International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Effectiveness of Agility Training on Balance Confidence in Unilateral Transtibial Amputees Wearing Prosthesis

Monmeet Mallick[1], Damayanti Sethy[2]

[1]Occupational Therapist, Indian Army Medical Corps Command Hospital, Kolkata, West Bengal
[2]Lecturer, Occupational Therapy, National Institute for Locomotor Disabilitires (Divyangjan), B.T road, Bonhooghly, Kolkata-90, West Bengal, India

Corresponding Author: Damayanti Sethy

ABSTRACT

Objective: To investigate the effectiveness of Agility training on balance confidence in unilateral transtibial amputees with prosthesis.
Method: A total number of 30 unilateral transtibial amputee subjects attending Department of Occupational therapy and OPD, National Institute for Locomotor Disabilities, Kolkata were recruited for the study. Both experimental and control group consisted of 15 patients each. Agility Training along with conventional Occupational therapy was provided to the Experimental Group and only conventional therapy was provided to the Control group.
Illinois Agility Run Test, 505 Agility Test, Activity Specific Balance Confidence Scale and WHO Quality of Life-BREF are the four outcome measures used.
Result: The experimental group had better improvements in Agility Run Test (p=0.001), 505 Agility Test (p=0.01), Activity Specific Balance Confidence Scale (p=0.001), and WHO Quality of Life-BREF (p=0.001) over the conventional therapy group. Conclusion: Agility training along with the conventional occupational therapy yields significant Improvement in the linear sprinting speed, turning ability, balance confidence and Quality of life in unilateral transtibial amputees with prostheses; than the conventional occupational Therapy alone.

Key Words: Agility Training, Balance Confidence, Transtibial Amputee.

INTRODUCTION

Following lower limb amputation, somatosensory input, muscle activity and joint mobility in the amputated part are compromised. As a consequence, lower limb amputees are unable to use the same motor strategies for balance control as able bodied subjects and therefore have to adjust the habitual stance control strategies and develop new strategies. [1,2]

Transtibial amputation is responsible for bio mechanical changes and for modifications in both afferent and efferent projection. Because of this impairment, equilibrium is difficult to control for Transtibial amputees. [3] Falls regularly occur when balance control is hindered by an external perturbation. [4] Falls are a common and potentially dangerous event, especially in amputees. [5] Falling is an important clinical problem in lower limb amputee population where balance confidence is associated with the mobility, capability or performance and social activity. A previous study with 435 unilateral below knee and above knee lower limb amputee found that exactly 52.4% reported falling past year where as 49.2 %

reported fear of falling and concluded that falling and fear of falling are pervasive among amputees. [6]

Previous studies described that people with Below Knee Amputation were found to be significantly less stable than able-bodied person during standing. Deficits in proprioception inflow due to limb amputation contribute even more to this difference. There is a process of habituation and compensation achieved by means of prosthetic training and use. Balance control strategies of amputee differed significantly from those of able-bodies subject. Commonly, individuals bear less weight through the prosthesis, which decreases stance time and creates unequal step length leading to fall. [7]

Many studies have clearly indicated that changing direction is a common cause of fall because rotational loads are increased at least 100% at the time of changing directions. [8] Lower limb amputees have the substantial challenge with respect to gait of adapting motor control strategies to compensate for the functional loss of significant locomotor musculature and altered properties of the supporting limb. Agility training helps in strengthening and conditioning program of the lower limb and focuses on increasing the balance confidence of the lower limb amputee. [9] Agility is commonly defined as an effective and quick coupling of braking, changing directions and accelerating again while maintaining motor control in either a vertical or horizontal direction. [10] So while agility can be simply defined as an ability to quickly stop and restart motion, there is a high degree of complexity to this motor skill. First, developing agility will provide a strong foundation for neuromuscular control and motor skill function, thereby establishing overall athleticism. Second, changing directions is a common cause of injury, so by teaching individuals proper movement mechanics we may be able to reduce injury risk. Finally, a heightened ability to quickly change directions will enhance overall performance in both proactive offensive and reactive defensive circumstances. [11]

Agility training challenges the a) Hand eye coordination b) Foot eye coordination c) Static balance d) Dynamic balance e) Reaction time and helps to enhance the i) quickness endurance , ii) ability to turn rapidly and iii) reactive speed thus improving the balance confidence. [12]

The conventional Gait training in treatment of amputee infront of mirror using Visual feedback, weight bearing and weight shifting methods and other traditional methods though improve walking and to some extent balance, their effectiveness gets limited while turning and rotational movements of an amputee.

