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Effect of Roman Chair Exercise Training on the Development of Lumbar Extension Strength

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ABSTRACT

The purpose of this study was to determine the effect of 45° Roman chair exercise training on the development of lumbar extension strength. Fifteen healthy volunteers (9 women, 6 men) were recruited from a university setting and were randomly assigned to 1 of 2 groups. One group ($n = 9$) performed progressive resistance back extension exercise on a 45° Roman chair once weekly for 12 weeks. Training consisted of one set of 8–20 dynamic repetitions to volitional exhaustion using hand-held metal plates for additional resistance. The other group did not train (control, $n = 6$). Peak isometric lumbar extension torque was measured on a lumbar extension dynamometer before and after the 12-week program. Following training, peak isometric lumbar extension torque did not increase for the Roman chair group (before: 224.0 ± 134.1 N·m; after: 240.3 ± 137.4 N·m; $p > 0.05$) compared with the control group (before: 175.6 ± 68.9 N·m; after: 178.2 ± 69.9 N·m; $p > 0.05$), despite an increase in dynamic exercise load.

Key Words: progressive resistance exercise, trunk extension, low back pain

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Introduction

Lumbar extension strength can be developed through dynamic progressive resistance exercise using high-tech machines, such as lumbar dynamometers that provide mechanisms to stabilize the pelvis and limit the force input from the gluteals and hamstrings. Large gains in lumbar extension torque production have been reported following 12 weeks of low-frequency training (once-weekly) on lumbar dynamometers in healthy individuals and patients with chronic low back pain (11, 12, 22). Improvements in symptoms, disability, function, and psychosocial measures have been demonstrated in these patients following low-frequency intensive back extension exercise training on dynamometers (11, 12, 22, 23). Despite clinical efficacy, the use of high-tech exercise machines for back strengthening and rehabilitation programs has been discouraged because of their relatively high cost and inconvenience (1, 24, 25).

Low-tech mechanisms for lumbar extensor conditioning, such as floor exercise, prone back extension exercise, and Roman chair exercise, are utilized in clinical settings, health and fitness centers, and athletic facilities. These exercises, which effectively activate the lumbar extensors in healthy individuals and patients with back pain (8, 17), depend entirely on the load attributed to the upper body for resistance. The lumbar extensors contract at approximately 45% of peak strength during the Biering-Sorensen test (16). This test is an isometric trunk extension exercise that relies solely on upper body mass for resistance and where the torso is held unsupported in a similar horizontal position (2). Plamondon and colleagues (20) reported that the lumbar extensors are activated at less than 40% of their maximum voluntary contraction during prone back extension exercises on a horizontal table and concluded that prone back extension exercises are better for developing back muscular endurance than for strength. Training programs utilizing low-tech exercises without external loads improve lumbar muscle endurance but do not necessarily develop lumbar extension strength (19, 26).

Hand-held metal plates are frequently used in conjunction with Roman chairs to add resistive loads greater than those offered by the upper body. Lee (15) reported lumbar extension strength increases following a 12-week, twice-weekly exercise training program on a fixed-angle horizontal (0°) Roman chair using metal plates for additional resistance. It is not known whether exercise training on other types of Roman chairs using external loading mechanisms or at other training frequencies results in lumbar extension strength gains. The purpose of this study was to determine the effect on development of lumbar extension strength of a 12-week, once-weekly progressive exer-

