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Clinical Availability of Unstable Support Surface During Bridge Exercise for Training Core muscles

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Abstract

Purpose: This study was conducted to investigate the effects of change in the unstable support surface location during bridge exercise on the muscle activity of erector spinae and gluteus maximus. **Research design, data and methodology:** 12 healthy participants aged 23.32 ±1.02 were measured muscle activities of erector spinae and gluteus maximus during bridge exercise and compared between the exercise conditions; unstable support surface located on upper back and feet during bridge exercise. Paired t-test was performed to identify whether there was a significant difference in the muscle activities between the exercise conditions. **Results:** As a result, even though higher levels of the averaged muscle activities of both erector spinae and gluteus maximus during exercise in unstable support surface located on feet than upper back were observed, no significant differences were found. **Conclusions:** The change of unstable support surface location during bridge exercise for low back pain rehabilitation would be more appropriate to be used to increase levels of tension of muscle activities and train fine motor control rather than to strengthening muscle strength.

Keywords : Bride exercise, Core muscles, Human-care service, Motor control, Muscle activity

JEL Classification Codes : I10, I30, I31

1. Introduction

Currently, the incidence of non-specific low back pain according to lifestyle changes is gradually increasing. The number of days that daily activity is restricted due to low back pain throughout the year occurs to 22.04 days (Knibbe & Friele, 1996). As a result of this, 0.29% of gross domestic product (GDP) was lost (Ministry of Health & Welfare, 2005). In addition, medical expenses incurred for examination, treatment, and management due to low back pain are also considerable, for example, about 80% of

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adults complains of low back pain (Sato, Ito, Hirano, Morita, Kikuchi, Endo, & Tanabe, 2008).

The cause of low back pain has been mainly reported decrease in spinal instability the leads to excessive movement in spinal vertebrae (van Dieën, Cholewicki, & Radebold, 2003). Therefore, stabilization exercises were recommended as effective methods to reduce low back pain. Among them, bridge exercise is representative as a stabilization exercise and frequently utilized clinically for training core muscles (Kong, Park, Kweon, & Park, 2016). For this reason, the effects of bridge exercise on low back pain had been proved by many previous studies (Paolucci, Attanasi, Cecchini, Marazzi, Capobianco, & Santilli, 2019).

Furthermore, many previous studies have already observed changes in core muscle activities during bridge exercise in the presence or absence of unstable support surface (Imai, Kaneoka, Okubo, Shiina, Tatsumura, Izumi, & Shiraki, 2010; Czaprowski Afeltowicz, Gębicka, Pawłowska, Kędra, Barrios, & Hadała, 2014). However, few studies have still reported clinical instructions for utilization of unstable support surface. In addition, observation of core muscles was mainly confined to abdominal muscles. Therefore, this study aimed to observe the effects of unstable support surface location on the back and hip muscle activities during bridge exercise and propose the appropriate application method.

2. Literature Review

2.1. Core muscles of the body

Physically, core muscles correspond to muscles that locate at the center of the body including abdominal and lumbopelvic region muscles (Oliva-Lozano & Muyor, 2020). The core muscles primarily function to stabilize the spine like corsets. It plays an important role in balance ability during performance of functional movements. In addition, it has been proved that the application of unstable support surfaces during the stabilization exercise would be effective on increase in the core muscle activities and the posture stability.

2.2. Lumbopelvic hip complex

The lumbopelvic region connecting the legs and spine is one of factors that support the body's posture (Schache, Bennell, Blanch, & Wrigley, 1999). In addition, lumbopelvic region is important to transfer the force of the movement between the upper and lower extremity. In previous studies, it was important to stabilize gluteus muscles on the lumbopelvic region and allow leg extension and lateral rotation, and posterior tilting of the pelvis for functional movement. Especially, erector spinae and gluteus maximus play roles in stabilizing the pelvis along with the action of quadriceps and hamstring muscles.

3. Methodology

3.1. Participants

Participants enrolled in this study were 12 healthy adults aged 23.32 ±1.02 in Y university. Before participating in the experiment, all subjects received sufficient explanation about the study and received the consent. All participants had no neurological and musculoskeletal lesions. In addition, participants who experienced surgical operations during the last 6 months were excluded. The general characteristics of the study subjects were shown in Table 1.

Table 1: Characteristics of participants

Characteristics	Values
Sex (male/female)	2/10
Age (years)	23.32 ±1.02
Height (cm)	161.23 ± 4.22
Weight (kg)	52.10 ± 3.42
Skeletal muscle mass (kg)	24.23 ± 1.42
Body fat mass (%)	30.35 ± 1.63
BMI (kg/m2)	26.64 ± 5.53

3.2. Experimental procedure

While all participants performed bridge exercise with unstable support surfaces using balance pad (Alcan Airex AG, Sins, Switzerland) on the upper back and feet, respectively, measurement of erector spinae and gluteus maximus on the dominant leg side using surface electromyogram (Noraxon Inc. USA).

