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ORIGINAL ARTICLE

EVALUTION OF EFFECTIVENESS OF BALANCE TRAINING IN CONVENTIONAL PROSTHESIS VERSUS ULTRAMODERN PROSTHESIS IN UNILATERAL TRANSTIBIAL AMPUTEE BY USING FLAMINGO BALANCE TEST

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ABSTRACT: AIM: To estimate the effectiveness of balance training on unilateral transtibal amputee with conventional prosthesis and ultramodern prosthesis. To compare the Effectiveness of balance training in conventional prosthesis versus ultramodern prosthesis in unilateral transtibial amputee by using Flamingo balance test. **MATERIALS AND METHODS**: After obtaining informed consent from the patients, we studied a total of 40 patients, aged between 30- 60 yrs, where they were randomly allocated into two groups. 20 patients in Group A with conventional prosthesis and 20 patients with ultramodern prosthesis in group B were subjected to 3 weeks of structured exercise programme after initial assessment of balance with Flamingo's balance test and ten metre walk test. These tests were repeated in repeated in both the groups after the exercise programme and the results were tabulated and analysed. **RESULTS:** The mean age of population in group A was 50.55± 7.20 and in group B was 48.55±5.58, with age group ranging from 30 – 60 yrs. In group A the pre and post interventions mean values in Flamingo's balance test were 15.55±2.58 and 13.05±3.05 respectively. In group B the pre and post intervention mean values were 12.35±1.26 and 8.3±0.86 respectively. In group A the pre and post interventions mean values in ten metre walk test are 45.00±3.62 and 35.00±6.39 respectively. In group B the pre and post intervention mean value are 40.00±4.29 and 26.70±2.95 respectively. The mean difference of balance using Flamingo Balance test during pre and post intervention in both the groups were compared using independent 't' test, which showed (t of 4.971 vs 6.805 in Groups A and B respectively; p=000*). The mean difference of balance in both the groups for ten metre walk test were t of 3.979 vs 5.650 in Groups A and B respectively (; p= 000*). **CONCLUSION:** In both groups there are statistically significant improvements in scores flamingo balance test and 10mt. walk test (p=000*). The improvements in patients with ultramodern prosthesis were statistically more significant than in patients with conventional prosthesis. So exercise program of 3 weeks duration proved to be an effective method to reduce the imbalance and improve the gait efficiency.

KEYWORDS: balance training conventional prosthesis ultramodern prosthesis flamingo balance test

INTRODUCTION: Transtibial amputation is taken up in one fourth of the lower limb amputees and is quite common in middle age population. After an initial period of interim and temporary prosthesis usage, these patients can be fitted with permanent/ definitive prosthesis as a part of their rehabilitation.

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Definitive prosthesis can be conventional (Exoskeleton) or Ultramodern (endoskeleton) type. While the conventional type prosthesis are made of materials like wooden shank, aluminium shank, polyester resin laminated, epoxy resin laminated, HDPE pipe moulded or polypropylene moulded, they are heavy and cheaper. On the contrary, the ultramodern prosthesis which is made of aluminium or Carbon pylon are lighter but costlier.

Various factors influence the quality of rehabilitation in transtibial amputees with prosthesis. While the factors can be related to prosthesis or their biomechanical components, balance is found to be an equally important component affecting the outcome of rehabilitation. As it is natural that the decrease in proprioceptive inputs result in lack of postural stability in lower limb amputees, to succeed in rehabilitation, therefore, balance training and weight shifting is important.

Despite the existence of a myriad of factors affecting the outcomes, clinicians and researchers have embraced a notion that prosthesis should be as light as possible, presumably in part to minimize muscular effort and to gain the balance during locomotion and perhaps also to facilitate safer and faster walking speeds.

