The relationship between bridging exercise and standing balance in patients with stroke: A pilot study

ความสัมพันธ์ระหว่างการบริหารท่าสะพานโค้งกับการทรงตัวในท่ายืนในผู้ป่วยโรคหลอดเลือดสมอง: การศึกษานำร่อง

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ABSTRACT

Background: The bridging exercise is regarded as one of the basic clinical therapeutic exercises in patients with stroke. There was no previous report on the relationship between bridging exercise and standing balance in patients with stroke.

Objective: To investigate the relationship between bridging exercise and standing balance in patients with stroke.

Methods: A cross-sectional assessment of 25 patients with stroke was performed. The subjective clinical assessment of the 5-point nominal scale of bridging exercise and the 9-point scale of standing balance were developed from data of preceding researches. The order of testing was randomly determined.

Results: The average scores of bridging exercise and standing balance were 2.28±0.79 points (median = 2) and 5.00±2.12 points (median = 6), respectively. There was a high positive correlation between bridging exercise and standing balance in patients with stroke ($r = 0.876$, $p < 0.01$). In addition, bridging exercise could predict 77% of ability of standing balance in patients with stroke.

Conclusion: For patients with stroke who have a good sitting balance, physical therapists might predict standing balance from the ability of bridging exercise. However, clinical application has to perform according to the defined criteria of bridging and standing balance tests.

Keywords: Bridging exercise, Standing balance, Stroke

บทคัดย่อ

ที่มาและความสำคัญ: ท่าบริหารสะพานโค้ง (bridging) จัดเป็นท่าบริหารพื้นฐานที่ใช้ในการรักษาทางคลินิกในผู้ป่วยโรคหลอดเลือดสมอง ปัจจุบันยังไม่มีการศึกษาเกี่ยวกับความสัมพันธ์ระหว่างการบริหารท่าสะพานโค้ง กับความสามารถในการทรงตัวในท่ายืนของผู้ป่วยโรคหลอดเลือดสมอง

วัตถุประสงค์: เพื่อศึกษาความสัมพันธ์ระหว่างการบริหารท่าสะพานโค้ง กับความสามารถในการทรงตัวในท่ายืนของผู้ป่วยโรคหลอดเลือดสมอง

วิธีการวิจัย: การศึกษานี้เป็นการประเมินผลเชิงตัดขวางในอาสาสมัครที่มีโรคหลอดเลือดสมอง จำนวน 25 คน แบบทดสอบความสามารถในการบริหารท่าสะพานโค้ง มี 5 คะแนน และแบบทดสอบความสามารถในการทรงตัวในท่ายืนมี 9 คะแนน ได้ถูกประยุกต์ขึ้นโดยอาศัยข้อมูลจากการศึกษาที่ผ่านมา ลำดับของการทดสอบกำหนดโดยการสุ่ม

ผลการวิจัย: อาสาสมัครสามารถทำท่าสะพานโค้งได้คะแนนเฉลี่ยในระดับ 2.28±0.79 คะแนน (ค่ากลาง = 2) และมีความสามารถในการทรงตัวในท่ายืน 5.00± 2.12 คะแนน (ค่ากลาง =6) และพบว่ามีความสัมพันธ์กันในเชิงบวกระหว่างการบริหารท่าสะพานโค้งกับความสามารถในการทรงตัวในท่ายืนของอาสาสมัครที่มี

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โรคหลอดเลือดสมอง ในระดับสูง ($r = 0.876$, $p < 0.01$) นอกจากนี้ การบริหารท่าสะพานโค้ง ยังสามารถทำนายความสามารถในการทรงตัวในท่ายืนของอาสาสมัครได้ถึงร้อยละ 77

สรุปผล: สำหรับผู้ป่วยโรคหลอดเลือดสมองที่มีการทรงตัวในท่านั่งดี นักกายภาพบำบัดอาจทำนายความสามารถในการทรงตัวในท่ายืนจากความสามารถในการทำท่าสะพานโค้งของผู้ป่วยได้ อย่างไรก็ตาม การนำผลการศึกษาไปใช้ทางคลินิกต้องกระทำตามเงื่อนไขที่กำหนดไว้ในการประเมินท่าสะพานโค้งและการทดสอบการทรงตัวในท่ายืน

