The Effect of Pelvic Tilt Exercise During Sitting on Inclined Board upon Trunk and Balance Control in Individuals with Chronic Stroke: a Pilot Study.

Kalaya Kongwattanakul[1]*, Yodsawadee Chaopreecga[1], Aphisit phukphol[1], Mooleeyar Hayeemar[1], Bismee Tri[1] and NoormaNgorpulae[1].

Faculty of Physical Therapy and Sport Medicine, Rangsit University, Pathum Thani, Thailand
*Corresponding author, E-mail: Kalaya.K@rsu.ac.th

Abstract

Because poor trunk control can affect balance control in individuals with stroke, therefore, trunk control exercise is suggested for a rehabilitation program. Pelvic movement is necessary for trunk movement and related to functions in daily living such as reaching, sitting, standing, and walking. Individuals with chronic stroke demonstrate sitting with a posterior tilt of the pelvis. The improper sitting position may hinder trunk control training, especially anterior tilting. The technique that assists anterior pelvis movement may guide individuals with stroke to do trunk exercise. Therefore, this study investigated the effect of anterior pelvic tilt training on trunk control and balance during sitting on anterior inclined board. Pre- and post-test design were carried out on individuals with chronic stroke in the community of Pathum Thani province. The individuals with chronic stroke (n = 12) and age of 68.5 years (median, range: 40 – 80 years old) sat on the 10-degree anterior inclined board and were asked to perform anterior pelvic tilt exercise for 100 times/session, with 3 sessions/week for 4 weeks. In addition to the conventional exercise, the program was performed for 45 to 60 minutes. The trunk control was assessed using Trunk Impairment Scale (TIS) while the balance control was evaluated by the Berg Balance Scale (BBS) and Timed Up and Go test (TUG). The measurements were performed at a baseline every week. Friedman analysis was used to test the significance of each measurement. Moreover, the post hoc analysis was employed. The result showed that BBS and TIS had significant differences between the baseline and after training. Additionally, the gradual improvement of balance and trunk control was noticed in 3 weeks, except TUG. The study demonstrated that performing pelvic tilt exercise during sitting on anterior inclined board had a tendency to facilitate balance control in a short period of time.

Keywords*: *Trunk control training, Stroke, Balance control, Anterior pelvic tilt, rehabilitation, Sitting

1. Introduction

Sitting balance is a fundamental aspect for independence in activities of daily living (ADL) (Tyson, Hanley, Chillala, Selley, & Tallis, 2007), reaching forward and sitting to standing (Dean, Channon, & Hall, 2007). Additionally, sitting performance correctly predicts the future functional outcome in later stages of stroke (Masiero, Avesani, Armani, Verna, & Ermani, 2007). Poor trunk control commonly results in impaired dynamic sitting balance (Messier, Bourbonnais, Desoriers, & Roy, 2004). The decrease of control is observed as resulting from an inappropriate muscle activity pattern (Dickstein, Shefi, Marcovitz, & Villa, 2004), muscle weakness (Karatas, Cetin, Bayramaglu, & Dilek, 2004) and the reduction of amplitude of trunk movement. Impaired control of trunk in forwarding flexion and weakness of abdominal muscle in individuals with stroke indicated the problem of trunk movement in a sagittal direction. Lower trunk control provides the movement to the pelvis which further serves stability during performing forward reaching and transferring the load to lower extremities in sitting. Individuals with stroke complete reaching tasks by using the upper trunk more than the lower trunk or anterior tilt of pelvis (Messier et al., 2004). The limitation of pelvic anterior tilting may serve as a compensatory movement to prevent loss of balance which further develops or hinders functional activities in daily living. Individuals with stroke also commonly present, poor sitting posture with trunk forward flexion to adapt for poor trunk control (Verheyden et al., 2014) and muscle weakness. Prolonged forward flexion in sitting may lead to typical posterior pelvic tilt posture (Caneiro et al., 2010). Thus, trunk control training during upright sitting is significantly considered.

