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The effect of trunk stabilization exercise according to face-to-face, non-face-to-face, and self-exercise on balance ability

Kyung-eun Lee[1], So-eun Kim[1], Hyun-jeong Kim[1], Jeongwoo Jeon[2],
Jiheon Hong[3], Jaeho Yu[3], Jinseop Kim[3], Seong-Gil Kim[3], Yeongyo Nam[3], Dongyeop Lee[3*]
[1]Student, Department of Physical therapy, Sunmoon University
[2]Research professor, Digital Healthcare Institute, Sunmoon University
[3]Professor, Department of Physical therapy, Sunmoon University

대면, 비대면, 자가운동에 따른 체간안정화 운동이 균형능력에 미치는 영향

이경은[1], 김소은[1], 김현정[1], 전정우[2], 홍지헌[2,3], 유재호[3], 김진섭[3], 김성길[3], 남연교[3], 이동엽[3*]
[1]선문대학교 물리치료학과 학생, [2]선문대학교 디지털헬스케어연구소 [3]선문대학교 물리치료학과 교수

Abstract Study of the effect of interbody stabilization exercises on the static and dynamic balance of face-to-face, non-face-to-face, and self-group. We recruited healthy young adults The subjects were randomly divided into three groups to perform inter-body stabilization exercises, and static and dynamic balance were measured, respectively, before and after intervention. In the Face to Face Group, dynamic balance significantly increased in the anterior and posteriomedial directions before and after intervention. There was also a significant increase in static balance. In the Non face to face Group, there was a significant increase in the three directions of dynamic and static balance. The self-exercise group significantly increased in three directions of dynamic balance, but there was no significant difference in static balance. No significant differences between groups were found in any variables. The results of this study showed that interbody stabilization exercises are effective in improving static and dynamic balance. In the face-to-face group, the inter-body stabilization exercise was effective in improving dynamic balance and static balance, and in the non-face-to-face group, the inter-body stabilization exercise was effective in improving dynamic balance and static balance. In the self-contained group, it was effective in improving dynamic balance.

Key Words : Trunk stabilization, Static balance, Dynamic balance, Face-to-face, Non face-to-face

요 약 : 본 연구에서는 체간 안정화 운동으로 대면, 비대면, 자가로 실시하였을 때 정적균형과 동적균형에 미치는 영향을 알아보고자 하였다. 본 연구는 신체적으로 질병이 없는 건강한 20대 36명을 모집하였다. 대상자들은 무작위로 세 그룹으로 나뉘어져 체간 안정화 운동을 실시하였으며, 중재 전후 정적균형과 동적균형을 각각 측정하였다. 대면 및 비대면 그룹에서 중재 전, 후 동적 균형 및 정적 균형이 유의하게 증가하였다. 자가운동군은 동적균형 3방향에서 유의하게 증가하였으나 정적균형에서는 유의한 차이가 나타나지 않았다. 본 연구 결과, 대면 및 비대면 운동이 체간 안정화 운동이 정적균형과 동적균형 향상에 효과적임을 알 수 있었다. 이러한 결과는 균형 능력 향상을 위한 비대면 운동의 사용 가능성을 지지하며, 균형 능력 뿐만 아니라 다양한 신체 능력에 대한 비대면 운동의 효과에 대해 추가적인 연구가 필요합니다.

주제어 : 대면 운동, 비대면 운동, 체간안정화운동, 정적균형, 동적균형

*Corresponding Author : Dongyeop Lee(kan717@hanmai.net)
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1. Introduction

Interbody stabilization is the control of the muscles around the spine to maintain functional stability[1,2] and these interbody stabilization muscles protect the body and activate before movement begins, providing stability to the body[3,4]. The trunk muscles balance against gravity, adjusting posture and preparing for limb movements. It is an essential element to effectively move the body in various activities such as daily life movements, aerobic exercise, and general sports activities based on smooth use of limbs. Weak trunk muscles do not generate enough force to make efficient movements, which is the fundamental cause of inefficient movements that cause damage. The results of this study showed that interbody stabilization exercises are effective in improving static and dynamic balance. In the face-to-face group, the inter-body stabilization exercise was effective in improving dynamic balance and static balance, and in the non-face-to-face group, the inter-body stabilization exercise was effective in improving dynamic balance and static balance. In the self-contained group, it was effective in improving dynamic balance[5].