INTRODUCTION

Limited functions and long term disability is one of the most disabling consequences of stroke. Muscle weakness, spasticity and loss of motor control usually lead to problems with movement and balance. Therapeutic exercise is an essential technique used in neurological rehabilitation. Bridging exercise is one of the common exercises used for strengthening of trunk, hip and lower extremities muscles[1-3]. Generally bridging exercise is started in the supine position with both knees flex, hips slightly abduct apart, and feet which are under knees plant firmly on the floor, then raise both hips up and try to create a straight line from knees to shoulders. Bridging exercise can be modified to different styles, such as, changing the range of knee flexion or hip abduction, bridging on one leg, bridging with placing feet on an unstable surface. Bridging exercise can also start from the side lying or prone position. The present study involved in supine bridging exercise and thus the literature review was focused only on the supine bridging exercise.

Bridging exercise involved lower limb muscles, that is, gluteus maximus, hip adductor and abductor[4, 5], rectus femoris[2, 6], hamstrings[2, 4, 6], tibialis anterior and gastrocnemius[2, 6]. It also depends on the erector spinae, rectus abdominis, multifidus and external and internal oblique muscles[2, 6-8], and neck muscles (longissimus capitis and sternocleidomastoideus)[6, 9]. Therefore, bridging exercise involved not only the lower limb muscles but also the abdominal, back and neck muscles. These muscles were also active during sit to stand and standing posture.

Bridging exercise is safe and can be modified its difficulty according to the patients' ability. Bridging exercise at the rates of 3-24 trials per min was also reported as a useful protocol for stress-testing in patients with hemiplegia[10]. Furthermore, bridging exercise is clinically accepted as a simple exercise to facilitate functional control of the hip and trunk in hemiplegia in which patients can get the activation of sensory system through the weight bearing of both lower limbs [11, 12]. This exercise may enhance neuromuscular control of trunk and lower limb muscles which may be suitable for training functional stability of the lumbo-pelvic region[12]. Song and Heo[13] trained bridging exercises for four weeks in patients with stroke and found significant changes in weight bearing in a static standing position. However, this study did not have the control group so improvement of static standing balance may result from other factors, such as, a spontaneous recovery.

Modification of bridging exercise can be easily done which will affect muscles involvement. Changing of the knee flexion angle will alter the action of involved muscles[9, 14]. Placing the feet on the floor farther away from the hips will facilitate the activities of muscles, especially, hamstrings and hip extensor muscles[3]. Furthermore, modification of bridging exercise from double leg to single leg support will increase the activity of the trunk rotators[7, 15, 16], especially internal oblique muscle[7] and biceps femoris of the weight bearing limb[16]. The stability of surface also affected muscle activities during bridging exercise. Bridging on an unstable surface will increase muscle activity of the trunk (erector spinae) and lower extremities such as lateral hamstring and gastrocnemius[6, 16].

The muscle activity involved in bridging exercise also depends on the isometric adduction and abduction of the hip joint[5]. The hip joint abduction or adduction affected the trunk muscles such as, rectus abdominis, external and internal oblique, and gluteus maximus muscles[17, 18]. Jang and coworkers[17] found that bridging exercise with hip adduction required greater action of the abdominal and hip extensor muscles. During isometric hip adduction, transversus abdominis, external oblique, and adductor magnus showed the highest increased muscle activities compared to the normal bridging position[5]. However, during isometric hip abduction, rectus abdominis and gluteus maximus showed the highest increased muscle activity compared to the normal bridging position[5]. Using these previous research findings, we can concluded that bridging with less knee flexion is more difficult than a normal bridging exercise, a unilateral bridging and bridging on an unstable surface also requires higher activity and number of involved muscles than a normal bridging exercise.

