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Comparison of Trunk Muscle Thickness during Bridge and Plank Exercise According to Surface

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Abstract

Background/Objectives: This study compares muscle thickness with surface changes during bridge and plank exercises.

Methods/Statistical analysis: Twenty healthy adults participated in this study. All subjects performed plank and bridge exercises under three conditions: stable, trunk unstable, and lower extremity unstable. During the exercise, the thickness of the abdominal muscles was measured using ultrasonography. The muscle thickness in each condition was compared using repeated measures analysis of variance.

Findings: Transverse abdominis (TRA) thickness was higher in trunk unstable and lower extremity unstable than in stable, respectively ($p<.05$). TRA thickness was higher in trunk unstable and lower extremity unstable, respectively than in stable conditions ($p<.05$). In the case of internal oblique thickness, it was higher in trunk unstable compared to a stable condition ($p<.05$).

Improvements/Applications: The results of this study may provide information about unstable support surfaces that can be used to activate specific muscles when using plank and bridge exercises.

Keywords: Plank exercise, Bridge exercise, Abdominal muscle, Transverse abdominis, Internal oblique, External oblique

1. Introduction

Abdominal muscles play an important role in independent activities such as gait and balance maintenance and have an effect on stabilizing the spine to provide free movement in a stable posture [1]. These abdominal exercises include push-up, crunch, squat, bridge, and plank [2,3]. The plank exercise is a traditional exercise designed to increase core strength, endurance, and stability, and it can strengthen the abdominal muscles without applying much pressure on the spine, and the incidence of back injuries decreases when the core strength is increased [4]. Bridge exercise relieves back pain and improves body function by stabilizing the trunk so that large and small muscles work properly [5]. In addition, the above two exercises have been reported to improve internal abdominal oblique (IO), external abdominal oblique (EO), and transverse abdominal (TRA) [6-8].

Abdominal exercises using unstable surfaces or sensory conditions have been reported to increase exercise efficiency by increasing difficulty [9-11]. Before starting an exercise, it is necessary to evaluate the individual's ability and adjust the difficulty of the exercise accordingly [12,13]. It has been reported that bridge and plank exercises on unstable surfaces increase the activation of EO [14]. In addition, other previous studies showed that the bridge exercise on an unstable surface had a positive effect on the thickness of the IO and TRA [15].

Ultrasonography (US) imaging devices can evaluate the thickness of trunk muscles and are used in several studies as indicators of muscle hypertrophy and muscle atrophy [16]. US is known to be inexpensive and easy to carry compared to measuring instruments such as magnetic resonance imaging and computed tomography [16,17]. It has also been reported as a reliable device as it objectively measures muscle thickness and cross-sectional area when compared to others [18].

Studies comparing exercise on a stable and unstable surface report that exercise on an unstable surface is more effective. However, to the best of our knowledge, there are no studies comparing the effects of different positions of unstable surfaces (trunk or lower extremities). Therefore, the purpose of this study was to investigate the effect of unstable surface location on muscle thickness during bridge and plank exercises.

2. Materials and Methods

This study conducted a total of 6 measurements including stable bridge, trunk unstable bridge, lower extremity unstable bridge, stable flank, trunk unstable flank, and lower extremity unstable flank. In order to find out the muscle thickness, the muscle thickness was measured using US during the exercise and IO, EO, and TRA were measured to compare the two exercises according to the surface.

2.1. Subjects

Twenty healthy adults (age: 24.4 ± 1.87 years, height: 177.38 ± 5.44 cm, weight: 81.77 ± 13.59 kg) participated in this study. Participants with a history of lower extremity injury, neurological diseases, cardiopulmonary disease, and inflammatory diseases were excluded from this study. Subjects in this study voluntarily prepared the consent form through writing and were selected after hearing sufficient explanation of the purpose and method of the study by themselves. Exclusion criteria were selected based on a previous study with a surface for people who had no muscle, bone, nervous system disease, pelvic pain, knee pain, and back pain for 12 months and restricted exercise 48 hours prior to the test [19]. The sample size was calculated to N = 20 using the G-power program (3.1.9.4 version). This study was approved by the Institutional Review Committee of Sunmoon University (SM-202005-033-2).