Surface electromyography (SEMG) signals were collected at 1,500 Hz and filtered with a band pass filter of 10 to 500 Hz. After collection, the collected SEMG data were high-pass filtered at 20Hz, then, demeaned, rectified by a root mean square (RMS). Maximum volatility isometric contraction (MVIC) of each participant was additionally measured for data normalization. Alcohol was used to reduce skin resistance and attached parallel to each muscle.

The detailed placement of SEMG electrodes was introduced in SENIAM (Hermens, Freriks, Merletti, Stegeman, Blok, Rau, & Hägg, 1999). The averaged values of the electromyography signals during exercise for 10 seconds, excluding the start and the last 5 seconds during bridge exercise for a total of 20 seconds were calculated per participant.

3.3. Statistical analysis

SPSS (Version 20) in this observational study was used for statistical analysis. The averaged muscle activities of erector spinae and gluteus maximus were compared between two exercise conditions (i.e., unstable support surface located on the upper back and feet) using a paired t-test. The significance level was set at p=0.05.

4. Results

4.1. Changes in muscle activities depending on the location of unstable support surface

As a result of observing muscle activities during bridge exercises, both erector spinae and gluteus maximus tended to increase muscle activities during bridge exercise with unstable support surface when it located on feet than the upper back. However, there were no significant changes in muscle activities of erector spinae and gluteus maximus (respectively, P=0.055 and P=0.239) as shown in Table 2.

Table 2: Comparison of core muscle activities during exercise with different location of unstable support surface

Muscles	Values	*P*-value
Erector spinae		
Unstable support surface on upper back	15.308±1.930	0.0547
Unstable support surface on feet	20.733±1.801	
Gluteus maximus		
Unstable support surface on upper back	32.352±12.317	0.2392
Unstable support surface on feet	55.629±14.627	

5. Discussion

This study investigated the effects of unstable support surface location on muscle activities of erector spinae and gluteus maximus during bridge exercise. As a result, when the unstable support surface located on feet, it tended to increase muscle activities of both erector spinae and gluteus maximus, however, there were no statistically significant differences.

Clinically, weakness of muscle activities of core muscles causes excessive muscle activities of the lower extremity muscles, resulting in instability of the hip joint (Raabe & Chaudhari, 2018). In addition, there has been reported that the hip joint instability was associated with knee joint pain and anterior cruciate ligament sprain, and even instability of ankle joint as well as low back pain (Shu & Safran, 2010). Therefore, effective core muscle training is also very important to decrease risk factors of knee and ankle joint pain as well as low back pain.

In this study, the bridge exercise was used as core muscle training, and it was observed whether core muscles could be trained more efficiently by changing the minimum exercise condition such as the application location of unstable support surface. Since many previous studies have already reported that the use of unstable support surface during bridge exercise increases muscle activities of core muscles (Van Criekinge, Saeys, Vereeck, De Hertogh, & Truijen, 2018), this study more focused on whether the location of unstable support significantly affects the muscle activities. Considering the results of this study, it was suggested that the change in the location of the unstable support surface is more appropriate to train fine motor control in lumbo-pelvic hip complex and balance ability rather than muscular strength.

de Araújo et al (2009) stated that close-chain exercise methods, such as bridge exercise, are more effective in cooperative contraction and neuromuscular control than open-chain exercise. In addition, Urquhart, Hodges, Allen and Story (2005) emphasized that effective motor control improvement of the local muscle system is possible by utilizing the unstable support during close-chain exercise, furthermore, Sullivan (1997) reported that simultaneous contraction of deep muscles of spine vertebrae utilizing the unstable support surface is effective in reducing back pain. Kang, Son, and Kot (2016) proved that training focused on controlling the local muscle system using unstable support surfaces in the early stages of low back pain would be more appropriate to reduce pain. Therefore, in order to care low back pain effectively, although bridge exercise has been considered to be a typical exercise for strengthening core muscles in clinics, it would be effective to train fine motor control using the unstable support surface in the acute phase. Therefore, results of this study supported that utilization of unstable support surfaces during bridge exercise would be helpful to train fine motor control of local muscle system as well as muscle strength, especially when it comes to changing the application position.

However, this study had some limitations. First, there was a limit to the generalization of study results due to the number of participants. Second, since the quantification of degree of task difficulty given by the unstable support surface was unclear, other balance tools might produce different results. Therefore, in future studies, it is necessary to use diverse tools to identify whether consistent results are produced.

6. Conclusion

This study was conducted to propose an efficient bridge exercise method using unstable support surfaces. In conclusion, it is suggested that the change in the location of the unstable support surface during bridge exercise to train fine motor control of local muscle system for low back pain rather than muscle strength.