Trunk training exercise on stable surfaces has positive effects on trunk performance in sitting (Cabanas-Valdes, Cuchi, & Bagur-Calafat, 2013). The treatment program consists of stabilization exercise (Cabanas-Valdes et al., 2016), performing a reaching task (Dean et al., 2007). Moreover, trunk control training on an unstable surface shows a better result than a stable surface to promote trunk performance and

balance (Karthikbabu et al., 2011). However, trunk exercises on an unstable surface are going to be difficult jobs for individuals with stroke who already have sitting balance problems. Pelvis movement is one of key trunk exercise regimens. The progression of balance and trunk control requires intensive training courses. In previous studies, individuals with stroke have to practice five days a week for two weeks (Dean et al., 2007). As demonstrating posterior pelvic tilt posture, the individuals may make a lot of effort and may use a long period of time to progress pelvic control.

Good sitting posture is obtained by slightly anterior tilting of the pelvis (Corlett, 2006). Posterior pelvic tilt can improve by sitting on the anterior inclined seat. The previous study shows that sitting on 10-degree forward inclined seat passively tilts pelvis into anterior directions ranging from 1 to 4 degrees (Janssen-Potten, Seelen, Drukker, Huson, & Drost, 2001). Sitting on anterior incline seat may assist individuals with stroke who bound in flexion positions and present poor trunk ability to easily control pelvis in anterior tilting as a consequence of the degree of freedom reduction. The learning of pelvic control on anterior incline seats may facilitate the movement on flat chairs, which is essential for ADL.

2. Objectives

The objectives of the study were to investigate the effect of pelvic tilt exercise on trunk control and balance performance in individuals with stroke during sitting on anterior incline seat.

3. Materials and Methods

Subjects

Participants were recruited from the primary health care center in Beung Yitho and Lak Hok district, Pathum Thani, Thailand. Individuals with stroke were included if they had: (1) a diagnosis of first stroke resulting in hemiplegia more than 6 months, (2) a score of modified Rankin Scale ranging from 3-4, (3) no major cognitive or perceptual problems identified using the Mini-Mental State Examination ≥ 23, and (4) no neglect indicting using the Letter Cancellation Test (5) able to independently walk at least 6 meters. The exclusion criteria were (1) a diagnosis of other neurological conditions, such as Parkinson's disease and amyotrophic lateral sclerosis (2) lesions at cerebellum and brainstems (3) unable to sit for 10 minutes.

Interventions

During the training period, participants received regular physiotherapy intervention including sitting by reaching to forward and lateral directions, sit to stand training, ambulation training for 45 minutes/session. Additionally, participants were given the pelvic exercise training on 10 degrees anterior inclined board. The training involved participants completing 100 times of anterior and posterior pelvic tilts for each session, 3 times/week, for 4 weeks. The rest for 5 minutes between sessions was allowed to prevent muscle fatigue. During the training, participants were seated on anterior inclined board with their feet on support.

Outcomes

One physical therapist with more than 10 years of experience in stroke rehabilitation gave the participants the training program. Research assistants interviewed participants, collected personal and medical information, assessed Trunk Impairment Scale (TIS), Berg Balance Scale (BBS) and Time Up & Go Test (TUG). The intra-reliability ($ICC_{3,1}$) was good for TIS, BBS and TUG that was 0.978, 0.980, 0.991. The design of this study was an assessor-blinded pre and post-test trial.

Ethics

All participants were volunteers and signed a consent form approved by the Ethical Committee of Rangsit University.

Measures

The TIS consists of three sub-scales included static dynamic sitting balance, dynamic sitting balance, and coordination. The TIS score ranged from 0 to 23.

The BBS measures balance performance. This analysis consists of 14 items with each item scored on a 5-point scale ranging from 0-4 with 0 indicating the inability to complete the task and 4 indicating the ability to perform the task to completion[25]. Scores can range from 0 to 56.

The TUG evaluates functional mobility and evaluates the ability to rise from a chair, walking straight 3 meters, turn and sit down[23]. The time to complete the task was recorded in seconds using a stopwatch (Professional stopwatch, Model No. JS-519; Shenzhen Junsd Industry Co, Ltd.).

Data Analysis

The statistical analyses were conducted using SPSS version 22 (SPSS Inc., Chicago, IL) and STATA version 12 (Stata Corp. 2011. Stata Statistical Software: Release 12. College Station, TX: Stata Corp LP). The Shapiro-Wilk test was used to determine the normal distribution of data. Data characteristics of primary exhibited a non-normal distribution. The current study was to compare the effect of training for each week using the Friedman test and post hoc analysis using the Willcoxon test. Statistical significance was set at $p < 0.05$. The participants who attained 80 percent of treatment program carried out in the data analysis.