2.2. Procedure

All subjects performed a bridge exercise and a plank exercise. The duration and rest time of both exercises were the same. Each exercise was performed for 8 seconds, with a 1-minute rest period between exercises. Each exercise was performed on a different day. Bridge and plank exercises were performed under three conditions: stable, trunk unstable, and lower extremity unstable [Figure 1], [Figure 2]. During the exercise, the body was kept as straight as possible. The order of exercises applied to each subject was randomly assigned. Each exercise was performed 3 times and the average value was used for analysis.

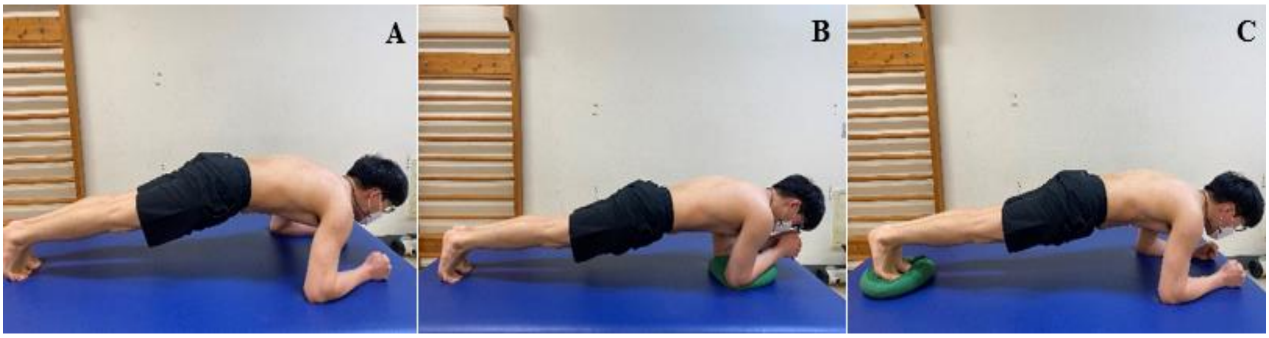

Figure 1. Plank exercise (A) Stable (B) Trunk unstable (C) Lower extremity unstable

Figure 2. Bridge exercise (A) Stable (B) Trunk unstable (C) Lower extremity unstable

2.3. Measurement

US B-mode (Ezono 3000, Germany, 2011) at 7~10 ㎒ was used to investigate the muscle thickness measurement during bridge and plank exercises [Figure 3]. To measure the thickness of TrA, IO, and EO, the subject was placed in a supine position. During measurement, the probe was positioned 2.5 cm outward (right) by drawing a virtual line parallel to the umbilicus. Muscle thickness was captured and recorded at the end of the breath while performing the exercise.

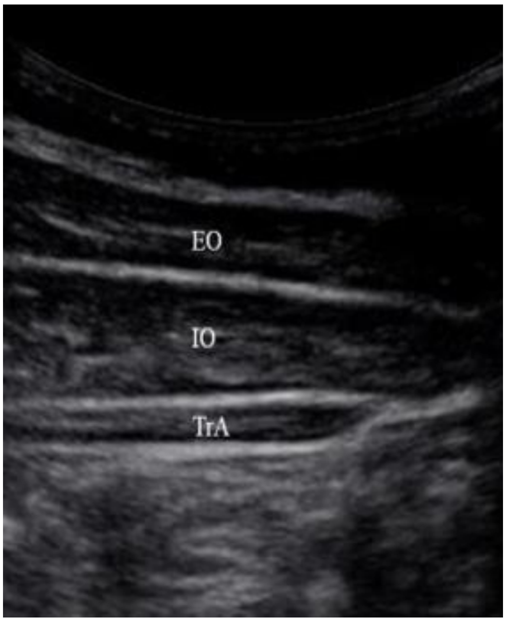

Figure 3. Abdominal thickness measurement

2.4. Statistical analysis

In this study, SPSS 22.0 (SPSS INC. Chicago, IL) for Windows programs was used for all statistical analyses. All data are presented as mean and standard deviation. Shapiro-Wilk normality test was performed. To compare muscle thickness for each exercise and surface, we used repeated measures analysis of variance (ANOVA), and for post hoc test (Scheffe) was used. All statistically significant α for hypothesis testing was set to .05.

3. Results

It was found that there was a significant difference in the thickness of the TRA according to the conditions of the surface during the plank exercise ($p<.05$) [Table 1]. As a result of post hoc analysis, TRA thickness was higher in trunk unstable and lower extremity unstable than in stable, respectively [Figure 4]. However, there was no significant difference in IO and EO according to the conditions during plank exercise ($p>.05$) [Table 1].