Exercise methods that may have an effect on stabilization of the trunk include Crunch exercise, Bridge exercise,

Bird dog exercise, and Flank exercise[6]. After applying 6 weeks of intensive somatic stabilization exercise to subjects diagnosed with hemiplegia due to stroke, analysis of the effect on daily activity physical strength and posture control ability reported an increase in muscle endurance and posture retention. Stroke patients who applied 4 weeks of interbody stabilization exercises with TUG and BBS were tested and found to have improved static and dynamic postural control[7,8].

In fact, most of the prior studies reported were conducted by therapists, trainers, or coaches in a face-to-face

manner with face-to-face feedback. There have been many studies on inter-body stabilization exercises, given this accurate exercise feedback face-to-face, but research on non-face-to-face remote exercise programs is lacking at a time when the importance of non-face-to-face exercise is increasing to prevent the spread of infectious diseases. Despite the need for constant exercise, time and space constraints have increased the interest in home training for those who are unable to exercise. Home training videos are readily available, but the lack of accurate feedback can lead to inaccurate postures. This puts strain on muscles and joints, so proper feedback from the therapist about posture during exercise is important[9].

Typically, therapy or exercise is performed face-to-face with the subject working with a therapist or trainer. Although these methods allow for immediate feedback and supervision, they have drawbacks in terms of convenience. If non-face-to-face exercise has the same effect as in-person exercise, each individual can have the advantage of being able to exercise in their personal space without having to visit a hospital or exercise center in person. Therefore, this study aimed to investigate and compare the effects on balance ability when stabilization exercises were performed in the face-to-face group, non-face-to-face group, and self-exercise group. The hypothesis of this study was that exercise in the non-face-to-face group would have the same effect as the face-to-face group. Additionally, the non-face-to-face group was expected to be more effective than self-exercise.

2. Methods

2.1 Participants and design

The design of this study shows the effect of inter-body stabilization exercises on balance ability according to face-to-face, non-face-to-face, and self-exercise was compared.

The study involved 19 healthy adult men and 17 women. The number of subjects used a sample number calculation program (G*Power, 3.1.9.2), and the values of the mean and standard error measured in the study were entered to produce the sample count results as follows. Considering the dropouts and dropouts, 10% of the personnel were added. The selection criteria for this study are those who do not have pain or discomfort due to movement of the musculoskeletal system, those who have not undergone surgical intervention on the musculoskeletal system, those who do not have inflammatory, degenerative joints, connective tissue diseases, and those who do not have past or present neurological defects. The study was approved by the Institutional Review Board (IRB) of Sunmoon University. All subjects agreed to written notice, explained the purpose of the experiment and the method of study, and the characteristics of the subjects are as shown in Table 1. There were no significant differences in general characteristics between groups at baseline.

Table 1. Subject general characteristics

	Face-to face (N=12)	Non face-to face (N=12)	Self-exercise (N=12)
sex (male/female)	6/6	6/6	7/5
Age (years)	22.5±3.77	21.75±3.77	22.08±1.55
Height (cm)	168.5±10.07	169.91±6.82	169.25±8.73
Weight (kg)	59.16±12.74	66.33±11.29	86.75±3.81

2.2 Experimental procedure

The exercise was conducted 3 times a week for a total of 4 weeks and randomly arranged in three groups: face-to-face, non-face-to-face, and self-exercise. Pre-training was conducted before the start of the exercise.

