

BALANCE TRAINING IN AMPUTEES: COMPARISON OF THE OUTCOME OF TWO REHABILITATION APPROACHES

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SUMMARY

Introduction: Since the primary purpose of lower limb amputee rehabilitation is safe and functional ambulation, problems in postural stability have a negative effect on prosthetic rehabilitation. The study presented here was performed to research the effectiveness of two training procedures on the balance of below-knee amputees.

Material and Methods: Forty amputees with a mean age of 40 years were participated in this study. Control and study groups were consisted from twenty amputees each. Amputees in the study group were treated with balancing activities using balance board and audio-visual stimulus, while strengthening, posture and parallel bar activities were given to control group as conventional approach. In balance assessments "Flamingo Balance Test" is used.

Results: Finally an important difference was found between the pre and post treatment values of balance on single foot while eyes were opened and closed ($p < 0.05$) in favor of the study group.

Conclusion: Consequently, it can be said that using balance board in balance training is an effective way of achieving adequate balance in amputees.

Key Words: *Balance Board, Rehabilitation, Amputee.*

ÖZET

AMPUTELERDE DENGE EĞİTİMİ:
İKİ REHABİLİTASYON
YAKLAŞIMININ KARŞILAŞTIRILMASI

Giriş: Alt ekstremitte amputelerde postural stabilitenin azalması protez rehabilitasyonunu olumsuz yönde etkilemektedir. Amputelerin rehabilitasyonunda emniyetli ve fonksiyonel ambulasyon ise primer hedeftir. Bu çalışma diz altı

amputelerde iki eğitim yönteminin denge üzerine olan etkisini araştırmak amacıyla planlanmıştır.

Hastalar ve Yöntem: Çalışmaya 40 ampute dahil edilerek 20'si kontrol, 20'si deney grubu olarak ayrılmıştır. Kontrol grubuna konvansiyonel rehabilitasyon programı (kas kuvvetlendirme, postür egzersizleri, paralel bar aktiviteleri) uygulanmıştır. Deney grubuna ayrıca denge tahtası kullanılarak özel olarak seçilmiş denge egzersizleri ayna karşısında görsel ve sözlü uyarılarla çalıştırılmıştır. Dengenin değerlendirilmesinde Flamingo denge testi kullanılmıştır.

Bulgular: Eğitim öncesi ve sonrası gözler açık ve kapalı tek ayak üzerinde yapılan değerlendirmelerde farkın deney grubu lehine anlamlı olduğu bulunmuştur ($p < 0.05$).

Sonuç: Fonksiyonel ve emniyetli bir ambulasyonu ulaşabilmek için denge eğitiminde denge tahtasının kullanılmasının etkili prosedürlerden biri olduğu sonucuna varıldı.

Anahtar Kelimeler: *Denge Tahtası, Rehabilitasyon, Ampute.*

INTRODUCTION

Upright posture is maintained by the constant readjustments of body's center of gravity over the base of support. Since standing is a dynamic and complex event, it requires the integration of inputs from the exteroceptive, vestibular and proprioceptive systems¹.

It is natural that the decrease in proprioceptive inputs result in lack of postural stability in lower limb amputees². As the primary objective is achieving safe and functional ambulation, insufficient postural stability produces difficulties in rehabilitation³. To succeed in rehabilitation therefore balance training and weight shifting is

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important. Various methods such as verbal ,audial feedback and mirrors have been used in lower limb amputees in order to decrease the body sway velocity and increase the standing balance⁴⁻⁶.

Fernie and Holliday stated that body sway is increased in below knee amputees when compared with healthy volunteers². Vittas et al reported that normal stability during standing could be achieved in below-knee amputees when an effective rehabilitation programme is applied^{8,9}.

MATERIAL AND METHODS

Forty amputees who hadn't any systemic disease which will produce difficulties during evaluation and training were included in the study. Ages were ranged between 20 to 45 years and all of them were amputated because of trauma. Amputees underwent an evaluation programme in the preprosthetic stage including muscle testing, posture analysis, range of motion, antropometric measurements, respiratory assessments and stump evaluation. The patients had to meet the following criteria before starting the research.

- No other problems in the lower extremities, except amputation.
- Normal range of motion capability in the lower extremity joints.
- Normal or good muscle strength in lower extremities and trunk.
- Normal learning ability and motivation.