Significant differences were found in TRA and IO thicknesses according to the surface conditions during the bridge exercise (p<.05) [Table 1]. TRA thickness was higher in trunk unstable and lower extremity unstable, respectively than in stable conditions. In the case of IO thickness, it was higher in trunk unstable compared to a stable condition [Figure 4]. However, there was no significant difference in EO according to the conditions during the bridge exercise (p>.05) [Table 1].

Table 1. Abdominal muscle thickness according to exercise and surface conditions

		SS	TUS	LEUS	P value
Plank	TRA	6.57±1.86	7.38±2.09	6.93±1.83	.003
	IO	11.72±2.76	12.50±3.33	12.07±3.09	.223
	EO	9.06±2.02	9.52±2.39	9.64±3.00	.303
Bridge	TRA	6.56±1.61	7.18±2.08	7.14±2.03	.042
	IO	12.27±3.43	13.23±3.25	12.89±3.52	.028
	EO	8.13±2.82	8.27±2.80	8.20±2.31	.875

Mean ± standard deviation

SS: stable surface, TES: trunk unstable surface, LEUS: lower extremity unstable surface, TRA: transverse abdominis, IO: internal oblique, EO: external oblique

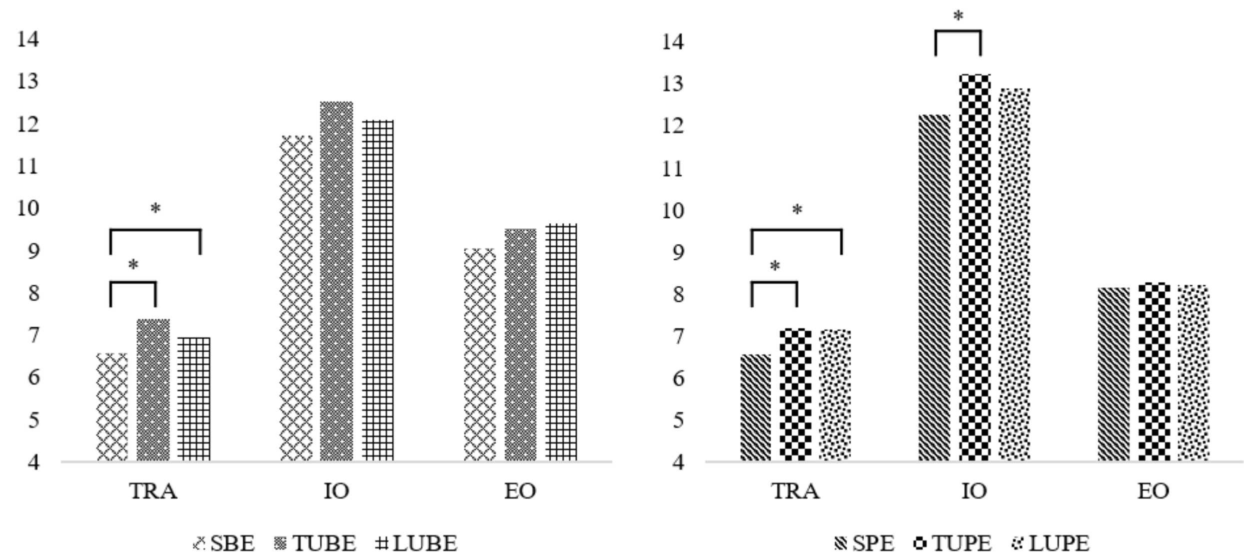

Figure 4. Abdominal muscle thickness according to exercise and surface conditions. TRA: transverse abdominis, IO: internal oblique, EO: external oblique, SBE: stable bridge exercise, TUBE: trunk unstable bridge exercise, LUBE: lower extremity unstable bridge exercise, SPE: stable plank exercise, TUPE: trunk unstable plank exercise, LUPE: lower extremity unstable plank exercise.

4. Discussion

The purpose of this study was to compare the effect of thickness of abdominal muscles EO, IO, and TRA on the position of the surface during bridge and plank exercise. This study showed that the performance of plank and bridge exercises on unstable surfaces increased the thickness of abdominal muscles compared to a stable surface. In addition, unlike previous studies that compared only stable and unstable surface exercises, plank and bridge exercises were conducted on a stable surface, unstable surface, and lower extremities unstable surface, muscle thickness not muscle activity was measured and TRA, EO, and IO compared.

