

Kinect Base Virtual Reality versus Biodex Gait Training on Lower Limbs Function in Burned Patients

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Abstract : Back ground and purpose : Mobility is a major problem for burn patients regarding their quality of life, the burn injury influence the ability to participate in daily living activities. Patients physical health significantly affected by their immobility. The purpose of the current study was to investigate is there is a difference between the use of Kinect base virtual reality and Biodex gait training for improvement of lower limbs functions in burned patients.

Subjects : Forty-two post lower limbs burn patients participated in this study and divided into two groups, twenty-one patients each (9 males and 12 females in each group). Their age ranged from 18 to 40 years.

Procedures : In the first group, patients practiced aerobic exercises using Xbox Kinect 360™ for twenty minutes a day, three times/ week for 4 weeks , while the second group patients practiced aerobic exercises using Biodex Gait trainer 2™ treadmill for the same time. The functions of the lower limbs were assessed by lower limbs function index and the measurement of gait parameters using Biodex Gait trainer 2™ treadmill.

Results : The study showed a significant improvement in lower limbs functions and gait parameters in both groups ($p < 0.05$) except the time on each foot which found to be insignificant . Also it showed that there was no significant difference between the two groups.

Conclusion : It was concluded that using either Kinect base virtual reality or Biodex Gait training had a significant benefits for improving lower limbs functions after burn, but there was no significant difference between them.

Key words : Kinect Virtual reality, Biodex treadmill, Burn, lower limbs function.

Introduction

Burn injury to different body tissues can be caused by exposure to heat, chemicals, electricity, friction, or radiation. The normal ability of skin tissue to prevent loss of heat and water and to protect the body from infection can be compromised¹. In lower limbs burn, legs and feet most commonly occur from exposure to steam, flames, hot liquids, chemicals, or electricity. Including the feet it represents 36% of the total body surface area in adults. Burns of the leg will be evaluated for depth and amount of surface area damaged to determine burn severity and appropriate therapy². The outcome of the burn injury influences the ability of patients to participate in daily life activities. If the patient is immobile for long time, they may have adverse effects on perceived physical health, resulting in more dependence on others and perceived helplessness³. Burn

trauma affects almost every physiological system within the body causes losses in functional capacity, so there is a real need for effective rehabilitative exercises⁴. Improved measures of physiological function such as aerobic capacity and strength in patients recovering from severe burns were found in patients who participated in progressive rehabilitative exercises. Because of that, exercises should be a component of patients outpatient care to restore their functional abilities. Interactive video games are increasingly being used in occupational and physical therapy regimens. These games have been found to offer injured or disabled patients an entertaining and mobile option that can be integrated into many rehabilitative plans⁵. Burn rehabilitation is essential for improving physical and psychological abilities. Playing interactive video games as a therapeutic tool become a complement in the treatment regimen due to its easy use and affordability. Kinect base virtual reality using Xbox Kinect 360™ has advantage over similar devices, due to its free controller interaction utilizing three dimensional motion capture soft ware. Xbox Kinect 360™ has potential use for rehabilitation because the patients can practice different tasks comparable to their daily activities⁶. Walking endurance, gait stability, muscle function, and balance will be increased to a greater degree in a patients receiving treadmill training. Also it offered repeated opportunities to build muscle strength in the lower limbs and stimulate neuronal connections that are involved in regeneration of independence balanced walking^{7,8}. Using Biodex Gait Trainer 2™ for gait training offers all of the benefits of a regular treadmill but with a system that motivates the patient by visual and auditory feedback. It corrects the patients pattern by giving them cues or signals on the screen during gait that helps the patient stay focused during gait rehabilitation⁹.

Materials and Methods:

Subjects: Forty-two patients participated in this study divided into two groups with 9 males and 12 females each. The mean values of their ages are 29.5±8.36 yrs., 29.9±7.67 yrs., respectively. The mean values of their weight are 76.73± 10.98 kg, 78.37± 10.05 kg and with height mean values 164.9± 6.2cm, 163.8± 5.402cm respectively. The comparison between patients in the two groups regarding their demographic parameters, showed no significant difference between the two groups, (table 1).

Table (1): Demographic data of the two groups (mean ±S.D.).

Treatment Data	Group A (X- Box) (n=21)	Group B (Biodex Treadmill) (n=21)	T-value	Significance P-value
Age (yrs.)	29.5±8.36 yrs	29.9±7.67 yrs	-0.157	0.878 NS
Weight (Kg)	76.73± 10.98 kg	78.37± 10.05 kg	-0.601	0.552 NS
Height (cm)	164.9± 6.2cm	163.8± 5.402cm	0.408	0.686 NS

*Significant at alpha level < 0.05, SD = standard deviation, cm = centimeter, P = probability, NS = non significance, and kg = kilogram.

