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The Role of Measured Resistance Exercises in Adolescent Scoliosis

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Abstract

Twenty adolescent patients (18 girls and 2 boys) with scoliosis ranging from 15°-41° in their major curve were treated with a progressive resistive training program for torso rotation. All patients demonstrated an asymmetry of rotation strength measured on specialized equipment, and surface electrode electromyograms showed inhibition of lumbar paraspinal muscles. Sixteen of 20 patients demonstrated curve reduction, and no patient showed an increase in curve.

According to Lowe et al,[1] the cause of idiopathic scoliosis continues to elude investigators. The consenus is that the etiology is multifactorial. It is difficult to separate cause and effect. For instance, the various studies that showed deficient proprioception, such as abnormal sway[2] and deficient proprioception in scoliosis patients compared to normal patients,[3] suggest these conditions are secondary to the deformity and do not lead to a basic necrologic deficit.

One factor that is relative for causation and treatment is the evidence of muscle asymmetry associated with the curvature. Histochemical and histologic studies demonstrate a difference in muscle status on the convex versus the concave side.[4-8] Also, asymmetric myoelectric activity on the convex versus concave side has been noted.[9-13] Hyperactivity seems to occur on the convex side. Muscle mass, as identified by real-time ultrasound, has shown asymmetry as well.[14] In this study, the lumbar multifidus muscles were larger on the opposite side of the thoracic convexity and on the concave side of the thoracolumbar curves.[14]

No data exists concerning strength differentials between sides for adolescents with scoliosis. A study that evaluated trunk extensor strength isometrically in a sagittal range did not compare one side to the other.[10] Extensor strength was normal in patients with scoliosis.

No study documents the benefits of exercise in the treatment of scoliosis. One preliminary study investigated the effects of an exercise program on adolescents with minimal idiopathic scoliosis.[15] The program was comprised of a series of calisthenics that included sit-ups, leg lifts, and pelvic tilts; no specific training to the spine was included. No particular rationale for treatment was offered, and no significant difference in curvature was found between the exercise and control groups. Strenuous exercise at 20 repetitions was not monitored. The authors noted that most patients did not exercise according to instructions. Only 59% remembered the exercises. No strength measurements were made at baseline or follow-up. No specific measurement of compliance was documented.

Asymmetry should offer some benefit to strength training. Evidence exists that asymmetric strength can create scoliosis. A Scandinavian study found that among elite athletes with single arm skills, such as javelin throwers and tennis players, a small thoracic curve of approximately 10° develops in >80% of participants who developed their skills during adolescence.[16] In a Bulgarian study of 100 girls engaged in rhythmic gymnastics, 12% had scoliotic curves of ⩾10°.[17]

Asymmetric strength also is demonstrated in junior olympic swimmers.[18] In a study of 336 swimmers who were evaluated for scoliosis, 16% had mild curves, all with the convex curvature on the hand dominant side of the body.[18] Again, this suggests that muscle imbalance is a possible cause of scoliosis. Asymmetric tor-

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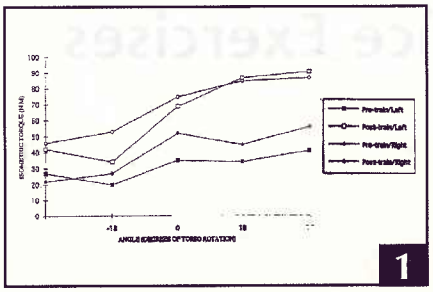
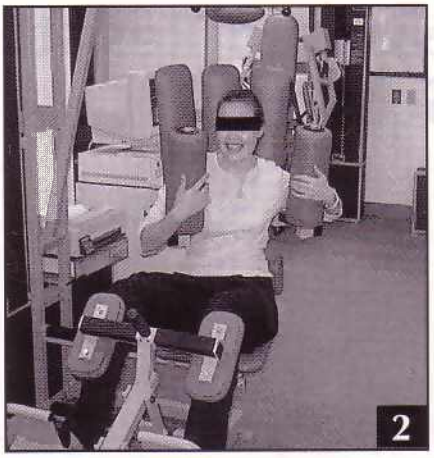


Figure 1: Pre- and post-training strength curves on the computerized MedX torso rotation machine (MedX 96 Inc, Ocala, Fla).