4. Results and Discussions

Results

Between November 2017 to March 2018, 12 eligible participants consented to participate. No participant dropped out during the period of training. The median of participants' age were 68.50 years from a range of 44.00 to 78.00 years. Eight of them were male and four were female. They have more right side weakness (n=7) than left side weakness (n=5). Almost all participants had mRS grade 3 (n=11). The demographic data was shown in Table 1.

Table 1 Demographic data of participants (n=12

Characteristics	Numbers or the otherwise were noted
Age (median, range)	68.5 years (44.00, 78.00
Sex	
Male	8
Female	4
mRS	
score 3	11
score 4	1
Weakness side	
Right	7
Left	5
Time since stroke (median, range)	24 months (8, 195)

The result showed that after trunk control training, the score of the TIS and BBS significantly improved ($p<0.05$), except TUG as shown in Table 2. The TIS and BBS score gradually changed. The median score of TIS at baseline and in week 4 were 16 (range: 8, 23) and 21 (range: 15, 23), respectively. The BBS score also showed increase from 45 (range: 11, 53) to 51 (range: 11, 56).

Table 2 The median of outcomes at base line and after week 1, week2, week 3, and week 4, the data present as median and range score

Variables	Baseline	Week1	Week2	Week3	Week4	P values
TIS	16 (8, 23)	16 (8, 23)	17.5 (8, 23)	19.5 (14,23)	21 (15,23)	< 0.001*
BBS	45 (11,53)	45 (11,53)	45 (11,54)	50 (11, 55)	51 (11,56)	< 0.001*
TUG	23.59 (17.00,60.58)	23.59 (16.56, 60.40)	23.79 (15.08, 60.35)	22.78 (15.30, 60.51)	23.52 (17.09, 60.33)	0.420

*Note * p values < 0.05*

The comparing of TIS and BBS for each week using post hoc analysis, the finding showed that the increase of TIS score significantly differ between week 1 and week 2 while BBS score had considerably changed in week 3. Figure 1 and 2 demonstrate post hoc analysis of TIS and BBS score within the period of training.

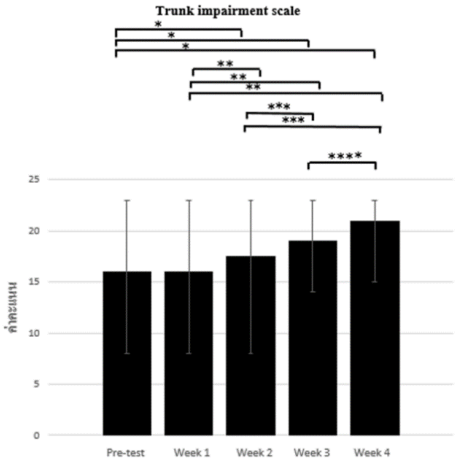

Figure 1 Comparing TIS score between Pre-test and during training in at the end of week 1, week 2, week 3 and week 4
*Note * p values < 0.05 comparing between pre-test and week 1or 2 or 3 or 4;** p values < 0.05 comparing between week 1 and week 2 or 3 or 4; *** p values < 0.05 comparing between week 2 and week 3 or 4; **** p values < 0.05 comparing between week 3 and week 4.*

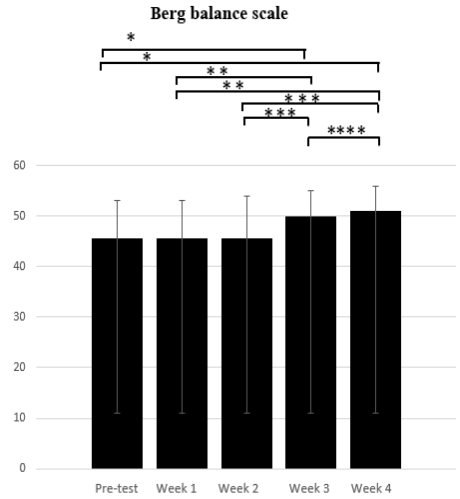

Figure 2 Comparing BBS score between Pre-test and during training in at the end of week 1, week 2, week 3 and week 4

