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Original Article

The effect of the inspiratory muscle training on functional ability in stroke patients

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Abstract. [Purpose] This study was to find out an inspiratory muscle training (IMT) program therapeutic effects on stroke patients' functional ability. [Subjects and Methods] Twenty stroke patients were assigned to one of two groups: inspiratory muscle training (n=10), and control (n=10), randomization. The inspiratory muscle training participants undertook an exercise program for 30 minute per times, 5 times a week for 6 weeks. The investigator measured the patients' trunk impairment scale (TIS) and 6 minute walking test (6MW) for functional ability before and after IMT. [Results] The TIS appeared some significant differences in both groups before and after the training. The 6MW test showed some significant differences in the inspiratory muscle training group, but didn't show any significant difference in the control group. And the differences in both groups after depending the inspiratory muscle training were significantly found in the tests of TIS and 6MW test [Conclusion] The results showed that the inspiratory muscle training in stroke patients are correlated with the trunk stability and locomotion ability, suggesting that physical therapist must take into consideration the inspiratory muscle training, as well as functional training to improve physical function in stroke patients.

Key words: Inspiratory muscle training, Trunk impairment scale, Stroke

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INTRODUCTION

Stroke patients can experience hypoxia due to oxygen saturation and decreased cardiopulmonary function[1)]. These problems can weaken the strength and endurance of respiratory muscles in stroke patients and impair respiration and their ability to control their trunk muscles[2, 3)].

Reduced respiratory muscle movement increases the risk of respiratory muscle injury and chest pain due to damage to the chest walls, thereby impacting respiratory cycles and decreasing respiratory muscle strength and endurance[3)].

Hemiplegia patients with stroke also suffer abnormal movement of the body, particularly abnormal movements of posture and motor control[2)]. The abnormal movement of the trunk and pelvis interferes with trunk stability and the strength of the leg muscle used for locomotion; thus, it affects the ability to walk[4)].

This study aimed to verify the effects of the functional performance of stroke patients through a 6-week inspiratory muscle training (IMT) program.

SUBJECTS AND METHODS

This study was conducted in K Rehabilitation Center, Daegu, Korea. The experiment subjects were people who have been diagnosed with a stroke 6 months or longer, hemiplegic patients, through computed tomography (CT) and magnetic

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Table 1. Comparison of 6MW test and TIS within and between group (n=10 per group)

Parameters	IMT G		Control G		IMT G	Control G
	Pre	Post	Pre	Post	Post-pre	Post-pre
6MW (m)	151.2 (47.5)	187.2 (45.7)*	121.2 (50)	120.2 (52.3)	36.0 (29.2)	–1.0 (7.6)*
TIS (scores)	12.3 (2.4)	15.7 (1.8)*	10.9 (2.6)	12.1 (1.9)*	3.4 (1.7)	1.2 (0.9)*

Data were presented as mean (SD)
*p<0.05
IMT: inspiratory muscle training; 6MW: 6 minute walking test; TIS: trunk impairment scale

resonance image (MRI). We used a randomized controlled trial and assigned 10 people to the IMT group and the other 10 to the control group. All the subjects sufficiently listened to explanation on this study and consented to participate in the experiment. Inclusion criteria of the study and consented to participate in the experiment. Inclusion criteria of the study criteria of the study are as follow; had no visual field defect and auditory sense; Scored at least 24 on the Mini-Mental State Examination-Korean; Independent sitting and gait; had no pulmonary embolus; no orthopedic problem, or unstable cardiac condition; had not undergone chest or abdominal surgery[3, 5]. This study was approved by the University institutional review board and was conducted in accordance with the ethical standard of the Declaration of Helsinki.

Both groups received a temporizing Neuro Developmental Treatment (NDT) physical therapy for 30 minutes per time, 3 times a week, for 6 weeks. The experimental group received additional IMT. IMT was performed using a threshold, Respifit S (Inspiratory & Expiratory Rehabilitation System, Biegler GmbH, Australia).

IMT was a measure of the initial maximum inspiratory pressure and then the resistance was conducted in 80% of the measurements. We have calculated subjects' Pi_{max} (Maximal static inspiratory pressure) and began training with 80% of the maximum resistance. The amount of inspiration and expiration were displayed and if the amount was over 80%, it was recorded as a success and less than 80% was recorded as failure. If subject failed more than three times, we have reset the Pi_{max} and continued the test new Pi_{max}. IMT is set up 10 times in one training set and the two sets were carried out, it took a break of 10 seconds between each set[6].

Before the 6 minute walking (6MW) test, a 10 meter walking test was conducted twice to determine the ability of the subjects to walking ability ahead of the test. They took a 6 minute walking (6MW) test with a break time. The trunk impaired scale (TIS) consists of three items: static sitting balance, dynamic sitting balance and co-ordination (The trunk impairment scale: a new tool to measure motor impairment of the trunk after stroke). TIS performed three times in order not to achieve the maximum value in one or both attempts.

All analysis were performed using SPSS for Window version 18.0 and expressed as mean ± standard deviation (SD). The change in each group's 6MW test and TIS between before and after the IMT program using the paired t-test. Comparisons between groups were performed via the independent t-test. P values less than 0.05 at the 95% confidence level were considered significant.

RESULTS

Investigating the IMT group's functional ability, there appeared significant difference in the tests of 6 minute walking (6MW) test and trunk impairment scale (TIS) before and after the IMT program (6MW; 151.2 ± 47.5 before and 187.2 ± 45.7 after, TIS; 12.3 ± 2.4 before and 15.7 ± 1.8 after; $p<0.05$). There was significant difference between IMT group and control group in 6MW test and TIS0 (6MW; IMT group 36.0 ± 29.2 and control group −1.0 ± 7.6, TIS; IMT group 3.4 ± 1.7, and control group 1.2 ± 0.9; $p<0.05$) (Table 1).