All of the amputees were provided with Patellar Tendon Bearing Prostheses using either supracondylar (PTB-SC) or supracondylar suprapatellar (PTB-SCSP) suspension. PTB-SCSP sockets are widely used over 40 years in the patients who have short stumps and require both anterior-posterior and medio-lateral stability. PTB-SC sockets are effective to provide medio-lateral stability and preferred to be used in the patients with standart or long stumps. In both sockets body weight is mainly born on the patellar tendon area and partially on the lower border of tibial medial condyle¹⁰. After the lower attachment including dynamic foot is done, amputees were randomly assigned into two groups consisted of 20 patients each. Control group received conventional rehabilitation programme including strengthening, posture exercises and parallel bar activities while special exercises using balance board (Figure 1) and visual-audial feedback with mirror were given to the study group (Figure 2). Amputees were

treated twice a day, 1-hour in the morning, 1-hour in the afternoon for 3 weeks. In balance assessment "Flamingo Balance Test" is used³ (Figure 3). This test measures the time required for balanced stance on one leg in seconds. Initial balance evaluation was performed after two weeks when there wasn't any problem in stump-socket fit, both with eyes closed and opened.



Figure 1: Posture exercise and parallel bar activities while special exercises using balance board.



Figure 2: Visual-audial feedback with mirror given to the study group.

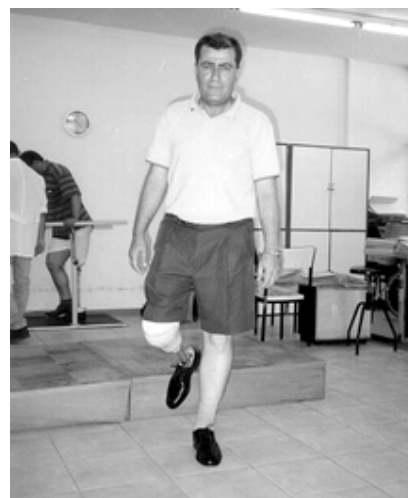


Figure 3: "Flamingo Balance Test".

This study was planned to be double-masked. The physiotherapist who performed the evaluations didn't know the exercise modalities received by the amputees. Another physiotherapist who gave the exercise programme also didn't have the idea of the parameters those are tested. The patients were also unaware of the study.

In the data analysis, students T-test were used.

RESULTS

Mean age of the lower limb amputees was 40.2 ± 3.61 years. Mean ages of control and study groups were found to be 39.05 ± 0.95 and 41.35 ± 1.45 years respectively.

Due to occupational assessment, in the control group 4 amputees were retired, 1 was university student, 7 were public worker, 5 were private worker and 3 were unemployed. In the study group 4 amputees were retired, 10 were public worker, 4 were private worker and 2 were unemployed.

After physiotherapy-rehabilitation assessments, it was found that there wasn't any specific factor which will influence the prosthetic use negatively.

Supracondylar-suprapatellar (PTB-SCSP) sockets were applied to 14 amputees while 6 amputees fitted with supracondylar (PTB-SC) sockets in the control group. In the study group, PTB-SCSP sockets were laminated to 17 amputees and 3 were fitted with PTB-SC sockets.

Amputation side was left in 13 and right in 7 amputees in the control group while 9 were amputated from the left side and 11 from the right side.

Pre Treatment Values of Balance Test : When the results of the first balance tests of both groups were compared there wasn't any statistically significant difference ($p > 0.05$) (Table 1).

Post Treatment Values of Balance Test : Post treatment balance test results showed statistically important differences in favour of the study group ($p < 0.05$) (Table 1).

Comparison of Pre and Post Treatment Balance Test Results in Control Group : There was statistically important differences in favour of the post treatment values when pre and post treatment values of the control group were compared (Table 2).

Comparison of Pre and Post Treatment Balance Test Results in the Study Group : There was statistically important differences in favour of the post treatment values, when pre and post treatment results of the study group were compared (Table 2).

DISCUSSION

Symmetrical weight bearing in lower extremities is the key point in normal ambulation. The amputees prefer to bear more weight on the non amputated limb because of insecurity and feelings of fear. This asymmetrical weight bearing is the primary cause of gait deviations so the patient must be stimulated by appropriate training to accept more weight through the prosthetic limb¹¹.