*Note * p values < 0.05 comparing between pre-test and week 1or 2 or 3 or 4;** p values < 0.05 comparing between week 1 and week 2 or 3 or 4; *** p values < 0.05 comparing between week 2 and week 3 or 4; **** p values < 0.05 comparing between week 3 and week 4*

Discussions

In the current study, pelvic exercise combined with conventional exercise had positive effects on trunk control and balance. The individuals with stroke performed the pelvic exercise in a total of 100 times a day, 3 days a week for a long time 4 weeks, therefore, participants received training of the pelvic exercise 1,200 times. In addition, participants were trained with the conventional program for a total of 250 times per day, therefore, representing 3,000 times at the end of the program. The study found the development of the TIS and the BBS within 3 weeks. Previous studies presented the improvement of dynamic sitting balance, the intensity of the program was 30 minutes/ session, 5 days a week and for 2 weeks (Dean et al., 2007). Additionally, unstable floor trunk control training showed the development of trunk performance in 3 weeks (Karthikbabu et al., 2011). This study indicates that doing pelvic exercise on 10-degree anterior inclined board had benefits and the duration of training can compare with the previous study. Individuals with chronic stroke were fixed in posterior pelvic tilt during sitting may compensate from poor trunk control and balance as the consequence of prolonging bounded in wheelchair or bed. The principle of rehabilitation mentioned the decrease of the degree of freedom in terms of the amplitude of movement and muscle forces have supported individuals with poor movement control (Shepherd, 2001). Sitting on forward inclined board broke the fixed posterior pelvic tilt position, and corrected the participant posture for preparing back and abdominal muscle in proper length, thus, individuals with stroke easily moved pelvis to anterior pelvic tilt.

The pelvis control training in this study was classified as impairment based practice. While exercising with anterior tilt and posterior tilt, the muscles that need to work were erector spinae, iliopsoas, rectus abdominis, external abdominal oblique, and latissimus dorsi. The previous study reported that improved trunk muscle exercise had transfer effects to balance control also (Dean et al., 2007; Howe, Taylor, Finn, & Jones, 2005; Kılınç et al., 2016; Saeys et al., 2012). Similarly, in this study, the ability to increase balance, which is the activity performance level, found that TIS has increased in value and that BBS has also increased. The task of BBS items consists of standing to sit, transfer, reaching forward and picking up an object from the floor (Berg, Wood-Dauphine, Williams, & Gayton, 1989). All tasks required anterior tilting of the pelvis, therefore, training pelvic movement promoted balance control. Pelvic movement training may improve muscle strength. The present study did not investigate trunk muscle strength, however, balance control in individuals with stroke had a relationship with trunk muscle activity in the previous study (Karatas et al., 2004). It indicated that pelvic exercise may improve trunk muscle strength. After completing the training, the TUG time was not significantly improved. TUG tasks consist of sitting to standing, walking, turning, and sitting down. Walking also requires lower extremity performance such as hip and knee flexion to move the leg forward. The program in this study did not include hip and knee flexion exercise, therefore, TUG pre-test was similar to TUG after training for 4 weeks.

5. Conclusion

The study found that trunk control training in the anterior pelvic tilt and posterior pelvic muscle while sitting on a 10-degree slope can improve trunk performance and balance control. The application of anterior inclined board may enhance pelvis movement better than using a flat chair. However, the current study was one group design, the further study should compare the result with individuals with stroke who receive only conventional physical therapy. Because of the small sample size, the interpretation of the result should be careful.

6. Acknowledgements

We thank Yodsawadee Chaopreecga, Aphisit phukphol, Mooleeyar Hayeemar, Bismee Tri and Noorma Ngorpulae for data collection. Our thanks is also extended to physical therapists, nurses, public health personals, and health volunteers who aided in this study.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

7. References

Berg, K., Wood-Dauphine, S., Williams, J., & Gayton, D. (1989). Measuring balance in the elderly: preliminary development of an instrument. *Physiother Can, 41*(6), 304-311.

Cabanas-Valdes, R., Bagur-Calafat, C., Girabent-Farres, M., Caballero-Gomez, F. M., Hernandez-Valino, M., & Urrutia Cuchi, G. (2016). The effect of additional core stability exercises on improving dynamic sitting balance and trunk control for subacute stroke patients: a randomized controlled trial. *Clin Rehabil, 30*(10), 1024-1033.