Different types of prosthesis have been developed in recent years and abundant studies have been undertaken on using flamingo balance test and 10 meters walk test as outcome measures, for quantification of balance during static and dynamic positions respectively. There is a lack of evidence comparing conventional prosthesis and the ultramodern prosthesis in unilateral transtibial amputee using flamingo balance test and 10 meters walk test as a measure. Hence this study is undertaken.

MATERIALS AND METHODS: Kempegowda Institute of Medial Sciences and Research Centre Institutional Review Board and Ethical Clearance committee approved the study. (IRB number: 0902-039-272) and informed consent were obtained from all patients prior to the allocation and balance training tests. No financial support was received for this study.

Over a period of one year, patients with Transtibial amputation fitted with a definitive prosthesis coming to Kempegowda Institute of Medical Sciences, hospital and Research Centre, Kempegowda Institute of Physiotherapy were screened for inclusion/ exclusion criteria.

All the Unilateral transtibial amputees aged between 30 – 60 years and having an ideal stump length were included in the study. The subjects also were screened to be free from tightness contracture deformity and any musculoskeletal abnormality. The patients with complications like stump Neuroma, Phantom pain, Stump edema, Bony stump, Short stump/ long stump, Skin disease/lesion of the stump were excluded as they might confound the results of balance of training.

Patients with any associated handicap/ disability, Bilateral amputees and associated fracture on sound side limb were also excluded in the study as it affects the weight bearing. Patients with visual impairment and associated cardiac/ lung/ renal problem were also excluded from the study.

The purpose of the study was explained to all the patients, those who volunteered to take part in the study and informed consent was obtained from them. All subjects were assessed using a specific Proforma (Annexure-1) and were allocated to two groups through Random Sampling method. Patients who were using a conventional prosthesis were allocated to Group A and ultramodern prosthesis were allocated to Group B.

The Flamingo balance test and 10 meter walk test were measured prior to the commencement of the intervention on the first day. A standardized exercise program was given to the patients of both groups, five times per week for 3 weeks (Table 1). At the end of 3 weeks of

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intervention both the test were measured again under similar conditions in both groups. Then the values of pre and post intervention were compared statistically.

1. Balance training -given by Antero - posterior sway and medio- lateral sway while patient standing on wobble board for 40 min/day for 5 days in a week and for 3 weeks
Balance was trained in both the groups -conventional PTB and ultramodern PTB.
2. Conventional treatment:
A. Resisted Exercises:
Bridging on the unaffected leg.
Isotonic exercises hip flexion.
Hip abduction.
Hip extension.
Hip adduction.
Stump exercises (SE)

B. Technique of application of Stump exercises (SE):
The exercises that are taught to the patients are:
1. Stretching exercises of Stump: Hold for 30 seconds, 5 repetitions per session and 3 sessions per day.
Hip flexor stretch: Patient in supine lying position. Non-amputated leg is flexed at the knee and drawn towards the chest. Therapist slowly resists the amputated limb at knee to prevent flexion at hip in turn leads to hip flexor stretch.
Adductor stretch: Patient is sitting against the wall and non-amputated limb is flexed at the knee, abducted and external rotated and amputated leg passively abducted in turn causes adductor stretching.
Strengthening exercises: Hold for 30 seconds, done for 10 repetitions per session and 3 sessions per day.
Static quadriceps: Patient in supine lying position, a towel roll is given below the knee joint of the amputated limb and asked to press the towel in turn strengthens the quadriceps muscles.
Prone hip extension: Patient in prone lying position and asked to extend the hip of the amputated limb.
Side lying with hip abduction: Patient in a side lying position and asked to abduct the hip.

(Table 1) The standardized exercise program given to both the groups for 3 weeks

HYPOTHESIS:

Alternative Hypothesis: It may be seen that conventional prosthesis and ultra-modern prosthesis along with balance training may be effective in the treatment of unilateral transtibial amputee.

Null Hypothesis: It may be seen that conventional prosthesis and ultra-modern prosthesis along with balance training may not be effective in the treatment of unilateral transtibial amputee.