2.3 Intervention

Type of exercise	Explanation
crunch	The subject lay on the floor, bent his knees, so that their feet did not fall off the floor, and then placed both hands on ears and applied force to abdomen to raise his head slightly. They contracted the epigastric region by bending his back round so that his shoulders were about 10 cm away from the floor, and slowly causing torso to lie on the floor while feeling the tension in the epigastrium. At this time, the head was not completely touched by the floor. 3 sets were performed 15 times, and the rest time for each set was set to 5 seconds.
plank	Stretching was performed as a preparatory exercise for 5 minutes before the plank exercise was performed. The plank exercise position consisted of prostrate and keeping both arms shoulder-width apart, shoulders and elbows perpendicular to the knees, and then maintaining the posture with the knees stretched out and tiptoe. They were also asked to keep their heads, backs, and legs in a straight line. Before the experiment, the exercise method was fully explained, and the hips were not raised or lowered based on the bar installed in the highest position of the hip during the exercise [10,11]. Stretched straight from head to toe and tensed the abdomen, sphincter, hip muscles, etc. so that the waist did not fall downwards [12]. 1 minute and 2 sets were performed, and the rest time for each set was set to 5 seconds.
bridging	The subject began in a position where he was lying down at a 60-degree angle, with both feet spread shoulder-width and attached to the floor in parallel, with both arms spread about 30 degrees apart and palms facing the floor. Both hands supported by the palm of the hand next to the pelvis, lightly pressing the floor from the shoulder to the fingertips, and then lifting the hips [13,14]. Three sets of 30 seconds were performed, and the rest time for each set was set to 5 seconds.
Four point kneeling	In the four-legged device position, the subject had his hands under the shoulder vertical, the knees under the hip vertical, and the force was applied to support the weight on the four feet. Hands and feet opposite each other were extended and held for about 2 seconds and brought down. 6 sets of 20 seconds were performed, and the break time for each set was set to 5 seconds.

2.3 Outcome measures

Static balance was assessed using TETRAX (Sunlight Medical Ltd., Ramat Gan, Israel). The measurement method of 4 independent regions (left anright toes and heels) was adopted, and the degree to which the center of the body was disconnected was measured followed by the measurement of body stability. The ability to balance with support surface changes was measured in a state where vision was allowed. TETRAX filler was used for measurement on unstable support surfaces. The body stability was measured based on the value calculated on the basis of 0 points when there was no shaking at all when maintaining the line position by the sensor of Tetrax's force measuring plate.

Dynamic balance was evaluated using Y-balance test (YBT). The subjects remained in a one-legged position on the middle footrest of the YBT tool after the tester's demonstration[15]. Reach distances in 3 directions including the anterior, posterolateral, and posteromedial on the right were measured. The dominant foot (the foot used to kick the ball) was carried out and measured a total of 3 times to record the average value. The experiment subjects progressed at the preferred pace and recorded the results. If the supporting foot fell from the middle footrest, the foot of the outstretched leg touched the ground, or if the leg did not return to the starting position after the leg was extended, it was considered a failure and re-measured[16]. The results were expressed as a percentage of each individual's measured leg length.

2.4 Statistical analysis

All statistical analyses in this study were conducted using SPSS /PC Ver.22.0 for windows program (SPSS INC. Chicago. IL) was used. One-way ANOVA, using statistical methods, was performed. In addition, a paired t test was used for before and after comparison in the group. The normality test used the shapiro-wilk test and the variance analysis for comparison between groups. All the data were represented by mean and standard deviation. The statistical significance level was set to 0.05.

3. Results

Table 2 presents changes within groups following the intervention. In the Face to Face Group, dynamic balance significantly increased in the anterior and posteriomedial directions before and after intervention. There was also a significant increase in ST (NO) in static balance. In the Non face to face Group, there was a significant increase in the three directions of dynamic balance and ST (NO, PO) of static balance. The self-exercise group significantly increased in three directions of dynamic balance, but there was no significant difference in static balance.

Table 2. Comparison of balance according to intervention.

			Face to face Group			Non face to face Group			Self-exercise Group		
			Pre	Post	p	Pre	Post	p	Pre	Post	p
Dynamic Balance (%)	Ant		1.4±.14	1.2±.20	.009	1.4±.13	1.3±.14	.033	1.4±.17	1.2±.19	.033
	PM		.99±.12	0.88±.14	.015	.96±.16	.86±.15	.001	.97±.16	.83±.09	.002
	PL		.98±.15	0.88±.15	.138	.92±.10	.82±.13	.002	.94±.12	.80±.05	.001
Static Balance (points)	WDI	NO	6.86±3.4	6.9±2.4	.924	7.6±2.4	8.2±3.4	.447	7.4±3.1	7.9±3.6	.664
		PO	4.6±2.6	6.1±2.9	.127	6.6±2.1	5.9±2.7	.320	5.8±3.1	6.5±4.7	.659
	ST	NO	14.6±3.7	16±4.1	.016	15.±4.9	19.±6.6	.000	13±3.9	15±5.4	.292
		PO	18±5.8	19.9±4.2	.199	16.±4.7	20.±4.5	.010	16±4.4	18±5.1	.062

Values are presented as mean ± SD, Ant: Anterior, PM: Posteromedial, PL: Posterolateral ST: Stability index, WDI: Wight distribution index, NO: Non pillow and eye open, PO: Pillow and eye open

Table 3. Differences in post-intervention changes between interventions.