Despite the number of researches explored on muscle involvement during performing bridging exercises, there is no published data which determines the relationship of the ability to do bridging exercise and a functional movement. In fact, research to support many clinically used therapeutic exercise practice is needed more attentions. From anecdotal evidence, physical therapists decide whether patients with hemiplegia can start training standing balance from many factors, such as, muscle strength of lower limb, sitting balance, and other conditions. Only a few studies reported the relationship of movement impairments to functional ability in patients with stroke. We proposed that the ability to do bridging exercise may have some association with the ability to perform standing balance. Because standing balance involved a similar group of muscles used during bridging activity.

Standing balance impairment is one of important problems in physical rehabilitation. Standing balance impairment also leads to muscle impairments, limitation of ambulation and is markedly related to the restrictions in daily living activities and quality of life. Richardson[19] reported that weight-bearing during standing can be used to reduce Achilles tendon shortening in patients with head injury. A step training for 6 weeks could improve standing balance which was measured using the Berg Balance scores in patients with stroke[20]. Resistance training of lower limb, walking, and postural control exercise have been reported to improve standing balance[21]. Impairment of trunk control in chronic stroke was reported and this impairment was significantly related with measures of balance, gait, and functional ability.[22] Patients with stroke who had a more forward leaning posture in standing scored worse on the Berg Balance Scale[23].

In spite of the fact that the bridging exercise is widespread used in clinic, there is so far no research demonstrated the relationship of the bridging exercise with standing balance in patients with stroke. To address this gap, we plan to determine the relationship of bridging exercise and standing balance in patients with stroke. The findings may help physical therapists make a better clinical decision by predicting the patients' standing ability from the bridging ability before trying the clinical standing balance training.

METHODS

A cross-sectional assessment of patients with stroke was conducted in which patients were recruited from the hospitals in Chonburi and Chiangrai Province, Thailand. This study was approved by the Ethics Committee, Faculty of Associated Medical Sciences, Chiang Mai University (AMSEC-57EX-130). All eligible patients were signed a consent form prior to participate in the study.

Subjects

Patients with first stroke both genders were invited to participate if they meet the inclusion and exclusion criteria. All patients had to be able to understand the command. Because all patients had to do standing balance, a good sitting balance on side of bed was also defined as one of the inclusion criteria. Patients with apraxia, global or receptive aphasia, Parkinson's disease, neglect and pusher syndrome were excluded.

Table 1 Demographical data of the participants (n=25)

Parameters	Mean±SD	Min	Max
Age (year)	58.96±10.70	46	79
Body weight (kilograms)	71.92±9.10	60	93
Height (centimeters)	167.84±8.23	155	183
Body mass index (kg/m^2)	25.50±2.55	21.26	32.03
Gender (male / female)		19/6	
Number of IPD/OPD		10/15	
Number of Infarction / Hemorrhage		16/9	
Number of Right / Left Hemiplegia		11/14	
Functional ability: Walk / Wheel chair		19/6	

Other impairments that might limit the ability to stand up such as, pressure sore, hip flexor tightness, loss of proprioceptive sensation of the lower extremity and the Modified Asworth Scale of quadriceps ≥ 2 were also excluded. Twenty five patients with stroke were volunteered in the study (Table 1). Twenty four patients were in chronic stage (time since stroke was more than 5 months) with one in subacute stage (1 month from the onset).

Procedures

Outcome measurements were the ability to do bridging exercise and standing balance using the developed test. One 4th year physiotherapy student was responsible for the outcome measurements. A 5-point nominal scale of bridging exercises with graded degree of difficulty was developed (Figure 1, Table 2). The order of the bridging exercise ability was based on the previous researches which were clearly reported the increased activity of muscles in bridging with different range of knee flexion[9, 14], bridging on one leg[7, 15, 16] and bridging on an unstable surface[6, 16]. Knee flexion was measured from the acute angle between the longitudinal axis of thigh and leg, thus, knee flexion 90 degrees will present as less flexion than knee flexion 60 degrees.

