Effects of Prone Spinal Extension Exercise on Passive Lumbar Extension Range of Motion

RICHARD L. SMITH
and DAVID B. MELL

The purpose of this study was to determine the effectiveness of prone spinal extension exercises for increasing passive lumbar extension range of motion in healthy young adults. Eighteen healthy female and 18 healthy male volunteers were divided randomly into control groups (women, n = 10; men, n = 8) and experimental groups (women, n = 8; men, n = 10). The experimental groups performed 20 repetitions of a prone extension exercise each day for four weeks; the control groups did not. We used spondylopectometry to measure lumbar extension ROM. The exercises produced a significant difference (p < .025) in the passive lumbar extension ROM between the male experimental and control groups preventing a loss of spinal mobility in the men who exercised. Analysis of the data revealed no significant difference between the female groups. The results are discussed in light of the clinical significance of lumbar extension ROM. We suggest further studies to examine the effects of lumbar extension exercises on patients with restricted ROM and low back pain.

Key Words: Exercise therapy, Lumbosacral region, Physical therapy, Spine.

Physical therapists routinely evaluate lumbar spinal mobility in patients with spinal disorders and often administer specific therapeutic regimens to increase lumbar extension range of motion in patients with restricted ROM and pain. Recent studies of reduced spinal motion1 and the long-term development of restricted ROM in patients with persistent low back trouble2 acknowledge the importance of lumbar mobility in the prognosis of patients' functional capacity.

Although the lumbar extension exercise regimen is used often by physical therapists, we found no evidence in the literature that these exercises increase lumbar extension ROM in either patients or healthy individuals. Although these exercises are administered to patients with lumbar dysfunction accompanied with pain, we believe examining the effects of extension exercises on healthy adults is a logical first step toward understanding this therapeutic intervention. Adults who are not engaged actively in spinal stretching activities should show a gain in spinal ROM if they follow a specific stretching regimen. The purpose of this study, therefore, was to determine the effects of passive lumbar extension exercises, specifically McKenzie's extension-in-lying exercise,3 on passive lumbar extension ROM in healthy young adults. Because reduced ROM may be the result of shortened soft tissue (ie, muscles, ligaments, joint capsules, fascia, and skin) and because stretching increases tissue mobility and results in increased ROM, we expected to observe an increase in passive extension ROM in both male and female subjects performing the exercises.

Lack of exercise and poor posture are two causes of dysfunction, designated by Mennell as a loss of involuntary movement, in the lumbar spine. Many individuals lead a sedentary life style and remain seated for long periods of time with the trunk held in lumbar flexion. McKenzie described a resulting dysfunction syndrome characterized by adaptive shortening of soft tissue and a partial loss of movement of the lumbar spine. This habitual posture of lumbar flexion, McKenzie hypothesized, results in reduced periaxial tissue length and elasticity and loss of mobility. Saunders described a similar lumbar flexion syndrome characterized by the reduction of lumbar extension. McKenzie suggested passive lumbar extension exercises to accentuate momentarily the lordosis and, thus, correct the dysfunction syndrome. McKenzie's extension principle for dysfunction is based on increasing ROM by stretching the shortened periaxial tissues and returning them to their original length.

Maintenance of the lumbar lordosis may provide a prophylactic safeguard against intervertebral disk protrusion. Cyriax postulated that the lumbar lordosis serves to protect the posterior longitudinal ligament from excessive strain and exerts anteriorly directed pressure on the intervertebral disk. Posteriorly directed disks may exert pressure on pain-sensitive structures resulting in low back pain, whereas passive hyperextension exercises may provide a prophylactic safeguard against intervertebral disk protrusion.10 McKenzie hypothesized that the lumbar lordosis could move the disk away from these structures. Nachemson, in his study of the lumbar disk, found high tangential strains in the posterior part of the annulus fibrosus of lumbar disks in subjects who sit unsupported or lean forward during sitting and standing and less disk pressure the more the lumbar spine was moved toward lordosis. Flattening the lumbar spine, or loss of the lumbar lordosis, resulted in increased pressure on the disk. Recovery of lumbar ROM is prognostic for patients with low back pain. The...
results of a recent study documented the effects of the McKenzie protocol in decreasing low back pain and increasing lumbar flexion and lateral flexion ROM. The ability to achieve lumbar extension in the acute phase has been shown to be predictive of resolution of low back pain syndrome, whereas marked limitation of extension reproducing lower extremity pain is considered to be a poor prognosis.

