The Effectiveness of Assisted Thera-band Resistance Exercises on Improving the Swing Phase of Gait in Hemiplegic Patients

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Abstract—

Hemiplegic patients typically present with an inability to perform ankle dorsiflexion & knee flexion during the swing phase of their gait cycle. This results in the circumduction of the affected lower limb with limitation of their walking abilities and daily functions. Improving their dorsiflexion of ankle & knee flexion in their gait circle is a main key role of their rehabilitation.

This study aimed to compare and measure the effects of thera-band elastic resistance gait training with conventional physiotherapy gait training.

This study used a randomized control interventional study design. Sixty (n=60), 3 to 5 months post-stroke male patients, aged between 45 - 55 years were recruited. These 60 patients then randomly assigned to either the control or the intervention group. Patients were then assessed according to the Wisconsin gait scale (WGS) at baseline. The control group was involved in conventional gait training while the intervention group was involved in thera-band resistance gait training. All study samples were assessed again after two months.

All of them scored greater than the median WGS score (>28) at baseline. There were significant differences (P<0.01) within the control and intervention group following gait training programs. The intervention group showed greater mean change (mean change 10.7700, standard deviation SD 4.596) than the control group (mean change 1.6967, SD 1.4534). Mean difference between both groups was significant [mean change -9.0733, (P<0.01)].

Both the conventional gait training and thera-band resistance gait training were effective for hemiplegic patients in improving their independence during activities of daily living.

However, the findings from this study suggest that assisted thera-band resistance gait training program may be superior to the conventional gait training to become recover in a shortest time period.

Keywords — Stroke, Hemiplegia, Gait-training

I. INTRODUCTION

Stroke is a clinical syndrome describing a range of disorders which result in focal cerebral ischemia. The World Health Organization (WHO) defined as rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24h or longer, or leading to death, with no apparent cause other than of vascular origin (Markus, 2003). Different mechanisms have been found to cause vascular insufficiency to brain resulting in stroke. However the most common causes are thrombus, emboli, and hemorrhage. When brain cells are damaged due to above causes, function of the relevant injured areas are also diminished or inhibited. According to the lesion patient may be hemiparesis, hemiplegia, paraplegia, quadriplegia or diplegia. The patients with hemiplegia present with a loss of voluntary movement and alteration of muscle tone and sensation throughout one side of the body due to damage/lesion to the opposite side of the brain or upper spinal cord (Raj, 2006).

The ability to walk independently is the main activity of a normal human being. Movement from place to another plays an important part of human's daily lives. For every patient who is suffering from hemiplegia, restoration of walking is important. Normally hemiplegic patients are difficult to manually assist to dorsiflexion. The loss of normal lower limb movements leads to a partial or complete decline in functioning and often affects employment and quality of life. The lack of

confident of gait performance may limit ADL (activities of daily living). If we assist them to maintain dorsiflexion of ankle & flexion of knee, they will able to improve from the circumduction gait and walk as normal healthy person. The elastic resistance training has been reported to increase gait, mobility and balance. Thera-band elastic resistance can also be used in assisted gait training for hemiplegic patients to facilitate a normal gait pattern (Patil & Rao, 2011).

The purpose of this study was to identify the effectiveness of assisted thera-band resistance exercises, for improving ankle dorsiflexion and knee flexion during swing phase of gait cycle of hemiplegic patients in Sri Lanka. The hypothesis for this study was that the inability to manually dorsiflex the ankle & flex the knee can be prevented through the assisted thera-band elastic resistance gait training. These assisted elastic resistance gait training techniques is not currently use in Sri Lanka for patients with Hemiplegia. It is worthwhile to investigate whether these gait training techniques are effective in Sri Lankan society, most modern techniques utilized in foreign countries as incorporative this type of gait training. Other than that due to increased unfavourable social activities, diet and lack of physical activities during the final years of life, the number of in patients with hemiplegia also began to rise rapidly in Sri Lanka. Consequently patients with hemiplegia and their families confront a specific set of problems requiring clinical services to regain their independence. These efforts are helpful in the decisive purpose of bestowing a comfortable and a pleasant life for these hemiplegic patients.