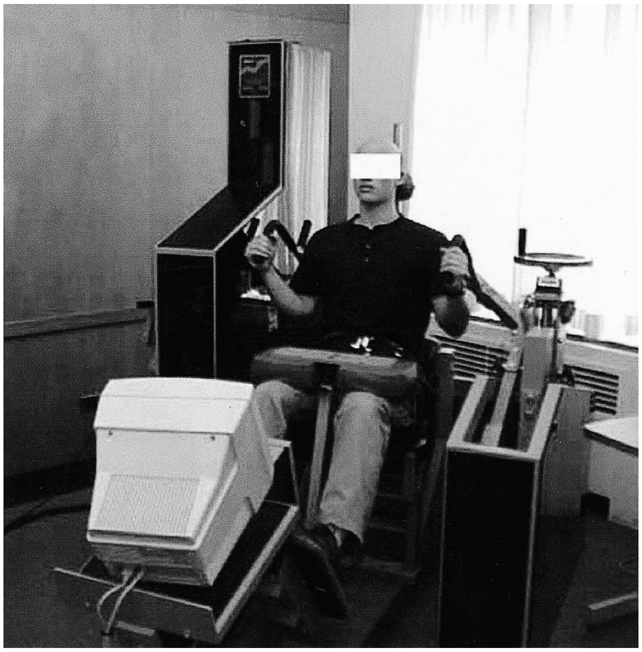

Figure 1. Lumbar extension dynamometer.

Figure 2. The 45° Roman chair.

cise training program with a 45° Roman chair using hand-held plates for additional resistance.

Methods

Experimental Approach to the Problem

A prospective, repeated measures exercise training study was conducted with healthy individuals who were randomly assigned to 1 of 2 groups: Roman chair exercise training and non-training control. Peak isometric lumbar extension strength was measured before and after 12 weeks of intervention.

Subjects

Eighteen apparently healthy individuals were recruited for this study from a university setting. Potential subjects were excluded from the project if they fit any of the following criteria: (a) under 18 or over 45 years of age; (b) significant history of low back pain; (c) history of other lumbar spine pathologies; (d) knee or hip disorders contraindicating the use of the pelvic restraint mechanisms on the testing device; (e) pregnancy; and (f) cardiovascular or orthopedic contraindications to resistance training. The experimental protocol was approved by the Institutional Review Board of Syracuse University, and all subjects provided written informed consent prior to participation.

Instruments

Strength testing was performed on a lumbar extension dynamometer (MedX, Ocala, FL) (Figure 1). The dynamometer is designed to assess isometric lumbar extension strength (torque) in the seated position over a 72° range of motion in the sagittal plane. The range of motion has been arbitrarily described in terms of lumbar flexion by the manufacturer: 72° equals full lumbar flexion and 0° is near terminal lumbar extension. Features of the dynamometer that allow for an accurate and reliable assessment of isometric lumbar extensor strength are well documented (10, 11). Pearson product-moment correlation coefficients (r) of 0.78–0.98 have been reported for test-retest measures of isometric lumbar extension strength on the dynamometer (10).

Dynamic progressive resistance exercise was performed in the prone position on a 45° Roman chair (Performance Technologies, Raleigh, NC) (Figure 2). The 45° Roman chair is equipped with adjustable ankle supports and pelvic roller pads for consistent subject positioning, comfort, and stabilization. Hand-held metal plates ranging from 2.3 kg to 23 kg in 2.3-kg increments were added when necessary to provide resistance in addition to upper body mass during Roman chair exercise.

Testing

All strength testing and exercise training was performed under supervision at the university's Musculoskeletal Research Laboratory. Each subject was seated in the lumbar extension dynamometer, and a lap belt was secured across the anterior thighs. If the iliac crests were not above the axis of rotation in the pelvic restraint pad, a cushioned board was placed on the seat. The neck pad was positioned to align with the mastoid region, and the subject was instructed to maintain a light grip on the handlebars. The feet were placed in the middle of the foot board in slight internal rotation, and the femur restraint pad was positioned so that the knees were flexed to approximately 20°. Next, the foot board was tightened, driving the thigh into the femur restraint pad and redirecting the femur to push the pelvis into the pelvic restraint pad,

Table 1. Subject characteristics.*

Group	n	Age (y)	Height (cm)	Weight (kg)
Roman chair				
Female	5	32.2 ± 12.1	164.0 ± 2.2	62.6 ± 8.7
Male	4	33.3 ± 9.2	184.8 ± 5.6	87.6 ± 11.8
Total	9	32.7 ± 10.2	173.2 ± 11.27	73.7 ± 16.2
Control				
Female	4	24.8 ± 4.6	163.3 ± 5.4	55.7 ± 3.8
Male	2	34.0 ± 4.2	180.0 ± 0.0	77.7 ± 2.8
Total	6	27.8 ± 6.1	168.8 ± 9.6	63.0 ± 12.0

* Means ± *SD*.

until there was no rotation in the pelvic restraint pad. The center of torso mass was determined using a counterbalancing procedure designed to offset the effect of gravity on torque production. Subjects performed a series of submaximal isometric strength tests and light dynamic exercise for familiarization to the device.