			Face to face Group	Non face to face Group	Self- exercise Group	p
Dynamic Balance (%)		Ant	-0.16±0.17	-0.11±0.15	-0.17±0.27	0.893
		PM	-0.10±0.12	-0.09±0.07	-0.14±0.11	0.306
		PL	-0.09±0.19	-0.10±0.08	-0.14±0.10	0.353
Static Balance (points)	NO	WDI	0.07±2.65	0.67±2.98	0.48±3.75	0.486
		ST	2.18±2.65	3.58±2.27	1.47±4.61	0.724
	PO	WDI	1.56±3.27	-0.66±2.21	0.67±5.14	0.656
		ST	1.64±4.17	3.40±3.80	1.97±3.29	0.600

Values are presented as mean ± SD, Ant: Anterior, PM: Posteromedial, PL: Posterolateral ST: Stability index, WDI: Wight distribution index, NO: Non pillow and eye open, PO: Pillow and eye open

Table 3 shows comparisons between groups. No significant differences between groups were found in any variables.

4. Discussion

As infectious diseases such as COVID-19 become prevalent, interest in non-face-to-face home training is increasing. This study indicates that trunk stabilization exercises performed non-face-to-face can be effective for participants' balance ability. This hyper-face-to-face home training physical activity can be a very efficient alternative to mobility constraints, but the relevant programs and studies to verify their effectiveness are very limited[17]. Accordingly, in this study, healthy men and women in their 20s were divided into 4-week face-to-face, non-face-to-face self-group groups and an inter-body stabilization exercise program was carried out, and the effect on dynamic and static balance was analyzed. This study was conducted to compare dynamic and static balances before and after performing interbody stabilization exercises in three groups: face-to-face, non-face-to-face, and self-contained. Studies have shown that after interbody stabilization, thedynamic balance and stillness of the face-to-face group have been significantly improved. In addition, the dynamic and static balance of the hypertrophic group were significantly improved. The self-group had improved dynamic balance, but there was no significant difference in static balance. There were no significant differences between the three groups.

Previous research has shown that the interbody muscles regulate posture by providing stability to the torso and maintaining balance against gravity. It also acts as a corset that stabilizes the body and spine regardless of the movement of the limbs, and plays a role in maintaining balance in a static position[6]. Through this, inter-body stabilization exercises improve inter-body muscle strength, thereby improving static balance ability. In this study, a significant improvement in static balance was also seen in the face-to-face and non-face-to-face groups after the interbody stabilization exercise. This was consistent with the findings of previous studies that showed that interbody stabilization exercises are effective in framing static balance. In recent prior studies, the inter-body stabilization exercise program contributed to the increase in muscle strength and stability of the hip joint, and there was an improvement in the ability to balance based on these positive factors[18]. Studies by Carpes et al. have shown that by applying inter-body stabilization exercises to patients with low back pain, there is a significant improvement not only in the reduction of back pain, but also in the ability to balance dynamically. In addition, children with

rigid cerebral palsy were given inter-body strength exercises to increase their ability to balance in a sitting position[19]. The results of this study also showed that the dynamic balance ability was improved through stabilization exercises, and the same results as in the previous study.

In this study, there was no significant difference between the three groups, but prior studies showed that the hypertrophic group was able to provide feedback at a close distance through a 1:1 face-to-face encounter between the therapist and the patient, so that muscle strength was improved by performing the exercises in the correct posture by concentrating on maintaining adequate muscle tension[20]. In addition, a comparison of physical function through door-to-door physiotherapy and physical therapy in patients discharged from the hospital with stroke showed no statistically significant difference. Previous research has shown that self-group groups can exercise at any time they want and don't have to care about others because of home training. Through home training, stress is relieved, and self-efficacy is also experienced, such as feeling the vitality of life and acquiring skills for exercising alone[21]. Based on these results, we can assume that this study also showed that there were no significant differences between face-to-face, non-face-to-face, and self-contained groups.