There was a significant difference in TRA values during trunk unstable plank, and muscle thickness improvement was shown to be the highest value. IO and EO showed no significant difference. Imai et al. (2010)

reported improvements in EO in unstable plank exercise as a result of comparing the stable and unstable surfaces of the plank exercise [14]. In this study, there was no significant difference in EO, unlike in previous studies, and there was a significant difference in TRA. There was a significant difference in TRA and IO values during trunk unstable bridge, and muscle thickness improvement was shown to be the highest value. The EO did not show significant differences. Hyeonsu et al. (2017) reported that the unstable surface bridge exercise was effective in improving TRA and IO [15]. In this study as in previous studies, there was a significant difference in TRA and IO. This difference in the previous study may be due to the difference in the position of other unstable surfaces, this may be the difference in the degree of difficulty of exercise and trunk unstable which may more affect the improvement of abdominal muscles.

The study of Saliba et al. (2010) provided an unstable surface by positioning a balance pad between the scapula of the subject, as in the previous study the balance pad was used as an unstable surface condition to give unstable of the same condition for each exercise [12]. The addition of the balance pads increases the movement of the body which can promote the improvement of the muscle [12]. In this study, significant differences were observed in the body unstable plank and body unstable bridge exercise body unstable exercise had a better effect on the improvement of the muscle thickness. In both of the various surfaces, the trunk unstable surface showed a significant effect, and there are the following reasons. TRA is a local muscle that is directly or indirectly attached to the lumbar vertebrae and is associated with stability during the posture control of the whole body. To increase this stability, local muscle movement is required [14]. IO was said to have a significant effect on unstable bridge exercises. This shows that maintaining balance in unstable exercise increases patient concentration and deep muscle improvement [15]. Exercise on the trunk unstable surface such as Swiss ball changes the recruitment pattern of the muscle of the patient with back pain and the abdominal muscle is improved. These improvements have been reported to reduce back pain, thus reducing pain through trunk unstable surface exercise in patients with lumbar instability, reported that interventions were conducted with a focus on abdominal and lumbar muscle strengthening [20]. The abdominal muscle is more recruited to the base on the pelvis towards the trunk when the holding surface is unstable, especially when the bridge exercise is unstable, more muscle recruitment and the power to maintain balance increase reported. The limb exercise during unstable surfaces caused agitating trunk balance and caused improvement of abdominal muscle reported [21,22]. For these reasons, the fact that plank and bridge exercises have improved muscle thickness from trunk unstable is due to the unstable of the trunk, which leads to more recruitment of the muscles in the trunk. The improvement was greater because the origin and insertion were connected to the trunk part, and the concentration and maintenance to balance the body showed a significant effect on the improvement of the deep muscle IO, and the improvement of the TRA, which is a muscle related to this stability, was also shown. These results indicate that the exercise to selectively strengthen TRA and IO and the surface can be selected. The effective exercise to strengthen both TRA and IO is the trunk unstable bridge exercise.

The limitation of this study was that it was not targeted at various ages because it was targeted at adult men in their 20s, and there was a limitation of cross-sectional research. Applying long-term mediation to see long-term changes in muscle thickness will result in more accurate research.

5. Conclusion

This study was conducted to compare the effect on the thickness of abdominal muscle EO, IO, and TRA depending on the position of the surface during bridge and plank exercises. It was measured in the position of three surfaces when exercising and measured during exercise using ultrasonic instruments. In conclusion, we can see that trunk unstable plank exercise is effective for TRA and trunk unstable bridge exercise is effective for TRA and IO. It can also be used as data for clinicians to choose where to place the surface, depending on the exercise they want to activate certain muscles.

References

[1]. Rangari SS, Qureshi I, Samal SN. Efficacy of Core Strengthening Exercises on Swissball Versus Mat Exercises for Improving Trunk Balance in Hemiplegic Patients Following Stroke. Indian Journal of Public Health Research & Development. 2020 Apr;11(4):407-11

[2]. Dafkou K, Kellis E, Ellinoudis A, Sahinis C. The effect of additional external resistance on inter-set changes in abdominal muscle thickness during bridging exercise. Journal of sports science & medicine.

2020 Mar;19(1):102.

[3]. Kim SH, Park SY. Effect of Head and Leg Positions on Trunk and Upper Trapezius Muscle Activities during Plank Exercise. PNF and Movement. 2019;17(3):401-9.

[4]. Snarr RL, Esco MR. Electromyographical comparison of plank variations performed with and without instability devices. The Journal of Strength & Conditioning Research. 2014 Nov 1;28(11):3298-305.

