Serial Case Reporting Yoga for Idiopathic and Degenerative Scoliosis

Informe de serie de casos sobre la yoga para la escoliosis idiópatica y degenerativa

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ABSTRACT

Background: Non-surgical techniques for treating scoliosis often focus on realigning the spine, typically by muscular relaxation or muscular or ligamentous stretching. However, such treatments, which include physical therapy, chiropractic, and bracing techniques, are inconsistently supported by current evidence. In this study, we assess the possible benefits of asymmetrical strengthening of truncal muscles on the convex side of the scoliotic curve through a single yoga pose, the side plank pose, in idiopathic and degenerative scoliosis.

Methods: Twenty-five patients with idiopathic or degenerative scoliosis and primary curves measuring 6 to 120 degrees by the Cobb method had spinal radiographs and were then taught the side plank pose. After 1 week performing the pose with convexity downward for 10 to 20 seconds, they were instructed to maintain the posture once daily for as long as possible on that one side only. A second series of spinal radiographs was taken 3 to 22 months later. Pre- and post-yoga Cobb measurements were compared.

Results: The mean self-reported practice of the yoga pose was 1.5 minutes per day, 6.1 days per week, for a mean follow-up period of 6.8 months. Among all patients, a significant improvement in the Cobb angle of the primary scoliotic curve of 32.0% was found. Among 19 compliant patients, the mean improvement rose to 40.9%. Improvements did not differ significantly among adolescent idiopathic and degenerative subtypes (49.6% and 38.4%, respectively).

Conclusions: Asymmetrically strengthening the convex side of the primary curve with daily practice of the side plank pose held for as long as possible for an average of 6.8 months significantly reduced the angle of primary scoliotic curves. These results warrant further testing.

SINOPSIS

Antecedentes: Las técnicas sin cirugía para el tratamiento de la escoliosis normalmente se centran en la realignación de la columna; por lo general, mediante la relajación muscular o el estiramiento muscular o de los ligamentos. Sin embargo, estos tratamientos, que incluyen la terapia física, quiropráctica y otras técnicas de refuerzo, son incompatibles de acuerdo con las evidencias actuales. En este estudio, se evalúan los posibles beneficios de fortalecer los músculos del tronco de manera simétrica en el lado convexo de la curva escoliótica a través de una única postura de yoga, la tabla lateral, para la escoliosis idiopática y degenerativa. Métodos: A 25 pacientes con escoliosis degenerativa o idiopática con curvas escolióticas de 6 hasta 120 grados según el método de Cobb se les hizo radiografías de la columna y se les enseñó a practicar la postura de yoga “tabla lateral”. Después de haberla practicado durante una semana con convexidad hacia abajo durante 10/20 segundos, se les enseñó a mantener la postura una vez al día durante todo el tiempo que pudieran hacerlo solamente por ese mismo lado. Entre 3 y 22 meses más tarde se volvieron a hacer radiografías por segunda vez. Se compararon las medidas con el método de Cobb antes y después de haber practicado yoga. Resultados: La experiencia media de autoevaluación de la postura de yoga fue de 1.5 minutos por día, 6,1 días por semana, durante un periodo de seguimiento medio de 6,8 meses. Entre todos los pacientes, se experimentó una mejora significativa de un 32,0% en el ángulo de Cobb de la curva escoliótica primaria. Entre 19 pacientes colaboradores, la mejora...
media alcanzó un 40.9 %. No hubo diferencias significativas de las mejoras entre los subtipos adolescentes idiopáticos y degenerativos (un 49.8 % y un 38.4 %, respectivamente).

Conclusiones: Al fortalecer asimétricamente el lado convexo de la curva primaria con la práctica diaria de la postura “tabla lateral” de yoga intentando mantenerla el máximo de tiempo posible durante una media de 6.8 meses se consigue reducir significativamente el ángulo de las curvas escoliólicas primarias. Estos resultados deben seguir investigándose.

INTRODUCTION
Scoliosis is a condition in which there is lateral curvature of the vertebral column. This right-to-left asymmetry is often accompanied by a rotational and/or kyphotic component. 
Scoliosis affects 2% to 3% percent of the population, or an estimated 6 to 9 million people in the United States. Medical and preventive advances in tuberculosis and polio have changed the statistics so that at present more than 80% of cases are idiopathic. Currently most scoliosis develops in infancy or early childhood. Although it is generally discovered in the age range of 10 to 15 years, it usually begins considerably earlier, and at the time of its origin, is equally common in males and females. Females, however, are eight times more likely to progress to a scoliotic curve of a magnitude that requires treatment. Degenerative adult scoliosis results from a combination of age and deterioration of the spine, generally with onset after the age of 40 years. It may be related to osteoporosis.

