ISSN 2733-6441 / eISSN 2733-645X http://dx.doi.org/10.26862/jkpts.2022.06.29.2.1

대한물리치료과학회지
Journal of Korean Physical Therapy Science
2022. 06. Vol. 29, No. 2, pp. 1-13

The effect of balance training using visual information on the trunk control, balance and gait ability in patients with subacute stroke: Randomized controlled trial

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Abstract

Background: This research was conducted to understand balance training in trunk control, balance, and walking in stroke patients.

Design: Randomized controlled trial.

Methods: The subjects included 40 stroke patients, of whom 20 undertook balance training using visual information and the other 20 undertook balance training using balance boards. Using visual feedback, the balance training group used a training program within the static balanced evaluation tool, while the balance training group trained using a balance board. All subjects underwent 20 mins of neurodevelopmental treatment, and both target groups underwent 10 mins each of balance training by using either visual feedback or a balance board. The treatment period lasted a total of 4 weeks, twice a day. Trunk control before and after training was evaluated with the Trunk Impairment Scale. Balance capability was assessed by the Berg Balance Scale, Functional Reach Test, Timed Up and Go test, and Static balance measurement tool. Walking capacity was measured using gait measuring equipment, and cadence and velocity were measured.

Results: Both groups showed a significant improvement in their interstitial control, balance, and gait ability after the experiments compared to before the experiments ($p<0.05$). The difference between the two groups was not significant. The visual feedback balance training group showed a more substantial improvement than the balance board training group.

Conclusion: In this study, we found that the balance training combined with visual feedback contributes to improving trunk control, balance, and gait in patients with hemiplegia due to stroke. In addition to this, I believe that balanced training combined with visual feedback can be used as a training method when considering patients who lack interstitial control, balance, and gait ability.

Key words: Balance, Gait, Stroke, Trunk control, Visual Feedback.

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Received 2021-09-03 / Revised 2021-10-08 / Accepted 2021-11-14

Ⅰ. Introduction

Stroke is a chronic disease that prevents blood from flowing smoothly to the brain tissue due to abnormal blood flow in blood vessels, which causes brain damage and limits daily life and social activities (Kim et al., 2020; Lim and Park, 2020; Park et al., 2020). Stroke is ranked fourth among the top ten causes of death in Korea, and the mortality rate has been reported to be high. In particular, the cerebrovascular disease has a mortality rate of 45.4/100,000 people (Statistics Korea, 2019).

The most typical stroke symptoms are incomplete or complete hemiplegia of the body opposite to the damaged brain lesion, resulting in weakening of the upper and lower limbs and impaired balance and gait (O'Sullivan et al., 2019; Kim and Lee, 2020). Trunk control ability in the early onset is an essential factor for predicting the degree of recovery in future functional areas, and rehabilitation for active trunk control ability from the beginning of the onset is required to improve functional recovery (Cabanas-Valdes et al., 2013). A stroke activation pattern by compensation action appears due to the weakening of trunk control muscles, limiting posture change or mobility ability (Pereira et al., 2011). Therefore, trunk stability and movement are related to trunk muscle coordination, and ensuring stability is a desirable goal setting for movement (Mcgill, 2001). In addition, the focus of rehabilitation exercise for stroke patients is trunk control, and in order to improve balance and gait, it is an essential task in the rehabilitation of stroke patients (Askim et al., 2009, Yavuzer et al., 2006).

Balance refers to the ability to maintain a stable posture continuously, and through a posture control mechanism, the body's center of gravity can be maintained within the support base (Radomski and Latham, 2008). However, the decrease in balance ability of stroke patients results in abnormal muscle mobilization on the non-paralyzed side due to decreased muscle strength on the paralyzed side, reduced movement, and difficulty in recovering daily life movements (Inness et al., 2014). Task-oriented training in rehabilitation to improve gait and balance in stroke patients is goal-oriented training providing specific tasks so that functional movements can be performed within an environment, such as daily life activities (Gergory et al., 2004).