Maximum voluntary lumbar extension isometric torque was recorded in foot·pounds and converted to newton·meters (1.356 ft·lb = 1 N·m) at 72°, 60°, 48°, 36°, 24°, 12°, and 0° of lumbar flexion. At each angle, the subjects were instructed to gradually build up force against the back pad and to push as hard as possible for at least 1 second using a monitor for instantaneous visual feedback of performance. The investigator verbally encouraged the subjects to generate maximum torque during all strength tests. This procedure constituted the pretraining strength test. A posttraining strength test was conducted 1 week after the 12th session of dynamic resistance exercise using a protocol identical to that of the pretraining test.

Group Assignment

On a subsequent day, the subjects were randomly assigned to one of the following two groups: Roman chair ($n = 9$) or control ($n = 9$). Based on the means, *SD*s, and effect sizes reported in previous studies (11, 22) that have utilized the same measure (isometric torque), it was determined that 18 subjects, in 2 groups of 9, were necessary to establish significance at an alpha level of 0.05 and a power level of 0.80. Three subjects in the control group did not report for the posttraining tests, so data from 6 control subjects were used for analysis (Table 1).

Exercise Training

Subjects in the control group did not train. Subjects in the Roman chair group performed 1 set of approximately 8–20 repetitions of dynamic exercise to volitional exhaustion once weekly for 12 weeks. This training frequency has been successfully used to develop lumbar extensor strength on other devices (11, 22). The subject was positioned prone on the 45° Roman chair so that the anterior superior iliac spines rested on the middle of the pelvic roller pads. Hands were crossed and placed on the contralateral shoulder. Each repetition was initiated in a position of full trunk flexion (approximately 70°–90° of trunk flexion). From this position, the subject was instructed to extend the back and hips until the trunk was parallel to the lower extremities (approximately 0° of trunk flexion) in a 2-second interval, to hold this position for 1 second, and to return to full flexion in another 4 seconds. The subjects were verbally encouraged to perform as many repetitions as possible. For the first training session, the load attributed to the upper body was the sole source of resistance. When the subjects could perform more than 12 repetitions, hand-held metal plates (held at the chest) were used for additional resistance in 2.3-kg increments at the next training session.

Statistical Analyses

Descriptive statistics (means and *SD*s) were derived for demographic data and strength variables. Peak isometric strength (torque) was evaluated within each group using an analysis of variance with repeated measures for angle and training effects. Because there were differences in the pretraining torque values between the groups ($p > 0.05$), an analysis of covariance was performed to compare training effects between the groups, using pretraining torque values as covariates. Significance was accepted at the 0.05 alpha level. All data are reported as means ± *SD*s unless otherwise noted.

Results

There were no significant differences in age, height, or body weight between the groups ($p > 0.05$) (Table 1). For the subjects in the Roman chair group, the number of repetitions of exercise performed at the first and last training sessions was 22.7 ± 6.7 and 16.2 ± 3.0, respectively. The weights of the hand-held metal plates used during exercise at the first and last training session were 0 kg and 15.3 ± 7.5 kg, respectively.