II. METHODOLOGY

The study was a randomized control interventional study which was conducted in between 4th of March 2013 and 4th of May 2013. The study sample for the control and intervention groups was obtained according to a simple random sampling method. The study was conducted in the Colombo, Gampaha and Anuradhapura district of Sri Lanka. Patients were belonged to various social, cultural, educational, and religious backgrounds representing above mentioned districts in Sri Lanka.

In this study, two main objectives were investigated. One was to identify the effectiveness of assisted thera-band resistance exercises, for improving ankle dorsiflexion and knee flexion during swing phase of gait cycle. The other one was identify the awareness of thera-band resistance among patients who suffering from stroke. For the treatment program, 60 participants were recruited. All 60 subjects had to fulfill following requirements.

A. Inclusion criteria:

Patients aged between ages 45-55 years, 03-05 months post stroke from the day of onset and only male patients with written informed consent from all participants was recruited for the study. In deciding 60 subjects for the evaluation of the treatment program, another prerequisite considered was having a disability in score above the median Wisconsin gait score (MWGS = 28).

B. Exclusion criteria:

Patients with mental disability, physically unfit for gait training; hearing and vision disabilities and patients following any other treatment for stroke (ayurveda/homeopathy/acupuncture), suffering from any other illness that can cause disability. i.e.: rheumatoid arthritis, bone disease, osteoarthritis, lower limb fractures were excluded.

C. Data collection tools

The WGS was a useful tool to assess the gait alterations of post-stroke hemiplegic subjects and to assess changes over time during rehabilitation training. This scale has several qualitative features, which had a good statistical properties and ability to paint a picture of the person's gait pattern consisted of use of hand held gait aid, stance time on impaired side, step length of unaffected side, weight shift to the affected side (with or without gait aid), stance width, guardedness, hip extension of affected side, external rotation during initial swing, circumduction at mid swing, hip hiking at mid swing, knee flexion from toe off to mid swing, toe clearance, pelvic rotation at terminal swing and initial foot contact. The score was calculated according to the special formula. The maximum score was 42. The minimum score was 13.35. The higher the score result, the more seriously affected the gait. The MWGS was 28.65 (approximately 28). MWGS score indicated moderate affectation of the gait. The minimum score 13.35 indicated the normal healthy unaffected gait.

1) Pre-inventory questionnaire 1
Pre-inventory questionnaire was designed in order to gather socio-demographic data and consent. It was a self-administered questionnaire which was sometimes interviewer assisted.

2) Pre-inventory questionnaire 2
Pre-inventory questionnaire was designed in order to gather the awareness of the thera-band usage. It was an interviewer-administered questionnaire, consisting of 15 questions.

D. Data collection procedure
At the commencement of the research oral and written information about the study was provided to the patients. A pre-inventory questionnaire was given to the patients who granted written informed consent in order to obtain demographic data and a questionnaire to assess the awareness of the thera-band prior to the research. The patients were assessed according to the WGS and 60 patients who have scored above MWGS (28) were selected by simple randomizing. Then patients were randomly categorized into two groups; a control group and an interventional group with 30 participants each.

1) Exercise protocol for Intervention group: The exercise program consisted of conventional gait training and assisted thera-band resistance gait training. Conventional gait training was the normal gait training method, currently used in the physiotherapy departments of government hospitals in Sri Lanka. This conventional gait training program is usually done without attachment of any equipment to the body. The position of the patient for the treatment program was the normal anatomical standing position, which was the neutral position of the patient throughout the rehabilitation program. Stepping with affected lower limb were forward/ backward/ sideways/ on & off the steps. The movement of the leg was followed according to the commands of step forward, neutral, sideways, neutral, backward, neutral….etc. 15 repetitions for each session. Stepping with unaffected lower limb forward/ backward/sideways/on & off the steps, 15 repetitions for each session. Then walked on printed foot prints on an even surface in front of the mirror (20 m distance / 2 repetitions) and allowed patient to walk in heel to toe walking pattern. Average stride length was 1.46m as recommended by The American College of sports medicine. (Houglum & Bertoti, 2012).