A consent form was signed before procedures and possible side effects had been explained for each patient.

Inclusive criteria:

The patients were selected males and females, their age ranged from 18-40 years, with a percentage of burn total surface area 35-45% and free from other physical problems which can affect the gait.

Exclusive criteria:-

Pregnant ladies are excluded; patients with burned total surface area more than 45% and also all patients with any physical disability or neurological diseases can interfere with the results of the study (e.g. Heart diseases, epilepsy, ataxia, myelopathy, fracture lower limbs bones, joint fusions or burned sole of the feet).

Equipment:

Biodex gait trainer 2TM treadmill used as measurement tool for measuring the gait parameters and as a treatment tool as well as Xbox Kinect 360TM.

Procedures:

Measuring tests:

The Biodex Gait Trainer 2TM was used to evaluate gait parameters pre- and post-treatment including: average step length (m), average step cycle (c/sec), walking speed (m/sec) and time on each foot (recorded as a percent of gait cycle). Patients data (age, weight and height) were delivered to the machine to calculate the personal data for each patient, patient walked for twenty minutes on the treadmill allowing Biodex Gait Trainer 2TM to assess the gait parameters.

Lower limb function index questionnaire was conducted pre and post treatment, it provided the patients with 20 item instrument on paper and instructed to indicate their current level of difficulty with each activity.

a. Treatment procedures:

- (a) Kinect base virtual reality group: Patients were stand in front on the screen facing X-Box 360TM camera and asked to practice aerobic exercises using Nike + Kinect TrainingTM for twenty minutes. It builds a unique program of exercises for reach patient whatever their level is real-time feedback and measure the progress to encourage repetitive tasks which are linked to a better motor control recovery.
- (b) Biodex gait training: Aerobic program was selected from the preloaded programs in the Bidex Gait Trainer 2 treadmill, speed was adjusted according to the patient tolerance, the timing on 20 minutes and the patients will follow the visual cues on the screen to achieve the target. The patients were instructed to hold on the rails while walking and bull the red safety key if they felt uncomfortable or losing balance.

Both groups receive treatment for three times/ week for 4 weeks.

Data analysis: Statistical package for social sciences (SPSS) was used to analyze data.

Results

The results of this study regarding to the mean values of the Biodex 4-Gait parameters (average walking speed, average step length, average step cycle and Time on each foot) for lower limbs pre and post-treatment had significant improvement in both groups ($p < 0.05$) as illustrated in Table (2).

Comparing these results between both groups pre-treatment and post-treatment indicated insignificant differences for the parameters for lower limbs ($p > 0.05$). (Table 2)

Table (2): Pre and post treatment means ± SD values of the Biodex 4-Gait Parameters for both groups:

Parameters	Group A (X-Box) (n=21)	Group B (Biodex Treadmill) (n=21)	F-test	Significance P-value
Average Walking Speed (meters/second)				
Pre-treatment	0.73±0.16	0.72±0.19		
Post-treatment	1.02±0.24	1.01±0.27	0.188	0.852 NS
Percentage of Improvement	39.7%	40.28%	0.171	0.862 NS
F-value (p-value)	-11.979*	-12.532*		
	0.000	0.000		
	Significant	Significant		
Average Step Cycle (cycles/second)				
Pre-treatment	0.65±0.12	0.615±0.17		
Post-treatment	1.02±0.269	0.91±0.24	0.799	0.429 NS
Percentage of Improvement	56.9%	47.9%	1.340	0.188 NS
F-value (p-value)	-9.339*	-15.292*		
	0.000	0.000		
	Significant	Significant		
Average Step Length (meters)				
Right				
Pre-treatment	0.43±0.16	0.45±0.15		
Post-treatment	0.703±0.25	0.66±0.17	-0.351	0.727 NS
Percentage of Improvement	63.5%	46.7%	0.605	0.549 NS
F-value (p-value)	-9.604*	-20.979*		
	0.000	0.000		
	Significant	Significant		
Left				
Pre-treatment	0.402±0.15	0.41±0.14		
Post-treatment	0.68±0.206	0.65±0.176	-0.142	0.888 NS
Percentage of Improvement	69.15%	58.5%	0.469	0.642 NS
F-value (p-value)	-13.802*	-18.102*		
	0.000	0.000		
	Significant	Significant		
Time on Each Foot (percentage)				
Right				
Pre-treatment	49.9±2.07	50.4±2.04		
Post-treatment	50.15±1.04	50.4±1.14	-0.769	0.447 NS
Percentage of Improvement	0.5%	0%	-0.724	0.474 NS
F-value (p-value)	-0.815	0.000		
	0.425	1.000		
	Insignificant	Insignificant		
Left				
Pre-treatment	50.1±2.07	49.6±2.04	0.846	0.403 NS
Post-treatment	49.9±1.07	49.6±1.14	0.857	0.397 NS
Percentage of Improvement	-0.4%	0%		
F-value (p-value)	0.677	-0.188		
	0.507	0.853		
	Insignificant	Insignificant		