Analysis of peak isometric lumbar extension torque values following training revealed that there were no significant time effects or time × group interactions ($p > 0.05$) (Figure 3). There were no time × angle interactions ($p > 0.05$), allowing for torque values of the 7 angles of lumbar flexion to be averaged for further analysis. There was no difference in the average torque values between the pretraining and posttraining tests for the Roman chair group (pre: 224.0 ± 134.1 N·m; post: 240.3 ± 137.4 N·m) or for the control group (pre: 175.6 ± 68.9 N·m; post: 178.2 ± 69.9 N·m) ($p > 0.05$). There was no difference in the adjusted posttraining torque values between the Roman chair and control groups (258.0 N·m vs. 244.2 N·m, respectively; $p > 0.05$). There was no gender interaction with respect to

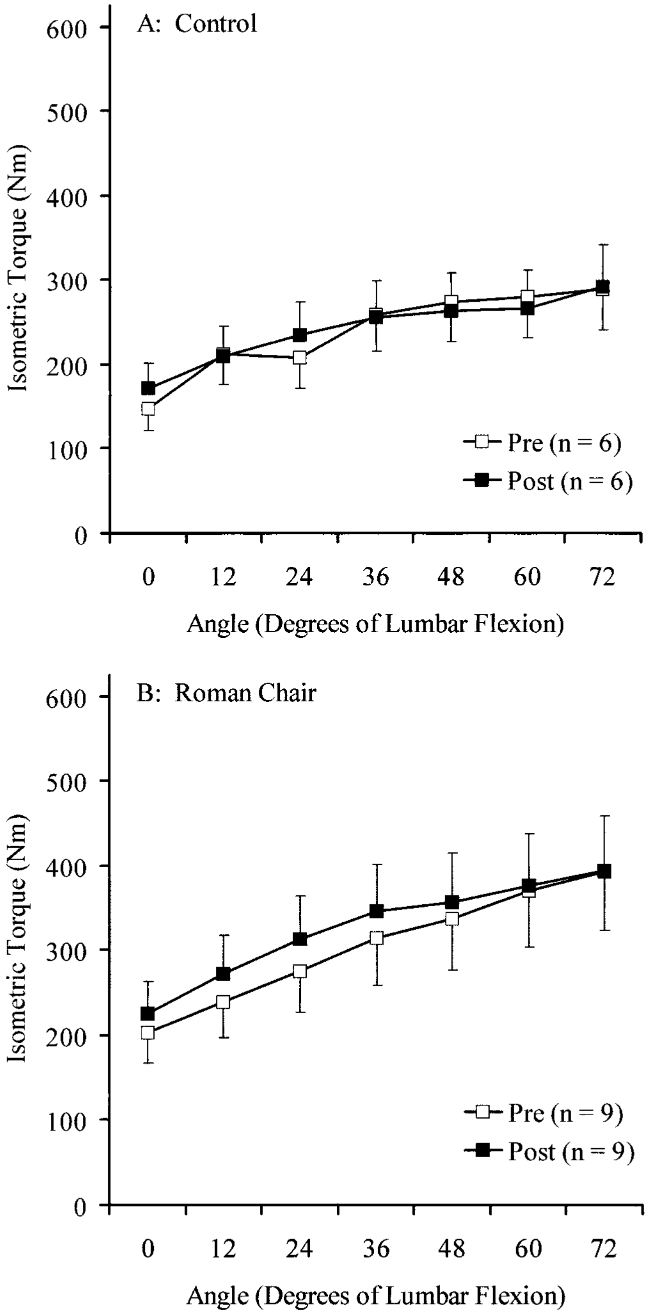

Figure 3. Pre- and posttraining isometric lumbar extension torque values (mean ± *SE*) for the nontraining control group (A, $n = 6$) and Roman chair group (B, $n = 9$) plotted as a function of angle of lumbar flexion.

training effects on the torque values within each group or between the groups ($p > 0.05$).

Discussion

The results of the present study indicate that a 12-week, once-weekly dynamic exercise training program on a 45° Roman chair with hand-held metal plates for progressive resistance does not improve isometric lumbar extension torque (as measured on the lumbar extension dynamometer). In contrast to the findings of the present study, Lee (15) reported improvements in isometric lumbar extension torque following a 4-week, twice-weekly dynamic progressive exercise program on a horizontal (0°) Roman chair with hand-held weights for resistance. These findings suggest that the horizontal position is better suited than the 45° position for lumbar extensor muscle recruitment. In support of this hypothesis, the myoelectric activity of the lumbar extensors during dynamic exercise on a variable angle Roman chair was greater when the device was set at 0° (horizontal) than when it was set at 45° (17). This finding and the lack of strength gains in the present study may indicate that the resistive loads offered by 45° Roman chair exercise in conjunction with hand-held plates are incapable of providing the overload stimulus required to elicit lumbar extension strength gains.