For the Intervention group, the above mentioned conventional gait training was followed by wrapping the thera-band around the affected Lower limb. The method of wrapping of the Thera-band has explained below on 0*4).* After the wrapping of thera-band patient could assist for maintaining of the affected lower limb without making a circumduction movement. All intervention group patients" should follow all steps of the above mentioned conventional gait training program along with thera-band assistance. During every movement patients had to give some resistance to gain normal pattern of walking and prevent abnormal movements (circumduction of the lower limb) by improving knee flexion and ankle dorsiflexion. Gait training program for intervention group was conducted in 45 minutes, three times per week throughout 2 months.

2) Exercise protocol for control group: For the control group the above mentioned conventional gait training was followed without use of the thera-band. All gait training commands given were the as same as for the intervention group. Here the difference of treatments of two groups was the application of the thera-band for the intervention group. Gait training program for the control group was conducted in 45 minutes, three times per week throughout 2 months. After end of the 2 months (24 treatment session), participants of both groups were assessed according to the WGS. WGS scores and the gathered previous data were analyzed in order to check the effectiveness of assisted thera-band resistance exercises.

3) Material used: The green color Thera band resistance tube was used. Recognized as the original system of progressive resistance for over 25 years, and endorsed by the American Physical Therapy Association (APTA), Thera-Band elastic resistance has been proven to increase strength, mobility and function, as well as reduce joint pain. For this gait training program, the green color thera-band was selected as it was currently being used in rehabilitation programs. The green color thera-band was also the recommended type for rehabilitation of stroke patients. The tension of the green color thera-band was adequate for the acute patients.

4) Techniques of wrapping of the Thera-band around The Lower limb: The first step was wrapping the middle of a long green thera-band around the distal foot. Double the pull of the resistive band was towards eversion by wrapping the band the lateral border of the foot. The band was crossed over the top of the ankle. Then the band was moved up around the back of the lower leg. Next the end of the band was brought around the back of the knee and in front of the thigh. This allowed the patient to hold it on his unaffected hand directly or by turning around neck and moving downwards to hold by the unaffected hand. This resistive band especially helped them during the unweighting phase of the limb by assisting swing phase preventing circumduction and gaining knee and ankle flexion and subsequent foot placement. And the patient can maintain the ankle dorsiflexion manually.

E. Data analysis
Statistical package for social sciences (SPSS) statistics version 17.0 was used to analyze the obtained data. Socio-demographic data, awareness of the thera-band, comparison of WGS pre score of WGS were described using frequency tables and charts. Distribution of pre and post score of WGS was demonstrated using frequency, mean and standard deviation tables. WGS pre and post scores of same group were compared using the paired sample t-test for both groups separately. Afterwards, pre and post scores of intervention and control group were compared using Independent sample t-test. Finally, the mean differences of pre and post scores of both groups were compared using Independent sample t-test.

III. RESULT

The study included 60 patients in hemiplegia, 30 (n = 30) for control group and 30 (n = 30) for intervention group. All patients were presented equal disability in walking and day to day activities.

A. Demographic Characteristics of the Population
The mean age of participants was 50.28(±3.189) years at the time of study. The mean age was 50.28 years and mode of age was 53. A greater part of the sample (90 %) was married. The mean number of children per family was 1.93. Thirteen families (13%) were not presented any children. 8.3% of families were shown more than three children. The monthly income of a participant

(56.7%) was more than 25,000/= per month and 10% was less than 10,000/= per month. Majority of participants (63.4%) were earned more than 15,000/= of monthly income. (Table 2) The participants were involved in different educational levels. All were attended to a school, and 53.3% (`n = 54) participants were passed Advanced level examination in Sri Lanka. Among above 53.3% (n = 54), 36.7% (n = 22) participants were allocated as trainers, with their trained knowledge. Majority of the