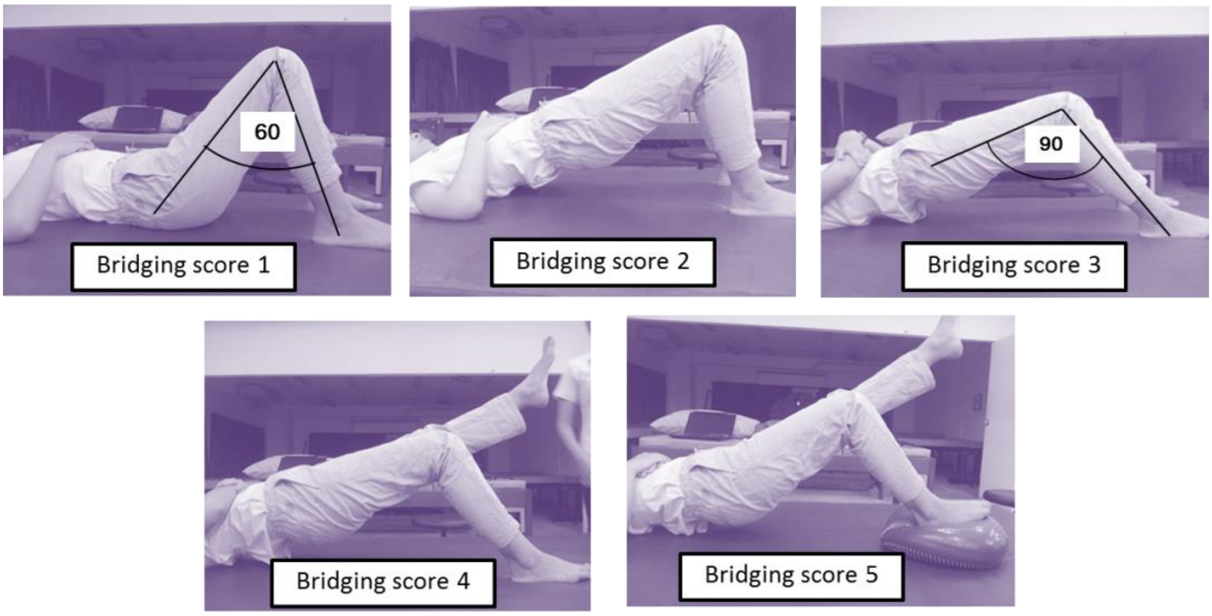

Figure 1 Bridging exercise test from score 1 to 5. Note that score 1 is in the static crook lying position. Score 1 and 2 sets knee flexion at 60 degrees and score 3 to 5 sets at 90 degrees. For detailed information see Table 2.

Table 2 Bridging exercise test

Score	Starting position	Movement criteria
1 Static crook lying	Crook lying with knee flexion at 60 degrees and hip abduction about the same distance as shoulder width, both arms cross on the chest.	able to hold the hip and knee joints in the starting position for at least 5 seconds without help
2 Simple bridging		able to raise the hip joints until the angle of hip flexion is between 150-180 degrees for at least 5 seconds
3 Bridging with less knee flexion	Crook lying with knee flexion at 90 degrees and hip abduction about the same distance as shoulder width, both arms cross on the chest.	able to raise the hip joints until the angle of hip flexion is between 150-180 degrees for at least 5 seconds
4 A single leg bridging with less knee flexion		able to raise the hip joints until the angle of hip flexion is between 150-180 degrees for at least 5 seconds while extend the unaffected knee
5 A single leg bridging with less knee flexion on a balance pad	Same as level 4 but the affected foot is placed on a balance pad.	able to raise the hip joints until the angle of hip flexion is between 150-180 degrees for at least 5 seconds while extend the unaffected knee

For the standing balance, the developed test was modified from the Functional Balance Scale[24] (Table 3). The order of testing, that is, a bridging test or standing balance was randomly determined. All patients were well informed and allowed to practice a few trials prior to the data collection which was based on the direct observation. The 3-5 minutes of resting period was allowed between the tests.

Statistical analysis

Correlation coefficients between the ability to do bridging exercise and standing balance was determined using the Spearman's rank correlation coefficient. A significance level of $p < 0.05$ was set. Data were analyzed using a SPSS version 17.0.