After the onset of a stroke, patients are damaged by sensory information, resulting in decreased visual and spatial perception, and they complain of difficulty in balance and gait ability (Kim & Eng, 2003; Shim et al., 2020). Biofeedback refers to controlling normal or abnormal reactions in the body through visual and auditory feedback using specific tools. This treatment technique is considered a practical evaluation and training method for stroke patients because it enables learning through repetitive training of the patient and shows the task performance pattern and evaluation results in real-time immediately after the exercise (Ng et al., 2008). In the visual feedback exercise, the subject's specific actual movements are reflected on the screen in various forms, providing the subject with biofeedback on his/her movement by imitation of the action. It also notifies the subject's position in the virtual space or the success of performing the movement using visual elements (Flynn et al., 2007). When an exercise that applies visual feedback is performed, it enables self-correction through continuous visual information leading to positive nerve recovery through repetitive stimulation of the brain's exercise plan and performance area (Saposnik et al., 2010). For patients with postural control problems after stroke onset, visual feedback training positively affects correcting weight-bearing ability and standing by improving postural symmetry. In addition, it enhances the quality of life by changing functions, such as posture control and muscle strength, and improving daily life skills (Lange et al., 2010).

This study aimed to investigate the effect of general physical therapy through trunk control and weight transfer balance training through visual feedback on trunk control, balance, and gait in stroke patients. In addition, we intend to provide primary data for effective training methods for stroke patients.

Ⅱ. Methods

1. Subjects

The experiment was conducted from October 2020 to December 2020 on stroke patients admitted to B Hospital in Seongnam City. The research subject selection criteria included those diagnosed with hemiplegia due to a stroke and those who were within 3 months of the onset. Furthermore, subjects had a Korean Mini-Mental State Examination-Korean score of 24 points or higher, so they could communicate, understand tasks, follow instructions, and stand up independently without support using a hand in the sitting position and could maintain an independent standing position for more than 1 min (Liu et al., 2016). Those who were unable to perform and maintain the standing motion due to limb fracture, joint pain, and limited range of joint motion; those who were unable to start walking; and those who had amblyopia, hemianopsia, vertigo, and vestibular dysfunction (Liu et al., 2016) were excluded.

Before the experiment, the study's purpose and necessary matters were explained in detail to the subjects who participated in the study. Subjects could withdraw their consent at any time during the study, and they signed a consent form to participate. This study was approved by the Institutional Review Board (2-1040781-A-N-012020082HR) of Sahmyook University.

2. Procedure

Before recruiting participants for this study, we performed a power analysis using G*Power Version 3.1.9.7(Franz Faul, University Kiel, Germany, 2020). The overall effect size index for all the outcome measures and the study's power were 0.5 and a probability of 0.05 to minimize type II error (power of 80%). Because the estimated target sample size was 34, we recruited 40 participants for this experiment.

In this study, the onset period, sex, age, and paralysis site, which are the general characteristics of the study subjects, were recorded before the experiment. The study and inspection method were explained verbally, and during the inspection, dangerous objects were removed, and a stable atmosphere was created to investigate the observation items. After written consent was obtained from patients who met the inclusion criteria, 40 subjects were selected and assigned to one of two groups through randomization. A pre-test was performed on 40 selected study subjects, and a post-test was performed after 4 weeks of treatment.

The experiment was conducted for 4 weeks. In both groups, central nervous system development treatment was performed twice a day for 20 min each time, and a balance training program using visual information was performed in the same manner for approximately 10 min in 5 sets. Balance exercises using a balance board were performed on two balance boards. Before and after the intervention, the subjects' Trunk Impairment Scale (TIS), Berg Balance Scale, Functional Reach Test (FRT), Time Up and Go (TUG) test, stability index (SI), weight distribution index (WDI), and gait ability test were used to measure gait velocity and cadence. It was performed in the same environment using the same inspector. The therapist was fully aware of possible problems that may arise from the examination. In addition, to reduce the test's error according to the standardized guidelines, the tests were measured three times, and the average value was used except for the gait ability test. When performing a balance training program with visual feedback and a balance training program using a balance board, training was conducted while explaining the importance of weight transfer to the subjects. The program was also verbally instructed. After the start of training, if any abnormalities, such as dizziness, fatigue, and changes in complexion appeared, the training was stopped immediately. Of the balance training group using visual feedback and the balance training group using a balance board, five patients dropped out due to discharge, and a total of 30 subjects, excluding ten participants, participated in the study.

3. Experimental method

1) Balance training program with visual feedback

Motor learning using visual feedback is a learning method conducted to control the trunk while receiving information on weight movement in real-time and was constructed to consider functional improvement. In this study, the balance training method using visual feedback placed the patient's foot on the force plate, the body was placed on the line of gravity, and the head was directed to the front. The subject's arm was placed in a state where the tension did not rise, and a monitor that could check the subject's training in real-time was placed right in front of the subject so they could confirm his or her training using visual feedback. Three balance training programs using visual feedback were applied to the patient for 10 min.