Therefore, the present study is aimed at knowing the effectiveness of Agility training on balance confidence in the unilateral transtibial amputees with prosthesis and to study the effect of Agility training on the quality of life of unilateral transtibial amputees.

METHODOLOGY

A convenience sample of 30 subjects with transtibial amputation attending Department of Occupational Therapy, National Institute for Locomotor disabilities, Kolkata, India were recruited for the study. The Inclusion criteria were: subject with unilateral transtibial amputation with first time prosthesis users, the sound limb should have a muscle grade more than 3, ability to stand at-least for 15 minutes un-supported and able to walk, minimum of 15 steps with prosthesis, age 18-50 years, ability to understand and follow the command. Subjects having associated psychiatric condition, subjects with sensory motor impairment due to a neurological condition and subjects with perceptual disorder were excluded from the study. All subjects provided written informed consent prior to participation in the study. This study was a single blind randomized controlled trial. The participants who fulfilled the inclusion criteria were randomly assigned to Experimental and Control group. Blank folders were numbered from 1 to 30 and were given concealed codes for group assignment by an independent researcher. When a participant was eligible and gave consent to participate in the study, the next folder was drawn by an independent therapist and accordingly a group was assigned to the patient. All the measurements were recorded by a researcher who is blinded to group allocation. Ethical approval was obtained from the Institute's local Ethical Committee in its 8th meeting held on 05th March, 2012.

OUTCOME MEASURES:

Illinois Agility Run Test:

The Illinois Agility Test is a tool for testing a person's ability to accelerate & decelerate as fast possible. The running course is composed of cones lined up, and a set running tracks those criss-crosses around the cones.

505 Agility Test

505 Agility test is a test of 180 degree turning ability. This test requires the person to run from the start line to the turn line and return to the start line as fast as possible. The person may step past the turn line with both feet before returning.

The Activities-specific Balance Confidence (ABC) Scale:

The ABC can be self-administered or administered via personal or telephone interview. Larger typeset should be used for self-administration, while an enlarged version of the rating scale on an index card will facilitate in-person interviews. Regardless of method of administration, each respondent should be queried concerning their understanding of instructions, and probed regarding difficulty answering specific items. Your level of confidence is indicated in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale form 0% to 100%. The ABC is an 11-point scale and ratings should consist of whole numbers (0-100) for each item.

The World Health Organization Quality of life - BREF

The World Health Organization Quality of Life (WHOQOL) project was initiated in 1991. The aim was to develop an international cross culturally comparable quality of life assessment instrument. It assesses the individual's perceptions in the context of their culture and value systems, and their personal goals, standards and concerns. The WHOQOL instruments were developed collaboratively in a number of centres worldwide, and have been widely field-tested. The WHOQOL-BREF instrument comprises 26 items, which measure the following broad domains: physical health, psychological health, social relationships, and environment. The WHOQOLBREF is a shorter version of the original instrument that may be more convenient for use in large research studies or clinical trials.

PROCEDURE

Prior to participation in the study, informed consent was taken from all the subjects. After taking the informed consent, the subjects were allocated to experimental and control group. The subjects of both the groups (first time prosthesis users) were given exoskeleton type of prosthesis and thereafter both the groups were evaluated for demographic data, history, cognitive & perceptual evaluation and all the outcome measures i.e. Illinois agility test, 505 agility test, WHO-BREF & activity specific balance confidence scale; prior to the intervention. Patients in the Experimental group received Agility training along with conventional therapy, and patients in Control group received conventional therapy alone. Post intervention all subjects were evaluated for all the outcome measures. There was always a standby assistance by another therapist to support the patient as and when required.

PROTOCOL:

EXPERIMENTAL TECHNIQUE:

Steady state drills 1st week, Burst speed drills 2nd week 25 minutes per session Elastic Response Drills: Linear & Lateral 3rd week, Elastic Response Drills: Linear/ Diagonal, 4th week Elastic Response Drills: Lateral/Diagonal, 5th week Elastic Response Drills: Rotational 6th week and Conventional Therapy 1st -6th week included 25 minutes per session

Data analysis

The Data was analysed by using the IBM SPSS statistics Version 20. Normality of the variable within the groups was tested with Kolmogorov-Smirnov test and Shapiro-Wilk test. Differences in outcome parameters among the two groups Control and Experimental were analysed by the following tests. The paired t-test was used to analyse within the group parametric data. The independent t-test was used to analyse between the group parametric data. The Wilcoxon Sign rank test was used to analyse within the group non-parametric data. The Mann-Whitney test was used to analyse between the group non-parametric data. The level of significance was set at $p<0.005$.