TREATMENT OF SCOLIOSIS
When untreated, scoliosis can be painful and can affect gait, posture, and other areas of physical functioning, measurably lowering self-esteem, negatively affecting body image in teenagers, and progressing to severely reduced respiratory function in aging populations. Recent studies predict as much as a 7% annual increase in untreated scoliotic curves. The standard of care recommends observation of patients with curves of less than 25 degrees, bracing of patients with curves in the 25 to 45-degree range, and surgery for patients with curves greater than 45 degrees.

The studies evaluating the efficacy of bracing and other conservative therapies are inconsistent, and thus their findings must be regarded as inconclusive. Several small studies are optimistic about yoga-like
Typical surgical treatments involve spinal fusion and/or wiring, with or without rods. Surgery brings a 44% to 50% reduction of the curves on which it is performed. However, there is substantial comorbidity, including restriction of spinal mobility, hardware malfunctioning, extra strain on the vertebrae above and below the fusion, and pseudoarthroses. A recent study documented a rate of 50% of revision surgery following Cotrel-Dubousset surgical intervention. The cost of the surgery, which is performed 38,000 times annually, varies from $125,000 to $250,000. Estimating the average cost at $187,500, the total annual cost for surgery in the United States would be $712,500,000.

For 3 to 22 months, we evaluated the effectiveness of regular home practice of a single yoga pose designed to strengthen the convex side of primary thoracolumbar curves. We began this study after observing that the side plank pose, done with the convex side down, had arrested and begun to reverse the natural progression of idiopathic and degenerative scoliosis in several patients.

METHODS

Patient Selection

We examined 25 consecutive patients in a retrospective study from the records of our private practice physical medicine and rehabilitation clinic in New York City, which is located in a neighborhood of affluent and educated people. We included adults with a documented scoliotic curve of 6 or more degrees, the willingness to perform the pose at least once daily for the entire study period, and the commitment to have initial and terminal scoliosis radiographs. Several of these patients did not follow the protocol. Among our candidates, patients with non-idiopathic, non-degenerative scoliosis, previous spinal surgery, pregnancy, or concurrent musculoskeletal or neuromuscular or psychiatric disorders were excluded from the study, as well as any persons we judged unable to perform the requisite exercises daily. Four patients were self-referred; the other 21 patients were referred by healthcare providers. We defined a noncompliant patient as one who did the side plank pose fewer than 4 times weekly.

Intervention

A slight modification of the classical Iyengar side plank pose was used wherein patients were instructed to elevate their ribs, which is not part of the classical Iyengar technique (Figure 1). In addition, the pose was modified for other medical conditions and for weakness (Figure 2). Complex or “S-shaped” curves were treated by adding a second contralateral strengthening pose that consisted of holding the free leg with the free arm, and bulging that part of the spine, generally the cervicothoracic spine, upward (Figure 3).

Study Procedures

Before treatment, the study patients were referred for scoliosis radiographs. Their local radiologists or orthopedic surgeons were asked to read and record the Cobb angles and send the radiographs to our clinic. Patients were then taught the side plank pose and instructed to perform it for 10 to 20 seconds daily for 1 week, and to perform it once daily for as long as possible thereafter. Between 3 to 22 months following their initial radiographs, study patients returned to their radiologists or orthopedic surgeons for a second set of scoliosis radiographs. The radiologists or orthopedic surgeons read and recorded Cobb angles and sent the radiographs to us.

Measures

The authors re-measured the Cobb angles and agreed to consult the original radiologist or orthopedic surgeon if our measurements differed from theirs by more than 5 degrees. Compliant patients were defined as those who reported performing the side plank pose at least 4 times per week for the entire follow-up period.

Statistical Analysis

Using paired sample t-tests, the mean change in primary and secondary Cobb angles were compared for all patients. Differences over time between degenerative and idiopathic scoliosis were compared using repeated measures analysis of covariance (ANCOVA). Differences over time between compliant and non-compliant patients were also compared using repeated measures ANCOVA. Age and gender were examined as covariates.