To prevent falls during training, the therapist monitored the subject, adjusted the frequency and difficulty to prevent fatigue, and allowed them to perform it while maintaining a symmetrical posture for 10 min. The training was conducted for 10 min per session twice a day, 5 days a week, for a total of 4 weeks, and during one training session, one set of 2 min and a total of five sets were conducted<Table 1>.

Table 1. Training Program

Weeks	Balance training program with visual feedback	Balance training using a balance board	General physical therapy (CNS development therapy)
1st	fore/hind weight shifting balance training (catching and avoiding moving object)	fore/hind weight shifting balance training	muscle length secure and basal surface adaptation in supine position
2nd	left/right weight shifting balance training (catching and avoiding moving object)	left/right weight shifting balance training	peripelvic muscle activation and bridge position in supine position
3rd	multidirectional weight shifting balance training (adjust to green point)	multidirectional weight shifting balance training	trunk separated movement and sit to stand task execution in sitting position
4th			postural stability and moving task execution of pelvis in standing position

2) Balance training using a balance board

In this study, the balance board training method placed the patient's feet on the balance board, made the body stand up, and performed balance maintenance training. Two types of balance boards were used, applied to the patient for 10 min, and applied in three sections. The training was conducted for 10 min per session twice a day, 5 days a week, for a total of 4 weeks, and during one training session, one set of 2 min and a total of five sets were conducted <Table 1>.

3) General physical therapy

The general physical therapy performed was central nervous system development therapy. Central nervous system development treatment is a Bobath treatment performed for patients in physical therapy rooms (Yang et al., 2010). All subjects performed 20 min per session, twice a day, and 5 days a week, for a total of 4 weeks<Table 1>.

4. Measurement tools and data collection process

1) Trunk control

In this study, the trunk damage scale was used to measure trunk control ability. It is a clinical test method for trunk movement in stroke patients, and it is a tool to measure static and dynamic balance and trunk coordination in a sitting position. In this study, since trunk control was also required, this scale was used, and the score ranged from 0 to 23 points. The trunk damage scale’s reliability ranged from r=0.87 to r=0.96, and the inter-investigator reliability was between r=0.85 and r=0.99, showing high reliability and internal validity (Verheyden et al., 2007).

2) Balance ability

The Berg Balance Scale, Functional Reach Test, static balance analysis system, and Timed Up and Go test were performed to measure balance ability. All tests were repeated three times so that the subjects were not conscious of the measurement to obtain an average value.

The Berg Balance Scale has been used to evaluate fall risk as a functional balance test for the elderly and patients with neurological diseases. This measurement tool has high reliability and validity in assessing the balance ability based on the reliability within the measurement (r=0.99) and the reliability between the measurements (r=0.98) (Berg et al., 1989; Bogle Thorbahn and Newton, 1996).

The functional reach test is a balance assessment tool that can be easily used in clinical settings. In a standing position, both hands were held together, and with the shoulder joint flexed at 90°, and the subject tilted as far forward as possible horizontally to the located baseline and reached out enough to prevent falling. In the meantime, the distance between the first and last points on the distal part of the third carpometacarpal joint was measured (Jenkins et al., 2010). The test-retest and the measurement are r=0.92 and r=0.98, respectively, with high reliability (Duncan et al., 1990). The measurements were performed after one exercise.

The Tetrax Balance system (Tetrax, Sunlight Medical Ltd., Israel) was used to evaluate the static balance ability. The reliability of repeated measurements was r=0.89 (Schwartz et al., 2005). The evaluation method is that the subject stood with both feet on the force plate and looked forward at 15°. For the measurement posture, the weight distribution index (WDI) and stability index (SI) measured using two of the eight postures were used: (1) Normal position with eyes open (NO) and (2) Normal position with eyes closed (NC). SI indicates the center of gravity’s stability by measuring the fluctuations in pressure applied to both force plates due to postural sway. The larger the value, the greater the fluctuation of the center of gravity. WDI represents the percentile of the weight placed on each of the four force plates. When 25% of the weight is placed on one force plate, the weight distribution is the most ideal. The greater the fluctuation, the larger the value, meaning that the weight distribution is unstable.