Statistical Analysis: Descriptive statistical analysis has been carried out in the present study. Balance is measured using flamingo balance test by counting number of times imbalance in one

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minute and Ten meters walk test -before and after intervention is presented in Mean SD (Min-Max) and results of categorical measurements are presented in number (%). Significance is assessed at 5 % level of significance.

Statistical Analysis: Chi square test is used to analyze the characteristics of the samples. Student t test (two tailed, independent) was employed to test the significance of study parameters between the two groups of subjects. Student t test (paired) has been used to find the significance of study parameters between pre and post intervention in each group. The Statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Figure 1: Balance training in patient with Conventional prosthesis.
Figure 2: Balance training with ultramodern prosthesis.

Figure 1

Figure 2

Figure 4: Flamingo balance test with conventional prosthesis.
Figure 5: Flamingo balance test with ultramodern prosthesis.

Figure 3

Figure 4

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Figure 5 & 6: Ten meter walk test.

Figure 5

Figure 6

RESULTS: In this study, a total of 40 patients was recruited and analyzed, with 20 patients in each group. The mean age of population in group A was 50.55± 7.20 and in group B was 48.55±5.58, with age group ranging from 30 – 60 yrs. Of the 20 patients in group A, 12 were males (60%) and 8 (40%) females. While in group B 16 of 20 patients (80%) were males and 4 (20%) were females.

In this study, in group A the pre and post interventions mean values in Flamingo's balance test are 15.55±2.58 and 13.05±3.05 respectively. In group B the pre and post intervention mean value is 12.35±1.26 and 8.3±0.86 respectively. Analysis using Freidman's ANOVA mean values of the number of times imbalance has shown that there was statistically significant difference within the Group A and Group B. Also, in group B (ultramodular below knee prosthesis), patients had lesser times of imbalance than group A (Conventional below knee prosthesis). (Table 4).

Flamingo test	Group A mean±SD	Group B mean±SD
Pre- intervention	15.55±2.58 (11-19)	12.35 ±1.26 (10 to 14)
Post- intervention	13.05 3.05 (7-5.17)	8.30 0.86 (7-10)
Significance	p =0.000**	p =0.000**
Percentage of change of improvement in imbalance		
Pre to post intervention	11.85%	6.81%

Table 4: Comparison of balance in Flamingo Balance test during Pre and Post intervention within the Group A and B

In this study, in group A the pre and post interventions mean values in ten meter walk test are 45.00±3.62 and 35.00±6.39 respectively. In group B the pre and post intervention mean value is 40.00±4.29 and 26.70±2.95 respectively. Analysis using Freidman's ANOVA mean values of duration to complete 10 meter walk test have shown that there was statistically significant difference within

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both the groups with intervention. Based on pre and post mean and S.D the group B showed better improvement than group A. (Table 5)

Flamingo test	Group A mean±SD in Sec	Group B mean±SD in Sec
Pre- intervention	45.00±3.62 (40 to 50)	40.00±4.29 (30 to 45)
Post- intervention	35.00 6.39 (23-45)	26.70 2.95 (20-30)
Within the group significance	p =0.000**	p =0.000**
Percentage of change in VAS score		
Before to 24 hours after intervention	33.71%	25.20%

Table 5: Comparison of balance in ten meter walk test during pre and post intervention within Group A and B

The mean difference of balance using Flamingo Balance test during pre and post intervention in both the groups were compared using independent 't' test, which has shown that there was statistically significant change in Group B than Group A in imbalance when compared to pre and post-intervention (t of 4.971 vs 6.805 in Groups A and B respectively; p=000*).(table 6).