References

Czaprowski, D., Afeltowicz, A., Gębicka, A., Pawłowska, P., Kędra, A., Barrios, C., & Hadała, M. (2014). Abdominal muscle EMG-activity during bridge exercises on stable and unstable surfaces. *Physical therapy in sport*, *15*(3), 162-168.

de Araújo, R. C., Tucci, H. T., de Andrade, R., Martins, J., Bevilaqua-Grossi, D., & de Oliveira, A. S. (2009). Reliability of electromyographic amplitude values of the upper limb muscles during closed kinetic chain exercises with stable and unstable surfaces. *Journal of Electromyography and Kinesiology*, *19*(4), 685-694. doi: 10.1016/j.jelekin.2007.11.014

Hermens, H. J., Freriks, B., Merletti, R., Stegeman, D., Blok, J., Rau, G., & Hägg, G. (1999). European recommendations for surface electromyography. *Roessingh research and development*, *8*(2), 13-54.

Imai, A., Kaneoka, K., Okubo, Y., Shiina, I., Tatsumura, M., Izumi, S., & Shiraki, H. (2010). Trunk muscle activity during lumbar stabilization exercises on both a stable and unstable surface. *Journal of orthopaedic & sports physical therapy*, *40*(6), 369-375. doi: 10.2519/jospt.2010.3211

Kang, K. W., Son, S. M., & Ko, Y. M. (2016). Changes in abdominal muscle thickness and balance ability on plank exercises with various surfaces. *The Journal of Korean Physical Therapy*, *28*(5), 264-268. doi: 10.18857/jkpt.2016.28.5.264

Knibbe, J. J., & Friele, R. D. (1996). Prevalence of back pain and characteristics of the physical workload of community nurses. *Ergonomics*, *39*(2), 186-198. doi: 10.1080/00140139608964450

Kong, Y. S., Park, S., Kweon, M. G., & Park, J. W. (2016). Change in trunk muscle activities with prone bridge exercise in patients with chronic low back pain. *Journal of physical therapy science*, *28*(1), 264-268. doi: 10.1589/jpts.28.264

Ministry of Health & Welfare. (2005). 2000 National health and nutrition examination survey results released. Retrieved August 31, 2014

Oliva-Lozano, J. M., & Muyor, J. M. (2020). Core muscle activity during physical fitness exercises: A systematic review. *International journal of environmental research and public health*, *17*(12), 4306.

Paolucci, T., Attanasi, C., Cecchini, W., Marazzi, A., Capobianco, S. V., & Santilli, V. (2019). Chronic low back pain and postural rehabilitation exercise: a literature review. *Journal of pain research*, *12*, 95.

Raabe, M. E., & Chaudhari, A. M. (2018). Biomechanical consequences of running with deep core muscle weakness. *Journal of biomechanics*, *67*, 98-105. doi: 10.1016/j.jbiomech.2017.11.037

Sato, T., Ito, T., Hirano, T., Morita, O., Kikuchi, R., Endo, N., & Tanabe, N. (2008). Low back pain in childhood and adolescence: a cross-sectional study in Niigata City. *European Spine Journal*, 17(11), 1441-1447. doi: 10.1007/s00586-008-0788-5

Schache, A. G., Bennell, K. L., Blanch, P. D., & Wrigley, T. V. (1999). The coordinated movement of the lumbo–pelvic–hip complex during running: a literature review. *Gait & posture*, 10(1), 30-47. doi: 10.1016/S0966-6362(99)00025-9

Shu, B., & Safran, M. R. (2011). Hip instability: anatomic and clinical considerations of traumatic and atraumatic instability. *Clinics in sports medicine*, *30*(2), 349-367. doi: 10.1016/j.csm.2010.12.008

Sullivan, O. (1997). Time waits for no (wo) man: An investigation of the gendered experience of domestic time. *Sociology*, *31*(2), 221-239. doi: 10.1177/0038038597031002003

Urquhart, D. M., Hodges, P. W., Allen, T. J., & Story, I. H. (2005). Abdominal muscle recruitment during a range of voluntary exercises. *Manual therapy*, *10*(2), 144-153. doi: 10.1016/j.math.2004.08.011

Van Criekinge, T., Saeys, W., Vereeck, L., De Hertogh, W., & Truijen, S. (2018). Are unstable support surfaces superior to stable support surfaces during trunk rehabilitation after stroke? A systematic review. *Disability and rehabilitation*, *40*(17), 1981-1988. doi: 10.1080/09638288.2017.1323030

Van Dieën, J. H., Cholewicki, J., & Radebold, A. (2003). Trunk muscle recruitment patterns in patients with low back pain enhance the stability of the lumbar spine. *Spine*, *28*(8), 834-841. doi: 10.1097/01.BRS.0000058939.51147.55