RESULTS

Our study included 25 patients between the ages of...
14 and 85 years (mean age of 52.1 y). The group included 23 white patients, one black patient, and one Asian American patient. Seven patients had secondary curves. Twelve primary curves and two secondary curves were convex to the right. For all patients, our spinal angle measurements and those made by the patient's radiologist or orthopedist were within 3 degrees. At the time of their second scoliosis radiographs, patients had been practicing the side plank pose nearly daily (average of 8.1 d per wk; range 5 to 7 d) for an average of 1.5 minutes (range 50 sec to 4 min).

**All Patients**

At baseline, the average Cobb angle for the primary curves was 37.2 degrees (range 6 to 120 degrees; SD 28.7) for the 25 patients. After practicing the plank pose for a mean of 6.8 months, the mean Cobb angle for the primary curve decreased to 25.3 degrees (range 3 to 90 degrees; SD 21.0), indicating primary curve improvement of 11.6 degrees or 32.0% (range: −50% to 72.1%; SD 18.5%). (P<.001). At baseline, the mean Cobb angle for the seven secondary curves was 38.3 degrees (SD 37.7) while the comparable angle after the yoga intervention was 29.7 degrees (SD 28.0), a reduction of 8.6 degrees, or 26%; (P=.108) (Table 1 and Figure 4).

**Table 1: Changes in Primary Cobb Angle of All Patients With Follow-up Data**

<table>
<thead>
<tr>
<th></th>
<th>Pre Mean (SD)</th>
<th>Post Mean (SD)</th>
<th>Mean difference</th>
<th>% change</th>
<th>df</th>
<th>t score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Angle</td>
<td>37.2 (28.7)</td>
<td>25.3 (21.0)</td>
<td>11.9</td>
<td>32.0%</td>
<td>21</td>
<td>5.25</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>(n=25)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Secondary Angle</td>
<td>38.3 (37.7)</td>
<td>29.7 (28.0)</td>
<td>8.6</td>
<td>22.5%</td>
<td>6</td>
<td>1.89</td>
<td>.108</td>
</tr>
<tr>
<td>(n=7)</td>
<td></td>
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**Effect of Compliance**

As shown in Table 2, there were substantial baseline differences between the Cobb angles of patients who were deemed compliant vs non-compliant. Compliant patients had significantly greater improvement in the Cobb angle of their primary curve (40.9% vs 0.5%; P=.014).
Table 2 Changes in Primary Cobb Angle of Patients by Self-reported Compliance

<table>
<thead>
<tr>
<th></th>
<th>Pre Mean (SD)</th>
<th>Post Mean (SD)</th>
<th>Mean difference</th>
<th>% change</th>
<th>df</th>
<th>F score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the pose</td>
<td>40.5 (31.1)</td>
<td>25.4 (23.5)</td>
<td>15.1</td>
<td>40.9%</td>
<td>1</td>
<td>7.26</td>
<td>.014</td>
</tr>
<tr>
<td>(n=20)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Did not do pose</td>
<td>27.0 (17.6)</td>
<td>25.1 (11.4)</td>
<td>1.9</td>
<td>0.46%</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>(n=5)</td>
<td></td>
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</table>

Adolescent Idiopathic Scoliosis and Degenerative Scoliosis

We limited our analysis of these two scoliosis subtypes to compliant patients only. Both groups showed significant improvement in primary curve angles from baseline to the post-yoga follow-up measurement. As shown in Table 3, the groups did not differ significantly in the amount of improvement, with degenerative scoliosis patients improving 38.6% and adolescent idiopathic scoliosis patients improving 49.6%.

Compliant Patients With Adolescent Idiopathic Scoliosis

At baseline, the mean Cobb angle for the primary curves in the seven compliant patients with idiopathic scoliosis was 22.8 degrees (range 6 to 43 degrees; SD 13). After patients practiced the unilateral side plank pose for an average of 6.5 months, the mean Cobb angle decreased to 11.2 degrees (range 3 to 23 degrees; SD 7.2), a primary curve improvement of 49.4% (range 0% to 71.1%; SD 18.6; P<.001 for primary curve reduction, Table 3).