Flamongo	Group A mean±SD	Group B mean±SD	95%CI		Significance
			Lower	Upper	
Pre-intervention	15.55.± 2.58	12.35±1.26	1.897	4.503	t= 4.971; p = <0.000
Post-intervention	13.05±3.05	8.30±0.86	3.337	6.163	t= 6.805; p = <0.000**

Table 6: Comparison of balance using Flamingo Balance test during pre and post intervention between the Group A and Group B

Similarly, the mean difference time taken to complete Ten meter walk test during pre and post intervention between both the groups were compared using independent 't' test, which has shown that there was statistically significant change in Group B than Group A in imbalance when compared to pre and post- intervention (t of 3.979 vs 5.650 in Groups A and B respectively; p= 000*). (table 7).

Ten mts	group A mean±SEM in cm	group B mean±SEM in cm	95%CI		Significance
			Lower	Upper	
Before to intervention	45.00±3.62	40.00±4.29	2.456	7.544	t= 3.979; p=0.000**
after intervention	35.60±6.39	26.70±2.95	5.711	12.089	t= 5.650; p= 0.000**

Table 7: Comparison of time taken to complete Ten meter walk test during pre and post intervention between both the groups

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DISCUSSION: Analysis of balance using Flamingo Balance test and 10 meter walk test within the Group A and B (Table 4 and 5) shown that there were statistically significant improvement in balance within both the groups when compared pre-intervention to post intervention.

When the percentage of improvement from pre-intervention to post intervention were compared with flamingo balance test (table 4), Group A showed 11.85% and Group B 6.81% decrease in the number of times imbalance. This implies that the subjects with ultramodern prosthesis were improved in balance than compared to subjects with conventional prosthesis.

When the percentage of improvement from pre-intervention to post intervention were compared with 10 meter walk test (table 5), Group A showed 33.71% and Group B 25.20% improvement in covering the distance in shorter time. This implies that the subjects with ultramodern prosthesis were improved in time taken to complete the 10 meter of distance than compared to subjects with conventional prosthesis.

In our study, we used PTB prostheses and from this aspect our research is nearly parallel with Vittas et al study. Isakov et al found that some people with a Below Knee Amputation sway less at the end of the rehabilitation period.[9] Outcome of our study also showed important differences in balance in favor of the post- treatment values supporting Isakov‘s research. In amputees, weight-shifting activities wobble board activities, strengthening exercises, treatment in specific phases of gait, other basic functional activities approaches to improve balance.

And also a possible explanation for this could be the material and method used in fabrication of ultramodern prosthesis. Subjects using ultramodern prosthesis had a better biomechanical prosthetic alignment and the prosthetic socket, the type of the prosthetic foot (Pinzur et al,) suspension of prosthesis than the conventional prosthesis.

Even the weight of prosthesis would have played a part in reducing the balance of Subjects with ultramodern prosthesis As a result of this approach, muscle-joint feedback performed by visual inputs is thought to be important to control posture and body sways which lead an obvious improvement in stump-socket adaptation.

Based on the analysis of results in the present study, 3 weeks of conventional exercise program along with balance training proved to be an effective method to improve the balance in subjects with transtibial amputees with either conventional or ultramodern prosthesis. Also, it is evident that the improvement is significantly higher in patients with ultramodern prosthesis when compared to those with conventional prosthesis, probably owing to light weight and improved biomechanics. The results do not support null Hypothesis and hence, the present study rejects the null hypothesis.

However, this study has certain limitations. The present study did not take into account previous levels of physical fitness of individuals. Also, the duration of prosthetic use prior to the study was not standardized. These might have confounded effect on the outcomes in either of the groups and hence need to be considered. For more accurate results further studies can be done by comparing two different prostheses on the same individual. Further studies should include comparing the gold standard method of measuring balance in unilateral transtibal amputees. These results also need to be tested on a larger sample size.

CONCLUSION: In the present study it is concluded that 3 weeks of conventional exercise program along with balance training proved to be an effective method to improve the balance in subjects with transtibial amputees with either conventional and in Ultramodern prosthesis.

Statically it is concluded that the ultramodern prosthesis samples showed significant improvement than a conventional prosthesis.

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