Many researchers reported increase in body sway patterns in lower limb amputees and stated that this increase is directly proportional with age¹²⁻¹⁵. Researchers studied postural sway with Kistler Platform and found that the vascular amputees had an increased sway in the lateral direction when compared with the healthy group¹⁶. Investigators also studied the effect of visual, vestibular and proprioceptive feedback on the postural stability¹⁷.

In this particular study, the effect of rehabilitation programme on the time required for balanced stance during weight bearing on one leg is researched.

A statistically significant difference was determined in favour of the study group due to pre to post treatment evaluations while eyes were opened and closed ($p < 0.05$) (Table 1). In the study it was observed that the amputees could perform good adaptation to weight shifting and exercises on balance board. An improve in the balanced stance time on single foot was determined in both groups when the pre to post treatment values were compared (Table 2).

Outcome of this study showed that intensive balance treatment is necessary to improve the functional use of the prosthesis. Vittas et al stated that a well fitted PTB-amputee stands at least as safely as a normal person.⁸ In our study we used PTB prostheses and from this aspect our research is nearly parallel with Vittas et al's study. Isakov et al found that some people with Below Knee Amputation sway less at the end of the rehabilitation period⁹. Outcome of our study also showed important differences in balance in favour of the posttreatment values supporting Isakov's research.

In amputees, weight-shifting activities, treatment in specific phases of gait, other basic functional activities and standing while performing arm movements as catching balls are important approaches to improve balance^{1,3}. In the study group the patients are stimulated by visual stimulus with the use of a mirror. As a result of this approach, muscle-joint feedback performed by

Table I
Pre Treatment and Post Treatment Values of Balance Test (Second)

	Control Group			Study Group			Student t Test	
	X	S	S _x	X	S	S _x	t	p
Pre Treatment (n=20)								
RIGHT FOOT (eyes opened)	23,85	19,19	4,29	26,05	19,56	4,37	0,35	> 0,05
LEFT FOOT (eyes opened)	12,40	15,67	3,50	14,65	18,11	4,05	0,42	> 0,05
RIGHT FOOT (eyes closed)	10,10	10,01	2,23	11,10	10,67	2,38	0,30	> 0,05
LEFT FOOT (eyes closed)	8,20	14,13	3,16	8,95	14,11	3,15	0,39	> 0,05
Post Treatment (n=20)								
RIGHT FOOT (eyes opened)	26,85	18,07	4,04	46,40	13,92	3,11	3,84	< 0,05
LEFT FOOT (eyes opened)	14,80	17,57	3,93	36,65	16,56	3,70	4,05	< 0,05
RIGHT FOOT (eyes closed)	10,20	10,20	2,28	38,25	19,11	4,27	5,79	< 0,05
LEFT FOOT (eyes closed)	8,40	12,21	2,73	21,45	12,73	2,84	3,31	< 0,05

X: Mean, S: Standart Deviation, S_x: Standart Error.

Table II
Comparison of Pre and Post Treatment Balance Test Results in Control and Study Group (Second)

Control Group (n=20)	D	S	S _D	Student t Test	
				t	p
RIGHT FOOT (eyes opened)	1,9	2,12	0,47	4,04	< 0,05
LEFT FOOT (eyes opened)	2,4	2,48	0,55	4,36	< 0,05
RIGHT FOOT (eyes closed)	1,85	4,35	0,97	1,90	< 0,05
LEFT FOOT (eyes closed)	1,4	2,43	0,54	2,59	< 0,05
Study Group (n=20)					
RIGHT FOOT (eyes opened)	20,35	25,37	5,67	3,58	< 0,05
LEFT FOOT (eyes opened)	18,35	13,60	3,04	6,03	< 0,05
RIGHT FOOT (eyes closed)	22	12,62	2,82	7,80	< 0,05
LEFT FOOT (eyes closed)	7,65	6,12	1,36	5,62	< 0,05

D: Mean Difference, S: Standart Deviation, S_D: Standart Error.

visual inputs is thought to be important to control posture and body sways which leads an obvious improvement in stump-socket adaptation.

CONCLUSION

It can be concluded that lower limb amputees can achieve a high functional level in daily living by gaining a more balanced stance. For this purpose special balancing activities must be applied in lower limb amputees besides the conventional rehabilitation approaches. Further research is also required to assess the balancing abilities in the uneven terrain, work and social settings.

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