Table 3 Changes in Primary Cobb Angle by Type of Scoliosis Among Compliant Patients

<table>
<thead>
<tr>
<th></th>
<th>Pre Mean (SD)</th>
<th>Post Mean (SD)</th>
<th>Mean difference</th>
<th>% change</th>
<th>df</th>
<th>F score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degenerative</td>
<td>50.4 (36.3)</td>
<td>33.1 (27.6)</td>
<td>17.3</td>
<td>38.4%</td>
<td>1</td>
<td>0.447</td>
<td>.511</td>
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<td>(n=12)</td>
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<tr>
<td>Idiopathic</td>
<td>22.8 (11.2)</td>
<td>11.2 (7.2)</td>
<td>11.6</td>
<td>49.6%</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=7)</td>
<td></td>
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Compliant Patients With Degenerative Scoliosis

Among the 12 compliant patients with degenerative scoliosis, the average Cobb angle at baseline of the primary curves was 50.4 degrees (range 10 to 120 degrees; SD 36.3). After an average of 4.9 months of practice, their mean primary Cobb angle decreased to 33.1 degrees (range 7 to 90 degrees; SD 27.6), indicating mean primary curve improvement of 38.4% (range 25% to 70%, Table 3).

Discussion

In this case series, we found significant improvements in the Cobb angle of the primary scoliotic curve among 25 consecutive patients who were prescribed a single yoga pose. The limited number of patients with secondary curves showed some additional benefit to the secondary curve as well. Interestingly, this occurred over a relatively short time period, with a mean follow-up of 6.8 months and as little as 3 to 6 months in many patients. Among our 19 compliant patients, 7 had sufficiently large scoliotic curves that they might be surgical candidates (ie, Cobb angles >45 degrees) and another three had large curves sufficient enough that bracing would be appropriate (ie, Cobb angles >25 degrees and <45 degrees). Untreated scoliosis is believed to progress to more severe spinal curvature over time. It appears that the improvements of the magnitude that we found (32% on average) would eliminate the need for surgery or bracing in most of these patients.

Possible Mechanism

To understand why this yoga pose may help in scoliosis, it is important to conceptualize the physics involved in creating scoliotic curves. A simplified analysis of how humans stand erect involves the symmetrical downward pull of the dorsal, abdominal, intercostal, and paraspinal muscles. Scoliosis, then, could be explained by asymmetry in the force these muscles exert on the spine. The spine will bend toward the stronger side, and thus, the muscles of the convex side may be weaker than their smaller-appearing counterparts on the concave side (Figure 5). We speculate that the side plank pose is useful for strengthening the convex side’s quadratus lumborum, iliopsoas, transverses abdominus, oblique, intercostal, and paraspinal musculature, which, in turn, might straighten the spine (Figure 5).

Limitations

Drawing firm conclusions from a small case series is challenging. In this study, we lacked both a control group and detailed notes on adherence to the treatment. However, it is notable that the reductions in the Cobb angle observed in these patients are superior to those from...
all the therapeutic studies of conservative treatments we identified and all but one therapeutic study of bracing. 
There may be added value for adolescents because the daily home practice of these poses is unlikely to raise the same psychological and self-esteem issues that occur with bracing as a treatment. Yoga involves no encumbrance or restriction of movement in daily life and no visible markers of practice. While the best surgical studies show 59% improvement for patients, our study could not determine how much total improvement would be seen if the side plank pose were carried out for a longer period of time. The relative ease and low cost of practice might prompt some parents and children to begin treatment earlier. As a result, some scoliotic curves might never advance to the degree that requires surgical correction. In addition, use of the side plank pose has no notable side effects apart from occasional and mild wrist and shoulder discomfort. We therefore believe that future studies of this intervention are warranted to determine the factors that promote success of the procedure and its longevity.

Future Studies

Future studies of yoga as a treatment for scoliosis would benefit from inclusion of Lehnek classification, which is used to determine surgical suitability by measuring the primary (largest) curve. In addition, future randomized studies in adolescent idiopathic scoliosis should include Risser sign, a measure of hip socket and iliac bone growth that serves as a proxy for full skeletal maturity. Use of these measures will help make these studies comparable to surgical studies. In addition, studies with longer follow-up periods are needed to clarify the relationship between improvement to the length of treatment and the possible side effects of prolonged treatment. Because past investigations found that both bracing and surgery impacted quality of life,54 including quality-of-life measures would further facilitate comparability to more traditional studies and may help patients and if applicable, their parents, with decision making about the most appropriate treatment.

REFERENCES