RESULTS

A total of 75unilateral transtibial amputee subjects were enrolled in the study. Out of which only 30 completed the study with 15 each in control and experimental group. The average age of the subjects in control group is 38.2 years (SD ±7.4years) and in experimental group is 37.0(SD ±8.6 years). Total number of males in each group is 8 and females are 7 with 4 individuals having athletic background in control group and 5 in experimental group.

Table 1: Group Characteristics

SL. NO.	Baseline Characteristics	Control group	Experimental Group
1	No. of subjects	15	15
2	Age (Range) in years	26-48	24-50
3	Mean age (SD) in years	38.2 (±7.4)	37.0 (±8.6)
4	Gender (Male/Female)	8/7	8/7
5	Athletic/Nonathletic Background	4/11	5/10

The Illinois Agility Run Test shows significant improvement of linear speed in the control (p= 0.019) as well as Experimental group (p=0.01) upon within group analysis post 6 weeks of respective intervention programme.

Table 2: Comparison of Pre & Post Test score of Agility Run test in Control and Experimental group

AGILITY RUN TEST (ILLINOIS)	Pre test Mean (SD)	Post test Mean (SD)	t value	P value
Experimental Group	288 (± 5.5)	147.4 (±9.6)	64.96	0.01
Control Group	288.5 (±5.8)	287.07 (±4.55)	2.662 14	0.019

The Agility 505 Test shows significant improvement of turning speed in Experimental group (p=0.01) upon within group analysis but the improvement of turning speed in Control group is found to be not significant (p=0.217).

Table 3: Comparison of Pre & Post Test score of Agility 505 test in Control and Experimental Group.

AGILITY 505 TEST	Pre test Mean(SD)	Post test Mean(SD)	t value	P value
Experimental Group	91.4(±1.9)	34.93(±5.0)	49.64	0.01
Control Group	91.87(±1.3)	91.67(±1.49)	1.871	0.217

The Activity Specific Balance Confidence Scale shows significant improvement of balance confidence in Experimental group (p=0.01) upon within group analysis but the improvement of the balance confidence in Control group is found to be not significant (p=0.157).

Table 4: Comparison of Pre & Post Test score of Activity Specific Balance Confidence Scale in Control and Experimental Group.

Activity specific balance Confidence scale	Z value	P value
Experimental Group	-3.461	0.01
Control Group	1.414	0.157

The WHO QOL+BREF shows significant improvement of each of its component (D1, D2, D3, D4) in the Experimental Group (p=0.001) upon the within group analysis. But there is a significant improvement of the D1 and D4 component only in the Control group whereas the D2 and D3 component of

Control group are found to be not significant.

Table 5: Within Group Comparison of WHO QOL-BREF in Control and Experimental Group

WHO QOL-BREF		D1	D2	D3	D4
Experimental Group	z	3.457	3.424	3.453	3.508
	p	0.001	0.001	0.001	0.001
Control group	z	-2.000	-1.633	0.002	2.070
	p	0.046	0.102	1.000	0.038

The Illinois Agility Run Test shows significant difference between the control and the experimental group in the final measurement (p= 0.001).

Table 6: Between Group Comparison of Agility Run Test

AGILITY RUN TEST (ILLINOIS)	**MEAN(SD)**	**t (Equal variance assumed)**	**P value**
Experimental Group	147.4±9.6	-50.749	0.001
Control Group	287.0±4.5		

The 505 Test shows significant difference between the control and the experimental group in the final measurement (p= 0.001).

Table 7: Between Group Comparison of Agility 505 Test

AGILITY 505 TEST MEAN (ILLINOIS)	**MEAN(SD)**	**t(Equal variance assumed)**	P value
Experimental Group	34.93±5.00	--42.05	0.001
Control Group	91.67±1.49		

Activity specific Balance Confidence Scale shows significant difference between the control and the experimental group in the final measurement (p= 0.001).

Table 8: Between Group Comparison of Activity Specific Balance Confidence Scale

Activity Specific Balance Confidence Scale	
z	**z** -4.817
p	**0.001**

The WHO QOL+BREF shows significant difference between the control and the experimental group in the final measurement (p= 0.001).