Another possible explanation for the lack of measured strength gain in the lumbar extensors is that the training frequency utilized in the present study (once weekly) was insufficient. Lee (15) found that a twice-weekly Roman chair training protocol was effective in increasing lumbar extension strength, and training frequencies of 2 or 3 times per week have been considered optimal for maximum strength improvements for other muscle groups (3, 7, 9). However, a once-weekly training regimen has been as effective as 2 and 3 times per week regimen for the development of lumbar extensor strength when training is conducted on other devices, such as the lumbar dynamometer (4, 11).

An alternative explanation for the lack of improvement in isometric lumbar extension torque production by the Roman chair group in the present study is the possible unfavorable specificity related to dynamic Roman chair exercise training when testing is performed isometrically in the seated position on a lumbar dynamometer. Testing specificity associated with the lumbar dynamometer has been implicated in previous research when testing and training were conducted on different machines (12). In the present study, subjects in the Roman chair group could not develop familiarity with the testing device and benefit from strength gains associated with a learning process.

In the present study, the improvement in dynamic exercise load (hand-held plates) following the 12-week training program, despite the lack of increase of isometric lumbar extension strength, suggests that strength gains were achieved in the other muscles groups involved in trunk extension on the 45° Roman chair. Lumbar extensor, gluteal, and hamstring activation has been documented during trunk extension exercise on a Roman chair (5, 18). The larger gluteals and hamstrings account for the majority of force production during trunk extension exercises that do not incorporate pelvic stabilization mechanisms (12, 22). Through pelvic stabilization, hip and pelvis rotation is restricted, and subsequently the force input from the gluteals and hamstrings is minimized (12, 22). Because the 45° Roman chair used in the present study does not have pelvic stabilization mechanisms, the larger, more powerful gluteals and hamstrings may have contributed more to force production, particularly at the higher loads. Consequently, these muscles may have been strengthened instead of the lumbar extensors.

Dul et al. (6) speculated that during movements requiring a synergistic activation of several muscles, larger muscles make proportionally greater contributions to force generation with increasing load. Clark and colleagues (5) reported that during dynamic Roman chair exercise, lumbar extensor myoelectric activity increased to a lesser extent than did that of the gluteal and biceps femoris muscles as external load increased. Using muscle functional magnetic resonance imaging, Ploutz-Snyder and associates (21) found no difference in lumbar extensor activity during dynamic Roman chair exercise between exercise intensities representing 50% and 70% of peak isometric force. Future research is needed to assess strength changes in the gluteals and hamstrings induced by Roman chair exercise training.

Practical Applications

Based on the results of this study, we do not recommend a 12-week, once-weekly exercise training protocol on a 45° Roman chair exercise using hand-held plates for additional resistance when designing exercise programs to challenge the lumbar muscles in healthy individuals. Morphological and functional abnormalities of lumbar extensor muscles, such as atrophy, weakness, high fatigability, and altered activation patterns have been associated with low back pain (2, 8, 13, 14). Thus, exercise regimens for the lumbar extensors should be included in back pain rehabilitation programs. Because the present study was conducted with healthy individuals, no direct clinical implications can be made from its findings. Future research is needed to address the clinical applicability and effectiveness of resistance exercise on various types of Roman chair devices and at various training frequencies and the relevance of lumbar muscle strength gain in patients with low back pain.

A 12-week, once-weekly dynamic exercise training program on a 45° Roman chair using hand-held weights for additional resistance does not develop isometric lumbar extension strength, as indicated by subsequent testing on a lumbar extension dynamometer in the seated position. This finding suggests that the training protocol does not provide the overload stimulus necessary to elicit lumbar extensor strength gains, that other muscles (i.e., gluteals and hamstrings) are strengthened, or that there is a testing and training specificity associated with the testing device (lumbar dynamometer).

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