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Original Article

Comparison of the isolated contraction ratios of the hip extensors and erector spinae muscles of the lumbar region and thoracic muscles during different back extension exercises

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Abstract. [Purpose] This study compared the isolated contraction ratios of the hip extensors, erector spinae muscles of the lumbar region, and thoracic muscles during different back extension exercises. [Subjects] Twelve males participated in this study. [Methods] The subjects performed various back extension exercises. The activities of the T7 erector spinae muscles, L3 erector spinae muscles, and the gluteus maximus were measured, and the isolation contraction ratios were calculated. [Results] The isolated contraction ratio of the T7 erector spinae muscles significantly increased during exercise 2. The isolated contraction ratio of the gluteus maximus increased by a significant degree during exercise 1 compared with the other exercises. [Conclusion] This study demonstrated that the back extension exercises 1 and 2 can be applied to selectively exercise the hip extensors, thoracic muscles, and muscles of the lumbar region.
Key words: Back extensor, Isolated contraction ratio, Selected exercise

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INTRODUCTION

Exercise-based active rehabilitation programs can reduce back pain intensity, alleviate functional disability, and improve back extension strength, mobility, and endurance[1)]. Therefore, the need to vary the exercises performed in programs and makes them a normal part of everyday life has been stressed as an important factor when recommending a training program[2)]. Back extension exercises have been used for rehabilitation of the injured low back, prevention of injury, and fitness training programs, but a high activation level of the lumbar paraspinal muscles may lead to unfavorable forces impinging on the spine[3)]. A variety of back extension exercises have been designed, including free weight exercises such as stiff-legged dead lifts, as well as chair-based dynamometer, and Roman chair exercises[4)]. The "back muscles" include the hip extensors as well as the erector spinae muscles of the lumbar and thoracic regions, and are considered the posterior spine muscle chain[2)]. However, most back exercises only focus on the erector spinae muscles of the lumbar region. The isolated contraction ratio indicates the proportional contribution of a muscle to a motion[5)]. So, this study compared the isolated contraction ratios of the hip extensors, erector spinae muscles of the lumbar region, and thoracic region muscles during various back extension exercises.

SUBJECTS AND METHODS

Twelve males participated in this study (age 23.5±1.6 years, height 175.5±3.2 cm, weight 64.8±5.2 kg). The participants had no history of musculoskeletal disorders, pain associated with the upper extremities, or back pain in the past 3 months. The present study was approved by the Inje University Faculty of Health Science Human Ethics Committee. All participants provided written informed consent before the start of the study. Surface electromyography was amplified, band-pass filtered (20–450 Hz), and then collected using a Trigno wireless system (DelSys, Boston, MA, USA). It was recorded digitally at 2,000 Hz/s. Wireless surface electrodes were attached parallel to the muscle fibers on the right side T7 erector spinae, L3 erector spinae, and gluteus maximus, and the maximum voluntary isometric contraction was then measured to normalize the sEMG amplitudes during back extension exercises. In the present study, the isolated contraction ratio was calculated using the following formula: isolation ratio = [muscle A or B or C / (muscle A + muscle B + muscle C)] × 100%. The isolated contraction ratio indicates the proportional contribution of a muscle to back extension. The subjects were taught to perform the 3 different back exercises. Exercise 1 (isometric, supine position) consisted of back extension with lifting of

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the hip into a bridging position. The participants maintained for position for 5 s. Exercise 2 (isometric, prone position) consisted of trunk extension: as in the Sorensen test with the participant prone on a table with the anterior-superior iliac spine placed at the edge of the table. The lower body was secured by straps. The participants maintained for position for 5 s. Exercise 3 (isotonic prone position) consisted of Roman chair trunk extension exercises with the gradient of the Roman chair set at 60° using an inclinometer. The subjects were prone on the Roman chairs with their anterior iliac spines placed on the anterior hip pad and their feet secured under the footpad, and the hands were placed behind the head with the fingers interlocked. From the individual maximal range of trunk flexion to an erect posture, defined as touching a bar, 5 s of EMG data during concentric trunk extension were collected. The speed of movement was controlled by using a metronome. The Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) was used to conduct repeated measure one-way ANOVA to analyze the significance of differences in the isolated contraction ratio for the different exercises. The level for statistical significance, α, was chosen as 0.05.

RESULTS

The isolated contraction ratio of the T7 erector spinae in exercise 2 (32.6 ± 8.2%) was significantly increased compared with those in exercises 1 and 3 (23.6 ± 7.0% and 24.9 ± 11.3%) ($p<0.05$). The isolated contraction ratio of the gluteus maximus in exercise 1 (34.0 ± 10.9%) was significantly increased compared with those in exercises 2 and 3 (26.2 ± 5.7% and 29.1 ± 14.5%) ($p<0.05$). The isolated contraction ratio of the L4 erector spine showed no significant difference among the 3 exercises (exercise 1, 38.8± 10.1%; exercise 2, 40.7± 8.0%; exercise 3, 37.9± 15.3%) ($p>0.05$).

DISCUSSION

This study compared the isolated contraction ratios of the hip extensors, erector spinae muscles of the lumbar region and thoracic region muscles during various back extension exercises. For optimal effectiveness, a training program should include dynamic thoracic/back/hip exercises with a high number of repetitions and should be performed for a period of time sufficient to build muscles and supportive tissues[2]. By changing the limb and trunk position, or by unbalancing trunk muscle movements, it is possible to increase trunk muscle activities. The back muscles groups are activated together to generate extensor moments for trunk extension, and several previous studies have investigated methods of selectively activating each muscle group, particularly for the thoracic and lumbar musculature[4, 6]. According to the results of the present study, the isolated contraction ratio of the T7 erector spinae in exercise 2 was significantly increased compared with those in exercise 1 and 3. We think that the 2nd back extension exercise, the Sorensen test, could be applied to selective exercise consisting of thoracic extension with lumbar back extensor exercise. The ability to resist one's own body weight is a criteria for evaluating the function of the thoracic muscles[7]. According to the results of the present study, the isolated contraction ratio of the gluteus maximus in exercise 1 was significantly increased compared with those exercises 2 and 3. The bridge exercise produced by back extension was combined with hip extension. We also think that the 1st back extension exercise, bridging exercise, could be applied to selective exercise consisting of hip extension with back extensor exercise. Trunk extension exercises use the resistance of the individual's upper body weight[8]. According to this result of the present study, the isolated contraction ratio of the L4 erector spine showed no significant difference among the 3 exercises and showed a range of 37–40%. We suggest that the 3 exercises in the present study would be the safest exercise for the local stabilizing muscles of the lumbar spine.

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