Table 9: Between Group Comparison of WHO QOL+BREF Scale

WHO QOL-BREF	D1	D2	D3	D4
z	-4.841	-4.748	-3.718	-4.762
p	**0.001**	**0.001**	**0.001**	**0.001**

DISCUSSION

The present study investigates the effects of Agility training along with conventional occupational therapy on linear speed, turning ability, balance confidence along with QOL in unilateral transtibial amputee population with PTB prosthesis. In the amputee community, a greater emphasis is being placed not just on acceleration, top speed and speed endurance training, but also on change of direction speed drills. This represents an emphasis on the specificity of the agility training protocol with specific movement patterns dealing with the improvement of linear speed (Straight sprinting) accompanied by change in direction. Our results indicate that although both the groups exhibited improvement in the Illinois Agility Run Test (first outcome measure) yet the Agility Run Test shows statistically significant improvement of straight sprinting speed in the experimental group post 6 weeks of intervention. These results are in compliance with those obtained by Draper & Lancaster (1985), [12] J.M. Sheppard et al. (2006) [13] and Goran Sporis et al.(2010). [14] The results obtained here may be due to gradual decrease in ground contact time and increased flight time as well. The apparent improvement in muscle reaction time and time to peak muscle torque with Agility training may be attributed to repetition motion dissimilar to the mechanics of straight running in the transtibial amputee population. It required the subjects to adopt a sideways learning posture (lower centre of gravity) in an effort to apply enough lateral force to the ground to successfully change direction at high speed. They also required significant adjustments to the stride pattern to decelerate and then accelerate around each marker (turning end).

The task of quickly turning the body, once a cue occurs at a random point in the step cycle, while still maintaining balance and some momentum is extremely complex. In the experimental group, post 6 weeks of intervention the body appears to use a number of simplifications to solve this complex problem. First, a series of responses for turning is initiated by a deceleration mechanism that was previously described for the rapid stopping task by Hase and Stein (1998). [15] The leg that ends up in front rapidly initiates a broad extensor synergy to brake the forward momentum, and the trailing leg shows a flexor synergy, which reduces the push-off power. Second, while braking is occurring, human subjects quickly choose one of two general turning mechanisms (the spin turn or the step turn). The forward leg then assumes a role as the axis of rotation. Rotation is already initiated, whereas some momentum remains to assist turning rather than stopping and then turning. Thus, within a few tenths of a second, braking flow into a turning strategy that is essentially complete within a single step cycle.

Confidence in Balance has been reported to be a better predictor of an individual's physical, daily, environmental activities than actual measure of physical performance among the transtibial amputees. Our third outcome measure i.e. the Activity Specific Balance Confidence scale suggests that there has been significant improvement of balance confidence in the experimental group following 6 weeks of intervention but the improvement in the control group is found to be not significant. Our results highlight that partaking the agility training may increase balance confidence in the transtibial amputee subjects with prostheses. This is in accord with those obtained by T. Liu-Ambrose (2004) [16] where he showed through his results that the Agility Training group improved balance confidence after the 13-week intervention period ($p = 0.031$) in the absence of good physical abilities in older women with low bone mass. Agility training can improve aspects of balance by restoring or improving subject's range of motion and contributing to better mechanical efficiency. Agility training improved posture which means better structural alignment for balance, thereby enhancing the balance confidence. Agility training helps subjects gain awareness for how body alignment and core stability affect their balance. Correct body alignment reduces strain on musculoskeletal structures, maintains muscle tone, and contributes to balance by enlarging the base of support and maintaining an individual's center of gravity over that base of support. Agility training on the Agility ladder makes the training specific to the tasks with which they struggle in activities of daily living (like managing stairs, obstacle crossing etc. It add, subtract and change complexity of tasks to make balance training even more effective.

Our fourth and final outcome measure is WHO QOL-BREF which consists of four domains such as Physical Health, Psychological, Social Relationships and Environment. Understanding these relationships is important as subject's perceived QOL may affect their transition into the workplace, engagement in physical and/or social activities and motivation to adhere to a programme of rehabilitation. Our results implies that there is a significant improvement of all the 4 domains of WHO QOL-BREF in the experimental group post 6 weeks of intervention whereas the improvement in the control group is found to be not significant in Psychological and Social Relationships. This result is in accord with C.T. Barnett (2011) [17] who suggested that during rehabilitation overall QOL improves but the Physical health and Environment components improves significantly than Mental and Social relationships components of WHO QOL-BREF.

Previous studies of Liu-Ambrose TY et al. (2005) [16] showed that only agility training significantly improved health-related quality of life in community-dwelling older women with low bone mass. The Agility training has achieved so by increasing environmental & social interactions as well as enhancing self-efficacy of physical abilities. Our results also highlights the same facts with a considerable significant improvement in the experimental group post 6 weeks of Agility training intervention than the control group.