*Significant at alpha level < 0.05

Table (3): Pre and post treatment means rank values of the lower limbs function index for both groups:

Lower Limb Functions Index	Group A (X-Box) (n=21)	Group B (Biodex Treadmill) (n=21)	Mann-Whitney Z-score	Significance P-value
Pre-treatment	54.3±8.45	54.5±8.37		
Post-treatment	77.9±3.507	77±3.21	-0.27	0.978 NS
Percentage of Improvement	43.46%	41.28%	-1.103	0.270 NS
Wilcoxon test Z-Score (p-value)	-3.928* 0.000 Significant	-3.922* 0.000 Significant		

The results for the lower limbs function index using Wilcoxon test pre and post-treatment had significant improvement in both groups ($p < 0.05$) as illustrated in Table (3).

Comparing these results between both groups pre-treatment and post-treatment using Mann-Whitney test indicated insignificant differences for the parameters for lower limbs function index ($p > 0.05$) (Table 3).

Discussion

The current study was conducted to find out which method is better during lower limb rehabilitation after burn, using kinect base virtual reality or Biodex gait training. The statistical analysis of the results indicated a significant statistical improvement in lower limbs functions in each group, but also showed that there was no significant statistical difference between the two methods used (kinect base virtual reality and Biodex gait training) after 4 weeks of treatment.

The results of the current study regarding kinect base virtual reality were supported by those gained by Parisod *et al.*,¹⁰ who stated that video games such as X-box Kinect™ have gross motor integrate, provide physical challenge and a greater variety of physical operations when compared to conventional treatments. Use of it increases fitness, and encourage patients to restore their previous health behaviors and practice advanced rehabilitation therapies. They have been used with demonstrated efficacy with children¹¹ and adults, including elderly adults, in community¹², rehabilitation, and long-term care settings¹³ increase overall physical fitness¹⁴ and functional capabilities¹³.

Moreover, the obtained results came in agreement with the results of systematic reviews conducted by Biddiss and Irwin,¹⁵ and Peng *et al.*,¹⁶ who evaluated interventions using active video games they demonstrated that active video games are capable of increasing physical activity and providing light-to-moderate intensity of it among children and adults. Also, Ruivo,¹⁷ results showed that active video games offered countless applicable cardiovascular and non-cardiovascular benefits and pose minimal risks for the adult patients, and considered as a funny, feasible, active, efficient and safe supplementary approach.

Regarding Biodex gait training, the result of this study was supported by the results of Yong-Wook and Sung-Jun,¹⁸. After using treadmill for gait training the results showed a significant increases in the walking speed, distance and step length comparing to the previous performance. These results are consistent with reports that treadmill training improves walking speed, endurance, and symmetric weight bearing. The research conducted by Konik *et al.*,¹⁹ showed that treadmill walking training program lead to significant improvement of temporal and spatial gait parameters. According to Parry *et al.*,²⁰ the Biodex Gait Trainer 2™ promotes correct stride length for early phase patients. Lower extremities can be manually positioned in the desired gait patterns to reinforce the proper rehabilitation techniques. Normative data allows clinicians to compare patient progress to baseline norms.

De Icco *et al.*,²¹ recorded an improvement in some gait parameters including improved gait speed; after using treadmill with visual and auditory signals, visual signals also normalized the stance/swing ratio, auditory signals reduced the number of strides and increased stride length. The findings support and characterize the

usefulness of signals strategies inpatients gait during rehabilitation. Treadmill training using visual signals has more useful effects than treadmill training without it²².

Conclusion:

Within the scope of this study, it was concluded that there is no significant difference between kinect base virtual reality and Biodex gait training regarding the improvement of lower limbs functions after burn. Authors suggested that the insignificant differences between the two groups were due to the approximate physiological effects of both methods by giving the patients visual cues and feedback which helped them to correct their movements and stay motivated. This opinion was supported by the results of Deutsch et al.,²³ and Jiang and Norman²⁴.

Acknowledgement:

We express our sincere gratitude to all patients who kindly and actively participated in our study.

Conflict of Interest: We stated that there are no conflicts of interest.

Research Ethical Committee No.: P.T.REC/012/00771- Faculty of Physical Therapy- Cairo University- Egypt.

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