Cabanas-Valdes, R., Cuchi, G. U., & Bagur-Calafat, C. (2013). Trunk training exercises approaches for improving trunk performance and functional sitting balance in patients with stroke: a systematic review. *NeuroRehabilitation, 33*(4), 575-592.

Caneiro, J. P., O'Sullivan, P., Burnett, A., Barach, A., O'Neil, D., Tveit, O., & Olafsdottir, K. (2010). The influence of different sitting postures on head/neck posture and muscle activity. *Man Ther, 15*(1), 54-60.

Corlett, E. N. (2006). Background to sitting at work: research-based requirements for the design of work seats. *Ergonomics, 49*(14), 1538-1546.

Dean, C. M., Channon, E. F., & Hall, J. M. (2007). Sitting training early after stroke improves sitting ability and quality and carries over to standing up but not to walking: a randomised controlled trial. *Aust J Physiother, 53*(2), 97-102.

Dickstein, R., Shefi, S., Marcovitz, E., & Villa, Y. (2004). Electromyographic activity of voluntarily activated trunk flexor and extensor muscles in post-stroke hemiparetic subjects. *Clin Neurophysiol, 115*(4), 790-796.

Howe, T., Taylor, I., Finn, P., & Jones, H. (2005). Lateral weight transference exercises following acute stroke: a preliminary study of clinical effectiveness. *Clin Rehabil, 19*(1), 45-53.

Janssen-Potten, Y. J., Seelen, H. A., Drukker, J., Huson, T., & Drost, M. R. (2001). The effect of seat tilting on pelvic position, balance control, and compensatory postural muscle use in paraplegic subjects. *Arch Phys Med Rehabil, 82*(10), 1393-1402.

Karatas, M., Cetin, N., Bayramoglu, M., & Dilek, A. (2004). Trunk muscle strength in relation to balance and functional disability in unihemispheric stroke patients. *Am J Phys Med Rehabil, 83*(2), 81-87.

Karthikbabu, S., Nayak, A., Vijayakumar, K., Misri, Z., Suresh, B., Ganesan, S., & Joshua, A. M. (2011). Comparison of physio ball and plinth trunk exercises regimens on trunk control and functional balance in patients with acute stroke: a pilot randomized controlled trial. *Clin Rehabil, 25*(8), 709-719.

Kılınç, M., Avcu, F., Onursal, O., Ayvat, E., Savcun Demirci, C., & Aksu Yildirim, S. (2016). The effects of Bobath-based trunk exercises on trunk control, functional capacity, balance, and gait: a pilot randomized controlled trial. *Top Stroke Rehabil, 23*(1), 50-58.

Masiero, S., Avesani, R., Armani, M., Verena, P., & Ermani, M. (2007). Predictive factors for ambulation in stroke patients in the rehabilitation setting: a multivariate analysis. *Clin Neurol Neurosurg, 109*(9), 763-769.

Messier, S., Bourbonnais D., Desrosiers J., & Roy Y. (2004). Dynamic analysis of trunk flexion after stroke. *Arch Phys Med Rehabil, 85*(10), 1619-1624.

Saeys, W., Vereeck, L., Truijen , S., Lafosse, C., Wuyts, F. P., & Heyning, P. V. (2012). Randomized controlled trial of truncal exercises early after stroke to improve balance and mobility. *Neurorehabil Neural Repair, 26*(3), 231-238.

Shepherd, R. B. (2001). Exercise and training to optimize functional motor performance in stroke: driving neural reorganization?. *Neural plast, 8*(1-2), 121-129.

Tyson, S. F., Hanley, M ., Chillala, J., Selley, A. B., & Tallis, R. C. (2007). The relationship between balance, disability, and recovery after stroke: predictive validity of the Brunel Balance Assessment. *Neurorehabil Neural Repair, 21*(4), 341-346.

Verheyden, G., Ruesen C., Gorissen M., Brumby V., Moran R., Burnett M., & Ashburn A. (2014). Postural alignment is altered in people with chronic stroke and related to motor and functional performance. *J Neurol Phys Ther, 38*(4), 239-245