Table 3 Standing balance test (Modified from Shumway-Cook and Woollacott[24])

Score	Starting position	Movement criteria
1	Standing with feet at the same length of shoulder width	needs minimal assisted force from a therapist to maintain standing balance
2		able to maintain standing balance independently using hands to support through a walking aid.
3		able to stand independently without using hands but less than 2 min
4		able to stand independently without using hands at least 2 minutes
5		able to stand unsupported without using hands with eyes closed at least 10 seconds
6	Standing with feet together	able to stand unsupported without using hands at least 30 seconds
7	Standing with one foot in front	able to stand unsupported without using hands at least 30 seconds
8	Standing on an affected leg	able to stand unsupported without using hands at least 3 seconds
9		able to stand unsupported without using hands at least 10 seconds

RESULTS

The bridging exercise scores was 2.28 ± 0.79 (ranges from 1-3 scores) and the standing balance scores was 5.00 ± 2.12 (ranges from 1-7 scores). Table 4 shows the minimum, maximum, mode and median of the standing balance score for each bridging score. Note that the maximum level of bridging score was only 3 from the 5-point nominal scales and the highest standing balance was 7 from the 9-point nominal scales. Significant correlation was found between the 5-point nominal scale of bridging exercise and the 9-point nominal scale of the standing balance (Figure 2). The Spearman's rank test showed a significant high correlation coefficient of these two tests ($r = 0.876$, $p < 0.01$, $r^2 = 0.767$).

Table 4 The standing balance scores for each bridging score

Bridging score	Standing balance score			
	Min	Max	Mode	Median
1	1	3	1	1
2	2	6	6	5
3	6	7	7	7

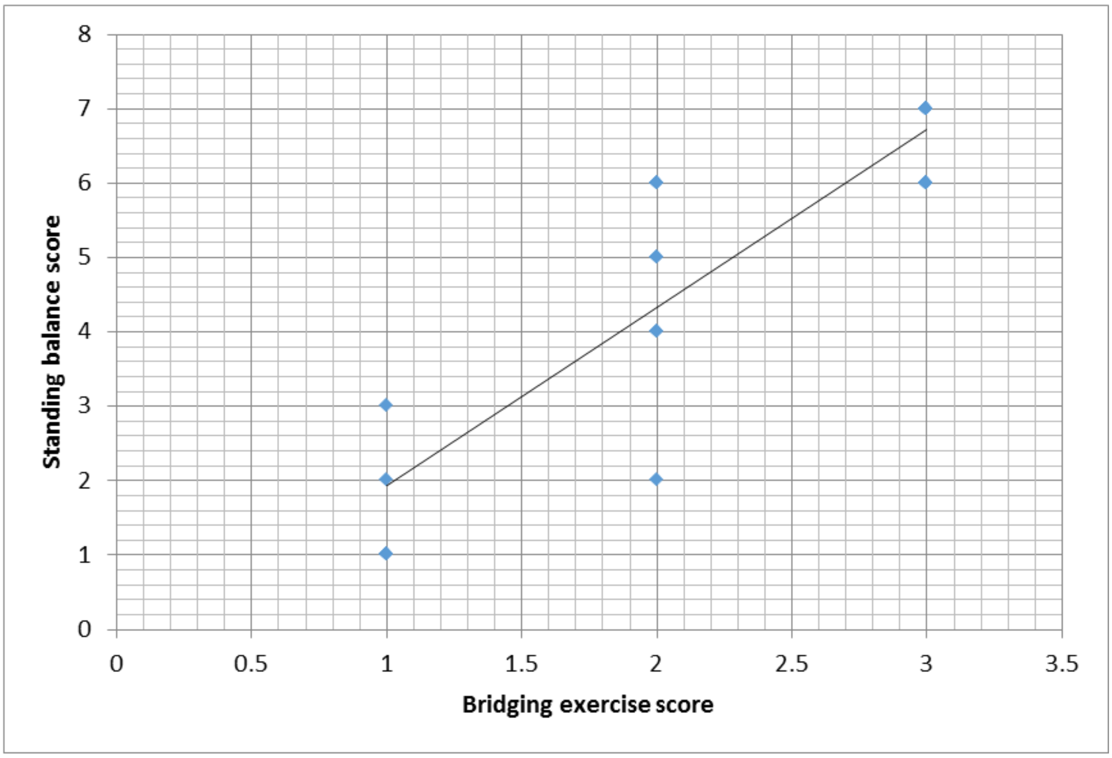

Figure 2 Relationship between bridging exercise level and standing balance level in patients with stroke (n=25) (r = 0.876, $p < 0.01$)