Table 1. Socio-demographic characteristics

Marital status	Married	54(90%)
	Unmarried	06(10%)
Number of children	No children	08(13.3%)
	One children	15(25%)
	Two children	17(28.3%)
	Three children	15(25%)
	More than three	05(8.3%)
Monthly income	Less than 10,000/=	10(16.7%)
	10,000 to 15,000/=	12(20.0%)
	15,000/= to 25,000/=	04(6.7%)
	More than 25,000/=	34(56.7%)
Education level	No schooling	00 %
	6 to 11 education	06(10 %)
	G.C.E. AL	09(15 %)
	Graduated	23(38.3 %)
	Trained	22(36.7 %)

Participants were smokers. Among 60 participants 70% (n = 42) were heavy smokers.

Table 2. Smoking or Non-Smoking

	Number of patients	Percentage of patients
Smoking	42	70%
Non-Smoking	18	30%
Total	60	100%

B. The Awareness of the 'Thera Band' among Hemiplegic Patients.
All of the subjects were administered by an interviewer administered questioner, which consisted of 10th questions with "yes"/ "no" answers. All participants were answered completely all questions. Question number one and three has expressed the patients" awareness about place of buying the thera-band for their day to day needs. 73.3% of the participants (n = 44) for the question number one were gave an incorrect answer. 26.7% (n = 16) were gave the correct answer. And for the question number three, 71.7%

(n = 43) gave incorrect answer. The fourth and fifth question were aimed on the colors of the thera-bands. 55% (n = 33) for the 4th and 56.7% (n = 34) for the 5th gave the correct answer. The 8th and 10th question were mainly aimed on thera-band exercises for different conditions currently recommended in health care sectors. 73.3% (n = 44) participants gave the incorrect answer for 8th question and 63.3% participants (n = 38) gave the incorrect answer for 10th question.

C. Comparison of WGS pre score of the intervention group and control group.

1) Pre score of the intervention and control group: For the comparing of pre score of WGS, the Independent sample T test (parametric test) was selected from the SPSS. When comparing the intervention and control group, their mean pre score were approximately equal (Intervention group M=36.587, control group M=36.263, Mean Difference= 0.3233). No significant difference (sig. 0.438) between pre scores of control group and intervention group (P > 0.1).

2) Pre and post score of the control group: For comparing pre and post score of control group, the paired sample T test was selected from the parametric test on SPSS. Pre score M=36.587 and post M=34.890, MD=1.6967. In connection with above represented data, there was a significant difference (sig. 0.000) in between mean of pre (M=36.587, SD=1.9024) and post (M = 34.890, SD = 2.1618) scores (P < 0.01).

3) Pre and post score of the intervention group: A Paired sample T test was conducted to compare mean improvement of pre and post score of the intervention group. The mean of the pre score was 36.263 and post score was 25.493. The intervention group shows 10.7700 score differences in their means. There was a significant difference (P < 0.01) in pre scores (M=36.263, SD=1.2308) and post scores (M = 25.493, SD = 4.2427), of intervention group t (29) = 12.835, [sig. (2-tailed) = 0.000.]

4) Comparison of mean difference of control group and intervention group: The independent sample t-test was selected to compare the mean differences of control group and intervention groups. Mean differences express the improvement of gait training program. From the Levene's test "the equal variances assumed" row was selected. The corresponding t is -10.310, DF = 58. There was a significant difference (P < 0.01) in the scores for intervention group mean (M=10.770, SD=4.5961) and control group mean (M=1.697, SD=1.4534), t (58) = 10.310. Intervention group have shown greater mean difference than control group. (MD = -9.0733).

IV. DISCUSSION

The risk of stroke increased significantly with age. This study found a mean age of hemiplegia due to stroke, 50.28(± 3.189) years. A greater part of the sample (90 %) were married. Majority of participants (63.4%) were earned more than Rs.15, 000/= of monthly income. All were attended school, 53.3% (n = 54) participants passed the Advanced level examination in Sri Lanka. Majority of the participants were smokers. 70% heavy smokers. There was a strong association between social class or other markers of socio-economic status and stroke risk. According to above results majority of participant's were doing desk jobs and their physical activities level was poor. These people in Sri Lanka were more prone to suffer from a stroke or TIA (transient ischemic attacks).