[5]. Kong YS, Park S, Kweon MG, Park JW. Change in trunk muscle activities with prone bridge exercise in patients with chronic low back pain. Journal of physical therapy science. 2016;28(1):264-8.

[6]. Üşen A, Kuran B, Yılmaz F, Aksu N, Erçalık C. Evaluation of the internal oblique, external oblique, and transversus abdominalis muscles in patients with ankylosing spondylitis: an ultrasonographic study. Clinical Rheumatology. 2017 Nov;36(11):2497-500.

[7]. Nashner LM, McCollum G. The organization of human postural movements: a formal basis and experimental synthesis. Behavioral and brain sciences. 1985 Mar;8(1):135-50.

[8]. Hodges PW, Richardson CA. Feedforward contraction of transversus abdominis is not influenced by the direction of arm movement. Experimental brain research. 1997 Apr;114(2):362-70.

[9]. Borreani S, Calatayud J, Martin J, Colado JC, Tella V, Behm D. Exercise intensity progression for exercises performed on unstable and stable platforms based on ankle muscle activation. Gait & posture. 2014 Jan 1;39(1):404-9.

[10]. Kim MH, Oh JS. Effects of performing an abdominal hollowing exercise on trunk muscle activity during curl-up exercise on an unstable surface. Journal of physical therapy science. 2015;27(2):501-3.

[11]. Nam CW, Kim K, Lee HY. The influence of exercise on an unstable surface on the physical function and muscle strength of patients with osteoarthritis of the knee. Journal of physical therapy science. 2014;26(10):1609-12.

[12]. Saliba SA, Croy T, Guthrie R, Grooms D, Weltman A, Grindstaff TL. Differences in transverse abdominis activation with stable and unstable bridging exercises in individuals with low back pain. North American journal of sports physical therapy: NAJSPT. 2010 Jun;5(2):63.

[13]. Czaprowski D, Afeltowicz A, Gębicka A, Pawłowska P, Kędra A, Barrios C, et al. Abdominal muscle EMG-activity during bridge exercises on stable and unstable surfaces. Physical therapy in sport. 2014 Aug 1;15(3):162-8.

[14]. Imai A, Kaneoka K, Okubo Y, Shiina I, Tatsumura M, Izumi S, et al. Trunk muscle activity during lumbar stabilization exercises on both a stable and unstable surface. Journal of orthopaedic & sports physical therapy. 2010 Jun;40(6):369-75.

[15]. Kim H, Bae W, Lee K. Comparison of the abdominal muscle thickness and activity by using tool and unstable surface which is accompanied bridge exercise doing abdominal drawing-in breath. Journal of the Korean society of integrative medicine. 2017;5(1):25-34.

[16]. Boling MC, Padua DA, Alexander Creighton R. Concentric and eccentric torque of the hip musculature in individuals with and without patellofemoral pain. Journal of athletic training. 2009 Jan;44(1):7-13.

[17]. Terhoeve C, Zura R, Reach J, King A. The Techniques and Merit of Ultrasound in Orthopaedics. InUltrasound Fundamentals 2021 (pp. 79-85). Springer, Cham.

[18]. Wachi M, Suga T, Higuchi T, Misaki J, Tsuchikane R, Tanaka D, et al. Applicability of ultrasonography for evaluating trunk muscle size: a pilot study. Journal of Physical Therapy Science. 2017;29(2):245-9.

[19]. Zimmerli L, Krewer C, Gassert R, Müller F, Riener R, Lünenburger L. Validation of a mechanism to balance exercise difficulty in robot-assisted upper-extremity rehabilitation after stroke. Journal of neuroengineering and rehabilitation. 2012 Dec;9(1):1-3.

[20]. Kang JI, Choi HH. Effects of 3d stabilization exercise on the muscle activity and static balance of patients with lumbar instability. The Journal of Korean Physical Therapy. 2017;29(4):181-6.

[21]. Yoon SO, Lee SY, Lee SH. The Effect of Bridge Exercise with Hip Adductor Contraction on Core and Low Limb Muscles Activity. Journal of Sport and Leisure Studies. 2017 Nov;70(70): 625-34.

[22]. joon Yun S, hee Kim J. Effect of shoulder abduction angles on EMG activity of the abdominal muscles during single leg holding on the foam roller. The Journal of Korean Physical Therapy. 2020 Aug 31;32(4):228-32.