DISCUSSION

The present study found a high positive correlation between the ability to do bridging exercise and the standing balance in patients with stroke. This high correlation may be due to the muscles which are involved during bridging exercise and standing balance is mostly related [2,4-9]. Patients who can do bridging exercise at a higher level will have a stronger muscle strength and a better control of lower limb which will result in a higher standing balance score. From our knowledge, this is the first study which demonstrates the relationship of the bridging exercise and the standing balance.

The present study found that the bridging exercise score varied from 1-3 but the standing balance score varied from 1-7. There was no patient in our study with the bridging exercise score at 4-5 or the standing balance score at 8-9. These top two last scores of both tests require the stronger muscle strength and a higher balance control in which not many patients with stroke are able to do. Although, most of our patients were in the chronic stage, they did not have enough muscle strength to do those actions.

Analysis of standing balance at each bridging score (Table 4) can provide a better clinical applications. Using the median score of standing balance, the present results implied that if patients have the ability to hold the hip and knee joints in the crook lying position for at least 5 seconds without help (bridging score 1), they will be able to do standing balance with hands support and may need a minimal assistance from therapists (standing balance score 1). If patients can fully raise their hips up in bridging exercise with knee flexion 60 degrees (bridging score 2), they are more likely to be able to stand independently without using their hands for at least 10 sec (standing balance score 5). In addition, the ability to do bridging exercise with knee flexion 90 degrees (bridging score 3), implied that patients will show a better control of standing balance, that is, standing independently with one foot in front for at least 30 sec (standing balance score 7).

The strong relationship between bridging exercise and standing balance may be used to encourage patients to do bridging exercise by themselves. Setting a patient's goal of bridging exercise, such as, at a bridging score 2, a therapist can inform patients that if they can attain the exercise goal, they are more likely to be able to stand independently without using their hand.

Since there is no previous report related to the relationship between the bridging exercise and the standing balance, we cannot compare our results with others. However, a few papers reported the association of the lower limb muscle strength and the standing balance. Hamzat & Fashoyin[20] found that patients with stroke had a better Berg Balance Scale and Motor Assessment Scale after training 60 repetitions stepping exercise on a stepper twice a week for 6 weeks. Hellstrom[25] also reported that patients with stroke had a better standing balance because of the strengthening program of the lower limb which facilitate by gait training. These studies implied that stronger lower limb muscles will promote the ability to do postural control.

For clinical application, it is essential to note that no assisted force was provided to patients for all levels of bridging exercise test. Moreover, setting a starting position according to the criteria of bridging exercise test is necessary, because using different starting position may change its difficulty. Our bridging action is set at hip abduction about the same distance as shoulder width and both arms cross on the chest.

There were a number of limitations in our study. First, all patients with stroke in the study had a good sitting balance, thus our findings may be not applicable to patients who is loss or has poor sitting balance. Second, the bridging exercise has not been validated and the score is ranged from 1-5, so its sensitivity has some limitation. Third, the standing balance test was modified from a functional balance scale, which has not been test for validity. However, a functional balance scale has been validated[24]. Fourth, the inter-rater reliability was not tested. Because, the scoring criteria of bridging exercise and standing balance were distinctively and clearly defined, we believe that an examinee's score will reflect only random measurement error. Fifth, only one examinee executed both tests, this condition might increase risk of bias. In addition, the present study had a small sample size and cannot differentiate patients with bridging score 4 and 5. Recruitment of patients with a different ability of daily activities or included the patients with independent walking ability may increase the relationship.

CONCLUSION

For patients with stroke, there was a high positive correlation between bridging exercise and standing balance. Therefore, physical therapists might predict standing balance from the ability of bridging exercise. However, clinical application has to perform according to the defined criteria of bridging and standing balance tests.

CONFLICTS OF INTEREST

The authors have no conflicts of interest relevant to this article.

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