References

1. Lin SJ, Bose NH. Six-minute walk test in persons with transtibial amputation. Archives of physical medicine and rehabilitation. 2008 Dec 1;89(12):2354-9.
2. Roon AJ, Moore WS, Goldstone J. Below-knee amputation: a modern approach. The American Journal of Surgery. 1977 Jul 1;134(1):153-8.
3. Wilmore JH, Knuttgen HG. Aerobic exercise and endurance: improving fitness for health benefits. The Physician and sports medicine. 2003 May 1;31(5):45-51.
4. McArdle WD, Katch FI, Katch VL (2006). Essentials of exercise physiology. Lippincott Williams & Wilkins. p. 204. ISBN 978-0-7817-4991-6. Retrieved 13 October 2011.
5. Moirenfeld I, Ayalon M, Ben Sira D, Isakov E. Isokinetic strength and endurance of the knee extensors and flexorsin trans-tibial amputees. Prosthetics and Orthotics International. 2000 Dec;24(3):221-5.
6. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public health reports. 1985 Mar;100(2):126.
7. Plowman SA, Smith DL. Exercise physiology for health fitness and performance. Lippincott Williams & Wilkins; 2013 Feb 25 Volume:3.
8. Patel H, Alkhawam H, Madanieh R, Shah N, Kosmas CE, Vittorio TJ. Aerobic vs anaerobic exercise training effects on the cardiovascular system. World journal of cardiology. 2017 Feb 2;9(2):134.
9. Darter BJ, Nielsen DH, Yack HJ, Janz KF. Home-based treadmill training to improve gait performance in persons with a chronic transfemoral amputation. Archives of physical medicine and rehabilitation. 2013 Dec 1;94(12):2440-7.
10. Pitetti KH, Snell PG, Stray-Gundersen JA, Gottschalk FA. Aerobic training exercises for individuals who had amputation of the lower limb. JBJS. 1987 Jul 1;69(6):914-21.
11. Wezenberg D, van der Woude LH, Faber WX, de Haan A, Houdijk H. Relation between aerobic capacity and walking ability in older adults with a lower-limb amputation. Archives of physical medicine and rehabilitation.2013Sep 1;94(9):1714-20.
12. Enright PL, Sherrill DL. Reference equations for the six-minute walk in healthy adults. American journal of respiratory and critical care medicine.1998Nov 1;158(5):1384-7.