The Timed Up and Go test is a measure of the ability to move, dynamic balance, gait, and rotational movement. After the subject sits on a chair with armrests on flat ground, they stand up with a signal, walk back to 3 m halfway point, and sit back on the chair, and the time it took to get back is measured (Podsiadlo and Richardson, 1991). In this study, the subjects were instructed to return to the halfway point based on the non-paralytic side. The validity, test-retest, and inter-inspector reliability of the test were r=0.99 (Morris et al., 2001).

3) Gait ability

In this study, the gait ability test was used to objectively determine the decrease in gait ability and recovery of function following treatment. Based on the pressure sensor built into the gait analysis system, the patient's gait ability was analyzed by measuring the COP, pressure distribution during gait, time, and distance. The gait analyzer (GAIT-Rite, CIR system Inc., USA, 2008) analyzes and measures temporal gait characteristics and spatial gait characteristics using a computer. This evaluation tool was used because gait requires body control, which expects balance ability and prior posture control. The measurer reliability of this test is r=.90, and the correlation coefficient in all gait measurements of comfortable gait speed is r=.96 or more (Van uden and Besser, 2004).

5. Statistical Analysis

SPSS ver. 22.0 was used for all the statistics in this study. The average and standard deviation were calculated, and descriptive statistics were used for the subject’s general characteristics. An independent sample t-test was performed to determine the homogeneity between groups, and it was normally distributed. Measured values were also normally distributed, and the corresponding sample t-test was performed to confirm the descriptive statistics. All statistical significance levels α of the data were set at 0.05.

Ⅲ. Results

1. General characteristics

Table 2 presents the participant’s general characteristics. There were no significant differences in the homogeneity test, so the two groups’ pre-intervention characteristics were homogeneous<Table 2>.

Table 2. General characteristics (N=30)

Parameter	Balance training program with visual feedback group (n=15)	Balance training using a balance board group (n=15)	$t(p)$
Male/Female	12 / 3	10 / 5	-0.807(0.116)
Age (year)	55.40 ± 16.03[a]	62.47 ± 13.09	-1.322(0.423)
Oneset (month)	1.20 ± 0.414	1.67 ± 0.488	-2.824(0.116)
Affected (Lt./Rt.)	10 / 5	6 / 9	-1.468(0.478)

[a]Mean±SD.

2. Comparison of pre-post test measures of TIS between two groups

The comparison of pre- and post-test measures of TIS between the two groups is shown in Table 3. The TIS scores significantly improved after the intervention in both the visual feedback and the balance board training group ($p<0.05$), but there was no statistically significant difference between them<Table 3>.

Table 3. The comparison of TIS (N=30)

Parameter		Balance training program with visual feedback group (n=15)	Balance training using a balance board group (n=15)	$t(p)$
TIS (score)	Pre test	13.53 ± 4.71[a]	13.86 ± 4.38	-0.200(0.937)
	Post test	19.13 ± 2.87	17.40 ± 3.62	
	Pre-post	5.60 ± 4.17	3.53 ± 3.64	1.445(0.660)
	$t(p)$	-5.199(0.000)*	-3.757(0.002)*	

[a]Mean±SD, $^{*}p<.05$, TIS=Trunk impairment scale.

3. Comparison of pre-post test measures of balance between two groups

The comparison of pre- and post-test measures of BBS, FRT, TUG, SI, and WDI between the two groups is shown in Table 4. The BBS and FRT were significantly improved after the intervention in both the visual feedback and the balance board training groups ($p<0.05$), but there were no statistically significant differences between them. TUG was significantly decreased after the intervention in both the visual feedback and the balance board training groups ($p<0.05$), but there were no statistically significant differences between them. The SI and WDI were not significantly reduced after the intervention in either the visual feedback or the balance board training groups, and there were no statistically significant differences between them.

Table 4. The comparison of balance (N=30)