The awareness of different types of treatments played a main role in rehabilitation of patients after any neurological, muscular skeletal or any kind of conditions. A patient suffering from stroke, his impaired awareness of conditions and treatment programs produced inconsistent results. One aim of this study was to measure the awareness of thera-band. According to the results of awareness question a majority of participants was unable to give correct answer even for the question of place of buying and usage of thera-band. And 73.3% (n = 44) patients were not aware of the exercise programs which were doing by using the thera-band for arthritis, diabetics, hemiplegia and other neurological conditions. These results have shown the knowledge of Sri Lankan people about rehabilitation techniques. They were following the same traditional treatments programs and they have to wait for longer time to gain their independent life style.

When comparing the Pre scores of the control group and the intervention groups there were no significant difference (P > 0.1). All patients were scored above median MWGS scores. Here the MWGS has used to express the middle disability

stage of each patient, which showed the ascendancy of approximately equal disability of both control and intervention groups.

The post scores of both groups shows that there was a significant difference (P < 0.01) between post scores of the both groups. The mean difference of post score (M = 9.3750) was significantly increased more than mean difference (M = 0.3233) of pre scores. These results expressed the gait training program has made an effect when compared with pre scores of both groups, and also observed difference between pre and post scores of each group individually. The control group showed 1.6967 mean differences and there was significant difference (P < 0.01) between pre and post scores of control group. Intervention group showed 10.7700 mean differences and also had a significant difference (P < 0.01) between pre and post scores.

To measure the gait improvement of both control and intervention groups, the comparison of mean difference (Pre and Post mean difference of each group) of control and intervention groups was used. This study has shown that both control and intervention group have presented significant difference (P<0.01) after following either conventional gait training or thera-band resistance assisted gait training programs. But when we compare the final mean differences, intervention group has shown prominent reduction of mean (10.7700) than the control group (1.6967). Reduction of mean score was equal to the reduction of disability in gait.

V. CONCLUSION

The present study focused on identification of the effectiveness of assisted thera-band resistance gait training and awareness of the thera-band related to the rehabilitation, among patients with hemiplegia. There are important points to be highlighted from this study regarding the assisted resistance gait training. According to the result the both conventional gait training and assisted thera-band resistance gait training are effective for hemiplegic patients, to become independent in their day to day activities and walk with confidence without hesitation. But the assisted thera-band resistance gait training program is more effective to become recover in a shortest time period than conventional gait training. The great part of the

sample had a poor level of awareness of their condition and the ways of rehabilitation. It is suggested that both improvement of patients' awareness of their disease and application of new treatments techniques, both should be equally follow during a rehabilitation process, otherwise difficult to achieve patient's normal life activities successfully within shortest time period.

A. Future enhancements and recommendations
This study is the first research done in Sri Lanka, related to the gait training, by using thera-bands for hemiplegic patients. This gait training method helps to gain patient's confidence in their walking and day to day activities, within the shortest time period. But these gait training methods are not used currently for the Sri Lankan hemiplegic population. It is worth to apply this gait rehabilitation method for all patients in hemiplegia throughout the Sri Lankan population. The investigation was mainly aimed on patient's lower limb functions. But these thera-band exercises may effective in upper limb and trunk functions. So it is recommended to use the thera-band resistance exercises to improve upper body functions at future rehabilitation procedures of hemiplegic patients. And also this study was aimed on acute male patients. This gait training method will be effective not only for acute (male or female) patients but also chronic patients (male or female) too. The other future studies should follow, involving personal factors such as gender and acute/chronic conditions. When the other researches follow investigations related to hemiplegia should need to consider patient's psychological state at the time of assessing of gait. It is essential to make the adult aware about the importance of having a good health. They should be made aware of not smoking and to follow up regular physical exercises and management of body weight which are beneficial in having a strong, healthy life.

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