Lumbar extension therapy plays an adjunctive role in the management of arthritis and related rheumatic disorders, and active spinal extension exercises have been associated with reduced occurrence of vertebral wedging and compression fractures in patients with postmenopausal osteoporosis. The "sway-back" and "flat-back" postures involve a loss of lumbar lordosis. Kendall and McCreary defined sway-back posture as an increased flexion of the lumbar spine caused by a posterior deviation of the upper trunk. From a biomechanical standpoint, these orthopedic diseases and faulty postural positions result in muscular, ligamentous, and related soft tissue disorders of the lumbar spine that may be helped by passive ROM exercises. Furthermore, performance of passive extension exercises by healthy individuals possibly may maintain lumbar ROM and prevent low back dysfunction.

METHOD

Subjects

Thirty-six male and female student volunteers at the University of Montana participated in this study. Eighteen men and 18 women without a history of back injuries or low back pain within the previous six months were divided randomly into control and experimental groups by the flip of a coin. The two experimental groups consisted of 10 men and 8 women, respectively, and the two control groups consisted of 8 men and 10 women, respectively (Tab. 1). The subject group selection was known only by one of us (D.B.M.).

Based on their medical histories, we assumed all subjects had normal ROM. Although differences may exist between normal ROM and ideal ROM, we believe that healthy individuals not actively engaged in spinal stretching can increase their ROM with a specific stretching regimen.

The study was approved by the university’s Institutional Review Board for Human Research. All subjects were oriented to the study and gave their informed consent. They were asked to maintain their current level of activity for the duration of the study.

Instrumentation

We used a spondylometer to measure lumbar extension ROM. The spondylometer consisted of two steel rods that were 0.6 cm in diameter and connected at a central hinge joint. The rods were 40.6 cm long and were bent 12.7 cm from their free ends through an angle of 35 degrees. The free end of one rod carried a pointer that moved over the scale of a protractor joined at the midpoint of its base. Two rubber feet, a cephalic foot and a caudal foot, were fastened to the base of the protractor 6.8 cm apart. The other rod terminated in a small rubber knob (Fig. 1).

We considered the spondylometer to be an appropriate instrument for measuring lumbar spinal extension ROM because the design of the spondylometer allowed lumbar intervertebral joint movement to have a greater effect than thoracic joint movement on the measurement reading. The ROM measurement provided a measure of spinal mobility and did not represent the sum of the angles of movement occurring at each intervertebral joint. Because of the variable movement of the central hinge joint, the angle between the arms of the spondylometer and the index of spinal mobility decreased slightly on extension; therefore, these ROM data were considered to be ordinal and were analyzed accordingly.

A modified Spinex Maxi®* a pelvic fixation pad, was used to stabilize the subject’s pelvis during spinal extension ROM measurement. We found that the

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TABLE 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yr)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>s</td>
<td>Range</td>
</tr>
<tr>
<td>Experimental men</td>
<td>(n = 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.7</td>
<td>1.8</td>
<td>19-26</td>
<td>180 7</td>
</tr>
<tr>
<td>Control men</td>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.1</td>
<td>3.2</td>
<td>21-31</td>
<td>179 6</td>
</tr>
<tr>
<td>Experimental women</td>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.9</td>
<td>3.4</td>
<td>19-28</td>
<td>165 3</td>
</tr>
<tr>
<td>Control women</td>
<td>(n = 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.5</td>
<td>3.4</td>
<td>19-29</td>
<td>171 8</td>
</tr>
</tbody>
</table>
TABLE 2
Descriptive Data for Initial and Final Range of Motion and Range-of-Motion Differences for Male Subjects*

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial ROM</th>
<th>Final ROM</th>
<th>Change in ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X (°)</td>
<td>s (°)</td>
<td>X (°)</td>
</tr>
<tr>
<td>Experimental (n = 10)</td>
<td>43.6</td>
<td>7.8</td>
<td>44.3</td>
</tr>
<tr>
<td>Control (n = 8)</td>
<td>41.4</td>
<td>10.0</td>
<td>38.1</td>
</tr>
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</table>

* Absolute values measured in degrees.

RESULTS

The ROM data obtained from the male experimental and control groups and the female experimental and control groups are presented in Tables 2 and 3, respectively. The subjects in the male experimental group were compliant and performed the exercises for an average of 82.2% (range = 57%–100%) of the days of the exercise program. This group was measured an average of 28.5 days (range = 28–30 days) after the initial measurement. The subjects in the male control group were measured an average of 28.8 days (range = 28–31 days) after the initial measurement. The subjects in the female experimental group had an average compliance rate of 90% (range = 82%–96%) and were measured an average of 29.5 days (range = 26–39 days) after the initial measurement. Subjects in the female control group were measured an average of 28.9 days (range = 27–32 days) after the initial measurement.

The passive lumbar extension ROM increased in the male experimental group and decreased in the male control group. The Mann-Whitney U test value of 18 (critical value = 21) indicated that this difference was statistically significant (p < .025).

The average difference in extension ROM was 0.8 degrees between the female groups. Their Mann-Whitney U test value was 35 (critical value = 21) and, therefore, no significant difference was found at the .05 level.