Although the research has reached its aim, there were some unavoidable limitations. Firstly, because of the time limit, this research was conducted only on a small sample size of population who attended the study area. Therefore to generalize the results for larger groups, the study should have involved more participants. Secondly, because of the time limit, the duration of rehabilitation taken in this study is 6 weeks which seems to be a little short. A study including a rehabilitation period of 13 weeks minimum would have presented a better perspective. Future studies can be undertaken taking a larger sample size as well as a longer rehabilitation duration to examine the effects on a large scale population. The studies may also include different level of amputations in lower limb. There should be more studies on the effect of Agility training on the older adults (50-70 years of age). There should be a detailed study on the effect of Agility training on the psychological and social aspects of Quality Of Life on a larger population.

CONCLUSION

Agility training along with the conventional occupational therapy yields significant Improvement in the linear sprinting speed, turning ability, balance confidence and Quality of life in unilateral transtibial amputees with prostheses; than the conventional occupational Therapy alone.

REFERENCES

1. Kirkup J R. Introduction and Sources and Natural Causes of Dismemberment. In: A history of limb amputation. Springer; 2007. p. 12.
2. Bowker J H, Michael J W, American Academy of Orthopaedic Surgeons. Atlas of limb prosthetics: surgical, prosthetic, and rehabilitation principles. MosbyYear Book, St. Louis 1992.
3. Foster, Lee. Use of Prosthesis on daily basis. Journal of Prosthetic and Orthotics 2005; 16(2): 49-51.
4. Buckley JG, O'Driscoll, Bennet S J. Postural sway and active balance performance in highly active lower-limb amputees. Am J Phys Med Rehabil 2002; 81: 13-20.
5. Aruin AS, Nicholas JJ, Latash ML. Anticipatory postural adjustments during standing in below-the-knee amputees. Clin Biomech 1997; 12: 52-9.
6. Viton JM, Mouchnino L, Mille ML, Cincera M, Delarque A, Pedotti A, et al. Equilibrium and movement control strategies in trans-tibial amputees. Prosthet Orthot Int 2000; 24: 108-16.
7. LiuW, Kim SH, Long JT, Pohl PS, Duncan PW. Anticipatory postural adjustments and the latency of compensatory stepping reactions in humans. Neurosci Lett 2003; 336:1-4.
8. Curtze C, Hof AL, Otten B, Postema K. Balance recovery after an evoked forward fall in unilateral transtibial amputees. Gait Posture. 2010 Jul; 32(3):336-41.
9. Miller WC, Speechley M, Deathe B. The prevalence and risk factors of falling and fear of falling among lower extremity amputees. Arch Phys Med Rehabil. 2001 Aug; 82(8):1031-7.
10. Hak L, van Dieën JH, Wurff PV, Prins MR, Mert A, Beek PJ, Houdijk H. Walking in an unstable environment: Strategies used by transtibial amputees to prevent falling during gait. Arch Phys Med Rehabil. 2013 Aug; 94(8): 1435-41.
11. Summers GD, Morrison JD, Cochrane GM. Foot loading characteristics of amputees and normal subjects. Prosthet Orthot Int 1987;11:33-9.
12. Draper J.A., Lancaster M.G. (1985) The 505 test: a test for agility in the horizontal plane. Australian Journal of Science and Medicine in Sport 17, 15-18
13. Sheppard JM[1], Young WB. Agility literature review: classifications, training and testing. J Sports Sci. 2006 Sep; 24(9):919-32.
14. Goran Sporis, Luka Milanovic, Igor Jukic, Darija Omrcen and Javier Sampedro Molinuevo. 2010. The Effect of Agility Training On Athletic Power Performance. Kinesiology, 421:65- 72

15 Hase K, Stein RB. Analysis of rapid stopping during human walking. J Neurophysiol. 1998 Jul; 80(1):255-61.
16 Liu-Ambrose T, Khan KM, Eng JJ, Janssen PA, Lord SR, McKay HA. Resistance and agility training reduce fall risk in women aged 75 to 85 with low bone mass: a 6-month randomized, controlled trial. J Am Geriatr Soc. 2004 May; 52(5):657-65.
17 Cleveland Thomas Barnett. Biomechanics and Quality of Life in Transtibial Amputees During and Following Rehabilitation: A Longitudinal Study. Arch PhysMed Rehabil January 2011; 82: 1031-7.

How to cite this article: Mallick M, Sethy D. Effectiveness of agility training on balance confidence in unilateral transtibial amputees wearing prosthesis. Int J Health Sci Res. 2018; 8(7):97-104.

******