While this study is significant in that it is a study of online home training for people with disabilities in the context of COVID-19, there are limitations to the specificity of the object and environment and what needs to be supplemented in subsequent studies. As a limitation to this study, first, the number of subjects in the sample group was small, with 36 subjects, and caution is needed to generalize to all age groups by conducting it on healthy men and women in their 20s. Second, because the study was conducted using an unfamiliar non-face-to-face program, there are bound to be many limitations compared to the studies conducted on non-disabled adults under normal circumstances. Therefore, in view of these limitations in the future, if we can recruit more study participants and conduct studies on different ages, we will be able to derive more meaningful research results. In the future, these limitations need to be corrected and studied with care.

5. Conclusion

This study was conducted in a 4-week face-to-face, non-face-to-face self-contained group for healthy men and women in their 20s, and then the effect on static and dynamic balance ability was examined, and the conclusions obtained from this were all negative.

First, through a 4-week interbody stabilization exercise program, studies conducted before and after the intra-group experiments showed a significant improvement in the dynamic balance and staticism of the face-to-face group after interbody stabilization. In addition, the dynamic and static balances of the hyper-face-to-face groups were significantly improved. The self-group had improved dynamic balances, but no significant differences in static balances. There were no significant differences between the three groups. There were no differences between the groups.

The researchers in this study hypothesized that face-to-face groups would be more effective at improving balance than non-face-to-face and self-contained groups. Statistics show that there is no significant difference between the three groups, which translates into a similar improvement in the balance ability of the three groups. In this study, we adopted the null hypothesis that the improvement of the balance ability of face-to-face, non-face-to-face, and

self-group is similar. Based on the results of this study, inter-body stabilization exercises can be used to improve balance ability.

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이 경 은 (Kyeong-eun Lee) [학생회원]

· 2024년 2월 : 선문대학교 물리치료학과 졸업
· 관심분야 : 물리치료학
· E-Mail : kelee0905@naver.com

김 소 은 (So-eun Kim) [학생회원]

· 2024년 2월 : 선문대학교 물리치료학과 졸업
· 관심분야 : 물리치료학
· E-Mail : ksoeun0809@naver.com

김 현 정 (Hyun-jeong Kim) [학생회원]

· 2024년 2월 : 선문대학교 물리치료학과 졸업
· 관심분야 : 물리치료학
· E-Mail : rlaguswjd010@naver.com

전 정 우 (Jeongwoo Jeon) [정회원]

· 2022년 8월 : 선문대학교 물리치료학과(이학박사)
· 관심분야 : 물리치료학, 생체역학
· E-Mail : doublej_woo@naver.com

홍 지 헌 (Jiheon Hong) [정회원]

· 2011년 8월 : 영남대학교 의과학과(이학박사)
· 2012년 3월 ~ 현재 : 선문대학교 물리치료학과 교수
· 관심분야 : 신경물리치료학, 생체역학
· E-Mail : hgh1020@hanmail.net

유 재 호 (Jeaho Yu) [정회원]

·2011년 8월: 삼육대학교 물리치료학과(이학박사)
·2013년 3월 ~ 현재 : 선문대학교 물리치료학과 교수
·관심분야 : 정형물리치료, 운동생리학
·E-Mail : naresa@sunmmon.ac.kr

김 진 섭 (Jinseop Kim) [정회원]

·2012년 8월 : 대구대학교 물리치료학과(이학박사)
·2014년 3월 ~ 현재 : 선문대학교 물리치료학과 교수
·관심분야 : 심폐물리치료학, 정형물리치료학
·E-Mail : skylove3373@hanmail.net

김 성 길(Seong-Gil Kim) [정회원]

· 2014년 2월 : 대구대학교 물리치료학과(이학박사)
· 2020년 3월 ~ 현재 : 선문대학교 물리치료학과 교수
· 관심분야 : 정형물리치료학, 근골격계 물리치료학
·E-Mail : sgkim4129@sunmoon.ac.kr

이 동 엽(Dongyeop Lee) [정회원]

·2008년 8월 : 삼육대학교 물리치료학과(이학박사)
·2009년 3월 ~ 현재 : 선문대학교 물리치료학과 교수
·관심분야 : 운동치료, 신경계물리치료학, 암재활
·E-Mail : kan717@hanmail.net