Parameter		Balance training program with visual feedback group (n=15)	Balance training using a balance board group (n=15)	$t(p)$
BBS (score)	Pre test	41.26 ± 12.74[a]	43.26 ± 10.91	-0.462(0.961)
	Post test	52.40 ± 2.82	50.73 ± 8.77	
	Pre-post	11.13 ± 12.60	7.46 ± 7.21	0.978(0.179)
	$t(p)$	-3.421(0.004)*	-4.005(0.001)*	
FRT (cm)	Pre test	15.72 ± 8.37	14.90 ± 9.15	0.245(0.356)
	Post test	23.32 ± 3.69	20.28 ± 8.31	
	Pre-post	7.59 ± 7.20	5.34 ± 5.82	0.942(0.558)
	$t(p)$	-4.079(0.001)*	-3.553(0.003)*	
TUG (second)	Pre test	19.70 ± 12.39	18.37 ± 12.45	0.295(0.791)
	Post test	9.71 ± 1.62	11.18 ± 6.61	
	Pre-post	9.99 ± 11.98	7.19 ± 10.78	0.673(0.450)
	$t(p)$	3.229(0.006)*	2.584(0.022)*	
SI (score)	Pre test	25.43 ± 11.78	23.77 ± 7.90	-0.647(0.096)
	Post test	22.59 ± 7.23	23.14 ± 12.28	
	Pre-post	2.83 ± 7.84	0.62 ± 9.99	0.675(0.505)
	$t(p)$	1.675(0.116)	1.411(0.180)	
WDI (score)	Pre test	6.37 ± 2.51	6.79 ± 3.37	-0.386(0.342)
	Post test	5.27 ± 2.58	6.37 ± 3.40	
	Pre-post	1.10 ± 3.32	0.41 ± 2.45	0.644(0.525)
	$t(p)$	1.286(0.219)	0.658(0.521)	

[a]Meat±SD, *p<.05, BBS=Berg balance scale; FRT=Functional reaching test; TUG=Time up and go test; SI=Stability index; WDI=Weight Distribution Index.

4. Comparison of pre-post test measures of velocity and cadence between two groups

The comparison of pre- and post-test measurements of velocity and cadence between the two groups is shown in <Table 5>. The velocity and cadence were significantly improved after the intervention in both the visual feedback and the balance board training groups (p<0.05), but there was no significant difference between them.

Table 5. The comparison of velocity and cadence (N=30)

Parameter		Balance training program with visual feedback group (n=15)	Balance training using a balance board group (n=15)	$t(p)$
VC (m/min)	Pre test	66.45 ± 29.13[a]	70.07 ± 29.46	-0.339(0.731)
	Post test	101.90 ± 17.91	95.20 ± 28.71	
	Pre-post	35.44 ± 22.83	25.13 ± 23.22	1.227(0.756)
	t(p)	-6.011(0.000)*	-4.192(0.001)*	
CD (step/min)	Pre test	90.64 ± 19.29	93.47 ± 20.84	-0.385(0.744)
	Post test	109.28 ± 13.07	103.92 ± 12.81	
	Pre-post	18.64 ± 13.20	10.44 ± 20.75	1.290(0.557)
	t(p)	-5.468(0.000)*	-1.950(0.072)	

[a]Mean±SD, *p<.05, VC=Velocity; CD=Cadence.

Ⅳ. Discussion

In this study, proactive trunk control was intended to provide the necessary balance and gait ability conditions. The training was carried out on proximal torso control ability, separated movement, and limb coordination. TIS is used as a measurement value. After the intervention, TIS scores significantly improved in both groups (p<0.05). A study by Shin and Song(2016) on trunk control using smartphone-based visual feedback in stroke patients found that TIS in the experimental group was significantly improved (p<0.01). In this study, the task performance training group, through weight transfer using visual feedback, showed an improvement in the TIS score. In the standing position, the trunk control program required more stability and coordination of the trunk. The difficulty was high because the task had to be performed while adjusting the trunk shaking on a narrow support surface. Therefore, it is thought that the score improved further in the post-measurement period. In addition, in this study, the balance training group using a balance board performed trunk exercises in the supine and seated positions through a general physical therapy program. There was a significant difference in the induction of trunk regulation on the unstable support surface (p<0.05). According to Ham(2017), trunk exercises were performed on an unstable support surface. As a result of suggesting and mediating direction in supine and seated positions using a gym ball, there was a significant difference in the TIS score (p<0.05). As a result of this study, TIS scores improved in both groups. It would have been helpful for all patients in the two groups to control their trunks through active posture correction to recognize the general physical therapy program and changes in their weight shift, and to reduce agitation. Therefore, it is considered that the performance of the balance training task through visual feedback and the performance of the balance training task using a balance board have a positive effect on trunk control.