DISCUSSION

Stroke patients may also experience respiratory disorders that reduce their movement; this also impacts the electronic signal of the paralyzed side of the patients' thoracic area, it also directly and indirectly affects cardiopulmonary function[7]. These phenomena show the weakness of the paralyzed side of the diaphragm and the intercostal muscle, and the reduction of abdominal muscle and pulmonary function weakness, which makes it difficult to control posture and which can result in functional movement disorders[8]. Thus, asymmetric posture, decreased muscle strength, and paresis impact the efficiency of breathing and result in respiratory tract changes[9]. To address these concerns, it is necessary to properly maintain pulmonary function and to conduct proper interventions.

This study demonstrated that IMT was correlated with TIS and the 6MW test in stroke patients. Furthermore, in a previous study, IMT significantly increased the ability of stroke patients to engage in long walk and control their trunk muscles [10–12]. This result is similar to the result reported in the present study, which found that, after a 6-week IMT program, stroke patients' demonstrated significant improvement in balance and transverse abdominal muscle (TA) and internal oblique muscle (IO) thickness, and demonstrated that a 6-week IMT program improved deep abdominal muscle thickness. Moreover, the Berg

balance scale (BBS) scores were significantly increased in the experimental group than in the control group[12]. Therefore, this present study aims to determine if IMT would improve trunk control stability in stroke patients. As shown by the comparison between the IMT group and control group, TIS was significantly increased in the IMT group in comparison to the control group. The results explain the correlation between trunk stability muscles and respiratory muscle strength and endurance in stroke patients.

Dall'Ago et al.[11]demonstrated that a 12-week IMT program decreased the incidence of heart failure and strengthened inspiratory muscle after increasing the 6MW test distance by 19%. Kim[13] demonstrated that after engaging in respiratory muscle training, the 6MW test distance increased from 352.3 meters to 363 meters in patients with chronic obstructive pulmonary disease (COPD). In the present study, the 6MW test distance was significantly increased in the IMT group. This result shows that increased respiratory muscle strength leads to better trunk stability when walking. Such trunk stability has been shown to significantly increase when the walking distance increases by improving body balance and weight transfer in stroke patients.

In conclusion, the results of our study that IMT increased TIS and the 6MW test result in stroke patients, and it is believed that enhancement of respiratory function will speed up the patients' return to society by increasing their trunk control and locomotion ability. Further studies are need to provide functional ability items test for stroke patients.

REFERENCES

1) Roffe C, Sills S, Pountain SJ, et al.: A randomized controlled trial of the effect of fixed-dose routine nocturnal oxygen supplementation on oxygen saturation in patients with acute stroke. J Stroke Cerebrovasc Dis, 2010, 19: 29–35. [Medline] [CrossRef]
2) Dickstein R, Shefi S, Marcovitz E, et al.: Electromyographic activity of voluntarily activated trunk flexor and extensor muscles in post-stroke hemiparetic subjects. Clin Neurophysiol, 2004, 115: 790–796. [Medline] [CrossRef]
3) Britto RR, Rezende NR, Marinho KC, et al.: Inspiratory muscular training in chronic stroke survivors: a randomized controlled trial. Arch Phys Med Rehabil, 2011, 92: 184–190. [Medline] [CrossRef]
4) Barton CJ, Coyle JA, Tinley P: The effect of heel lifts on trunk muscle activation during gait: a study of young healthy females. J Electromyogr Kinesiol, 2009, 19: 598–606. [Medline] [CrossRef]
5) Jo MR, Kim NS: The correlation of respiratory muscle strength and cough capacity in stroke patients. J Phys Ther Sci, 2016, 28: 2803–2805. [Medline] [CrossRef]
6) Mueller G, Hopman MT, Perret C: Comparison of respiratory muscle training methods in individuals with motor complete tetraplegia. Top Spinal Cord Inj Rehabil, 2012, 18: 118–121. [Medline] [CrossRef]
7) Ferretti G, Girardis M, Moia C, et al.: Effects of prolonged bed rest on cardiovascular oxygen transport during submaximal exercise in humans. Eur J Appl Physiol Occup Physiol, 1998, 78: 398–402. [Medline] [CrossRef]
8) Kelly JO, Kilbreath SL, Davis GM, et al.: Cardiorespiratory fitness and walking ability in subacute stroke patients. Arch Phys Med Rehabil, 2003, 84: 1780–1785. [Medline] [CrossRef]
9) Seo KC, Kim H, Lim SW: Effects of feedback respiratory exercise and diaphragm respiratory exercise on the pulmonary functions of chronic stroke patients. J Int Acad Phys Ther Res, 2012, 3: 458–463. [CrossRef]
10) Jandt SR, Caballero RM, Junior LA, et al.: Correlation between trunk control, respiratory muscle strength and spirometry in patients with stroke: an observational study. Physiother Res Int, 2011, 16: 218–224. [Medline] [CrossRef]
11) Dall'Ago P, Chiappa GR, Guths H, et al.: Inspiratory muscle training in patients with heart failure and inspiratory muscle weakness: a randomized trial. J Am Coll Cardiol, 2006, 47: 757–763. [Medline] [CrossRef]
12) Oh D, Kim G, Lee W, et al.: Effects of inspiratory muscle training on balance ability and abdominal muscle thickness in chronic stroke patients. J Phys Ther Sci, 2016, 28: 107–111. [Medline] [CrossRef]
13) Kim AK: The study on the effects of a respiratory rehabilitation program for COPD patients. J Korean Acad Nurs, 2001, 31: 257–267. [CrossRef]