Analysis of the data standardized for height revealed no significant difference in the results for either men or women. Exercise compliance was not related to a change in ROM (Spearman’s correlation coefficient r = .35) and did not affect the outcome.

DISCUSSION

The critical Mann-Whitney U test value at the .05 level of significance was attained for the men, but not for the women. Further analysis of the mean change in ROM for the male groups revealed that, although the men who exercised gained an average of 1.0 degree of ROM, the control group actually lost 3.4 degrees of ROM (Tab. 2). The study was conducted during the winter quarter at the University of Montana, and the student subjects thus may have entered a relatively sedentary period of time, spending much of the time in sitting positions during the day in class and at night studying. These results suggest that prone extension exercises should be performed during periods of sedentary activity, possibly preventing loss of lumbar extension ROM and re-
The activity levels of the subjects in the experimental groups did not increase significantly their passive extension ROM. This lack of an increase may be explained partially by our exercise guidelines or by the small sample size. We instructed the subjects to stretch to the maximum limit of extension without causing pain, whereas McKenzie suggested that stretching should result in a brief increase of central back pain. An exercise routine including transient pain may be necessary for a gain in passive extension ROM. The small number of subjects examined also may have influenced the results; larger scale studies are needed to provide a clearer understanding of the effects of spinal stretching on spinal ROM.

The activity levels of the subjects in the experimental groups may have been different than the activity levels of the subjects in the control groups, and variations in activity levels may have confounded the results. Our observations indicated that the more active subjects did not demonstrate as much change in ROM as did the relatively inactive subjects. Accurate monitoring of activities may be necessary to study this possibility.

Although our subjects were healthy young adults with apparently normal ROM, passive lumbar extension exercises seem to be appropriate for young adults with decreased range of this important motion. Restricted spinal mobility has been associated with degenerative joint changes\(^1\) and low back pain.\(^2\) A regimen of spinal stretching exercises may help prevent these conditions. Lumbar extension exercises also might result in significant change in ROM when performed by older persons or by those with pathological problems and decreased lumbar extension ROM. Further research is necessary to explore these possibilities.

Our ROM data are consistent with ROM values reported for men and women in other studies. Sturrock et al, using spondylometry in the standing position,\(^18\) and Moll et al, using a tape measure method,\(^21\) documented no significant extension ROM difference between sexes in 15- to 24-year-old adults. We observed female extension ROM to slightly exceed male ROM (statistically insignificant) (Tabs. 2, 3). Although gravity may affect the passive extension ROM in both prone and standing positions, spondylometry had good reliability for measuring passive lumbar extension ROM in the prone position and thus should be considered for clinical use. The accuracy of spondylometry depends on many variables and requires a skilled user to detect small differences in ROM. For example, precise palpation of bony landmarks and placement of the instrument, in addition to consistent stabilization of the pelvis and standardized instructions to each subject, contributed to accurate measurements in this study. Furthermore, our normative extension mobility data may serve as baseline data for determining appropriate extension treatment strategies for young patients with low back pain.

Sagittal lumbar mobility should be assessed carefully by the clinician to determine possible biomechanical problems. Movement patterns may be diagnostic of ankylosing spondylitis\(^18\) and discogenic low back pain.\(^10\) Macnab warned that if degenerative disk changes cause a loss of elasticity in the anterior annular fibers, hyperextension of the lumbar segment may cause overriding and subluxation of the posterior joints.\(^22\) Soft tissue injuries often cause ROM restriction. Abdominal or hip flexor muscle tightness may restrict lumbar extension ROM. Even though the belief is widespread that restricted spinal mobility develops in patients with low back pain, restricted extension ROM has not been associated clearly with spinal dysfunction. Additional studies are needed to examine the relationship of spinal ROM and spinal dysfunction, and the effects of lumbar extension exercises on lumbar spines with reduced ROM.

**CONCLUSION**

Proximal lumbar extension exercises performed for two minutes each day for four weeks may have prevented a decrease in passive lumbar extension ROM in healthy, young, male adults. Extension ROM did not significantly change in healthy, young, female adults performing the exercises. We suggest that further studies be conducted of the effects of passive lumbar extension exercises on subjects of different ages and on patients with spinal dysfunction and restricted ROM.

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**TABLE 3**

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial ROM</th>
<th>Final ROM</th>
<th>Change in ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>s</td>
<td>X</td>
</tr>
<tr>
<td><strong>Experimental</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 8)</td>
<td>47.3</td>
<td>5.0</td>
<td>47.6</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 10)</td>
<td>43.7</td>
<td>16.0</td>
<td>43.2</td>
</tr>
</tbody>
</table>

* Absolute values measured in degrees.
REFERENCES


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