In this study, by performing balance training through visual feedback or a balance board, it was made to think and judge autonomously how to move the balance of the body in realtime to perform the task. In addition, a correct motion was induced through a visual target, and the compensation of other muscles was minimized (Yarossi et al., 2017). After the intervention, in the visual feedback balance training group, the Berg Balance Scale and FRT were increased compared to the balance board training group, and the TUG, SI, and WDI scores were lower. According to Kim(2016), as a result of performing weight transfer balance training through a visual feedback program in cerebellar ataxia patients, the control group improved more than the experimental group in the Berg Balance Scale (Kim, 2016). For TUG, both the experimental and control groups decreased, and significantly improved results were seen in the experimental group (p<0.05).

In this study, visual feedback balance training demonstrated motivation and concentration through mission performance and actively promoted selective trunk movement in various directions. During the training period, the physical therapy program for trunk control resulted in anterograde posture control based on standing on a force plate and using visual feedback to induce trunk alignment, trunk stability, neuromuscular control, and proprioceptive sensation. It had a significant effect on balance ability by raising the body's cognitive ability. In addition, I believe the weight shift training conducted using the visible target through visual feedback, increased interest in the game program, and the motivation to update the record was more helpful in recovery than the balance training group using the balance board. In addition, as a result of performing tasks through knee flexing and weight transfer on two types of balance boards, the Berg Balance Scale was improved.

In a study by Han(2012), one-leg standing, knee flexion, and weight transfer training were performed using a balance mat as a proprioceptive exercise program, and the Berg Balance Scale improved. Unlike the previous studies, the difference between the balance mat and the balance board has narrowed the limit of the balance board’s stability, increased the body’s fluctuation, and could further stimulate the proprioceptive sensory organs. Since the circular balance board requires more stability and movement in the ankle joint, these factors significantly improved proprioceptive sensation and balance ability. It is considered that the results of the two groups would have significantly improved with a balanced training program conducted with general physical therapy focused on the trunk rather than a program composed of such a single variable.

In this study, the gait speed and the number of minutes significantly improved in both groups (p<0.05), but there was no statistically significant difference between them. You et al(2005) found a difference between the two groups in an experiment that used visual feedback training while performing actual gait, such as a treadmill. The virtual reality gait program training positively affects sensory-motor activity, motor function, and gait speed compared to general gait exercises (You et al., 2005). However, the visual feedback balance training according to the experimental method acted as a more effective intervention when the training was carried out by giving similar situations as actual daily life movements. In addition, Kim(2009) suggested that there is a correlation between trunk control ability and balance ability (p<0.05) and that there is a correlation between balance ability and gait ability (p<0.01). Yang et al(2008) applied treadmill training with VR to stroke patients. Progress was made through varying levels of complexity that required fast gait speeds, successful adaptation to changes in obstacle height and surface slope, and increased decision-making opportunities to avoid collisions. The results showed that following virtual reality-based treadmill education, the experimental group showed significant improvement in all the results selected during the post-training period, improved community walking time, walking ability questionnaire scores, and showed significant differences in walking speed (p<0.05).

There is a high biomechanical correlation for trunk control, balance, and gait. When the trunk extensors and anti-gravity muscles are activated, the body's awareness of trunk alignment is enhanced, and weight distribution is stabilized accordingly, affecting balance ability, consequently, affecting gait. In addition, it seems that the gait speed and the minute speed were increased compared to the visual feedback balanced training group. However, both visual feedback and balance board training affected gait, but there were no statistically significant differences since the actual gait therapy was not combined.

As a limitation in this study, the correlation between the dependent variable and muscle strength was not observed because the evaluation of the patient's before and after muscle strength measurement was not performed. In addition, when measuring gait ability, only the quantitative part was measured, and the qualitative aspect was not accurate. Other factors, such as stability and coordination of the ankle, knee, and hip joints related to balance, were not identified. In particular, there is a limitation in that there is insufficient evidence for the number of times that confounding variables can be provided during central nervous system development treatment and each individual’s ability. In future studies, taking into account these limitations, it is believed that applying the balance training method with visual feedback to more subjects as well as gait training using visual feedback will contribute more to the recovery of the patient's function.

Ⅴ. Conclusion

This study was conducted to examine the changes in trunk control, balance, and gait ability of stroke patients through visual feedback balance training. The results showed that the visual feedback balance training group improved trunk control, balance, and walking ability compared to the balance board training group, but there was no statistically significant difference. However, based on these results, balance training using sensory feedback can be a reference material in clinical practice. It is thought that it can be used in treatment using a balance board. It can also be suggested that if the sensory feedback training method is applied in combination with the function to be enhanced, it will effectively improve trunk control, balance, and gait ability of stroke patients in future clinical practice.

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