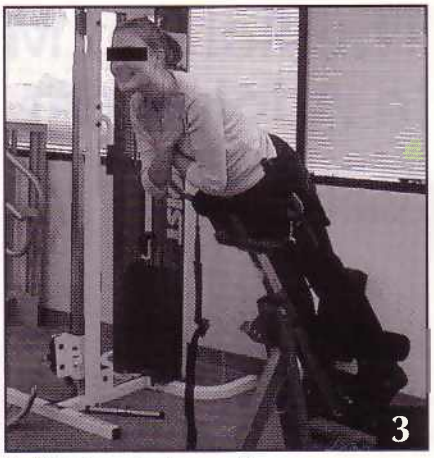


Figure 2: MedX exercise only torso rotation unit (MedX 96 Inc, Ocala, Fla). **Figure 3:** BackStrong variable angle roman chair (Backstrong, Brea, Calif).

sion seems to be a factor. Therefore, torsional strength should be compared between sides.

All studies related to exercise and scoliosis comment on repetition, but not performance. As a therapy, exercise needs to be measured. Also, if it is to be effective, compliance must be consistent and monitored, and progress should be evaluated.

A prospective study measuring torso rotation strength with a specific tool and the effect of resisted exercises on the strength was performed and reported in a preliminary study.[19] This article reports the continued efficacy with less complex equipment on additional patients.

MATERIALS AND METHODS

The computerized MedX rotary torso machine (MedX 96 Inc, Ocala, Fla) with torso rotation strength training and measurement of torso rotation range was used. With this device, the pelvis is stabilized in a sitting position, but the torso is free to move in a 96° arc, rotating from left to right or vice versa.

To allow standardized evaluation for this study, torso rotation was restricted to 36° in each direction. Thus, the full torso rotation was 72°. This device also stops every 18° to measure isometric strength. Therefore, for the full 72° arc rotating from 36° on the left to 36° on the right, isometric strength is measured at five points.

Rotation is resisted in the exercise mode by a weight stack with resistance translated from the rotary axis by a cam, therefore, constant resistance is present through full arc of rotation. In this exercise mode, the amount of resistance is known based on the weight stack and the number of repetitions accomplished before fatigue is recorded. Typically in this exercise mode, 20 repetitions at one level of resistance are accomplished before the resistance is increased by approximately 5% at the next exercise session. Based on this study, two sessions per week with MedX lumbar extension equipment showed sufficient improvement (Figure 1).[20,21]

Testing on the MedX machine was performed at monthly intervals. The isometric pattern was displayed from end rotation to beginning rotation. It was strongest at the beginning of rotation.

In the initial study, myoelectric activity of the muscles also was monitored. Surface electromyographs were recorded (ME1000; Mega Electronics, Kuopo, Finland). The multifidus muscle was monitored posteriorly and the oblique muscles were monitored anteriorly. The electrodes were placed 3 inches below the cage and 4 inches from the midline on each side.

For the expanded study, a noncomputerized rotary torso machine (MedX) was used. This device was considerably less expensive and allowed the patient to place him- or herself into the device independent of an attendant. The resistance was monitored by the weight stack, similar to the computerized rotary equipment. Torso rotation is resistive in the same manner with the pelvis restrained and rotation range variable (Figure 2).

The first study was comprised of 12 patients, and 8 additional patients were added to the follow-up study. The participants agreed to a 4-month training program. Based on the findings of the initial study, an additional treatment program was added. All patients in the second phase also were treated on a variable angle roman chair (BackStrong, Brea, Calif) to challenge their lumbar extensors (Figure 3). This device allowed increasing angulation for increasing challenge to the extensor musculature.

A total of 20 patients (18 girls and 2 boys) with scoliosis ranging from 15°-41° in the major curve, were treated with a progressive resistive training program for torso rotation. Treatment was twice a week until skeletal maturity or documented curve reduction was noted. No patient was braced during treatment. Starting resistance was one-third of body weight. Equal resistance was used in left and right rotation, although initially rotation was weaker in one direction compared to the other. Once the patient was able to complete 20 repetitions, the resistance was increased by 5%. Rotation range was increased as tolerated.