Original research

Pulmonary function after thoracoplasty and posterior correction for thoracic scoliosis patients

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ABSTRACT

Objective: To study the effect of the thoracoplasty on the pulmonary function after the posterior scoliosis correction operation.

Methods: From June 2001 to June 2010, 60 thoracic scoliosis patients (24 males, 36 females) were collected. Their average age was 17.6 ± 5.0 years. All patients underwent posterior 3-dimensional operation and thoracoplasty. The pulmonary function was examined preoperatively, 3 months, and 24 months after the operation. The correlation between the postoperative decrease ratio of pulmonary function parameters and postoperative recovery time was analyzed by Pearson correlations.

Results: The average Cobb's angle in the coronal plane was corrected from 99.1 ± 17.6° preoperatively to 49.8 ± 11.8° postoperatively, with the average correction ratio of (44.3 ± 12.6)°. There were significant decrease in the pulmonary function parameters 3 months after the operation [vital capacity (VC), 14.4%; percentage of the VC with measured/predicted value (VC%), 14.7%; forced vital capacity (FVC), 15.7%; percentage of the FVC with measured/predicted value (FVC%), 16.6%; the first second forced expiratory volume (FEV1), 13.2%; the percentage of FEV1 with measured/predicted value (FEV1%), 12.9%] (P < 0.05). The pulmonary function parameters at the last follow-up were slightly higher than the preoperative parameters, but the statistical difference was not significant (P > 0.05). The decrease ratio of postoperative pulmonary function parameters and the postoperative recovery time was positively correlated.

Conclusion: The pulmonary function will be decreased obviously after the thoracoplasty and the posterior scoliosis correction operation in the short time, but returns to the normal level after 2 years.

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1. Introduction

Scoliosis is a common clinical problem usually described as a structural lateral deformity of spine curvature measuring 10° or more on a plain radiograph. However, the scoliosis also manifests itself as an axial rotation of the vertebrae into the convexity of the curve and the spinous processes toward the concavity, which results in an altered alignment of the ribs in the thoracic region. On the concave side of the structural curve the ribs tend to be thinner and crowded together, lying in a more horizontal position, giving a flattened or depressed appearance to the posterior chest wall. Anteriorly, the lower rib deformity may appear as a prominence. On the convex side, the ribs tend to spread farther apart and pass around the chest at a more acute angle, rotate with the transverse processes and produce a posterior rib hump. If rotation is marked, the rib deformity may be so severe that the ribs will angle back, producing the razor back deformity. The convex rib deformity in young patients with thoracic scoliosis is often a major cosmetic concern. In addition, the rib hump seen on the convex side of a scoliosis can cause thoracic deformity, reduced diaphragmatic movement, and asymmetric breathing in the scoliosis patients, which lead to pulmonary dysfunction.

The posterior 3-dimensional (3D) correction technology has been demonstrated to be effective to correct the scoliosis...
deformity, however, it cannot improve the “razor back” deformity at present. Thus, the convex thoracoplasty is advocated. Some researches report that the pulmonary function can be further influenced and damaged by thoracoplasty, but other researches give the opposite view. The aim of this prospective study was to further compare pulmonary function preoperatively, 3 months after the operation, and 24 months follow-up after posterior instrumentation combined with thoracoplasty.

2. Materials and methods

2.1. Patients

From June 2001 to June 2010, 60 scoliosis patients (24 males, 36 females) were enrolled in our hospital. Inclusion criteria were thoracic curves with Cobb angle of at least 70° and the pulmonary dysfunction. Among these patients, there were 36 patients with congenital scoliosis, 16 patients with adolescent idiopathic scoliosis, 6 patients with adult scoliosis and 2 patients with marfan syndrome. Their average age was 17.6 ± 5.0 years old. Patients intolerant of operation due to other basic lesions or with the lumbar curves Cobb’s angle more than thoracic curves Cobb’s angle were excluded.

2.2. Surgery strategy

All the patients were scheduled for the spine posterior 3D correction and thoracoplasty. Briefly, all patients underwent general anesthesia and placed in a prone position on a surgical table. After a posterior midline incision was made, paravertebral muscle was dissected to expose the abnormal spine followed by implantation of pedicle screw bilaterally. Thoracolumbar fascia was dissected to expose abnormal rib and then the rib periosteum was cut. Rib stripper was used to elevate the periosteum circumferentially around the rib. The rib was transected proximally to the costochondral junction and distally to expose the 2–3 cm rib. After the rib bed was completely dissected, 3–5 ribs (about 5–7 cm) were removed with rib rongeur. Ribs bed bleeding was stopped with the application of absorbable gelatin sponge and bleeding of ribs cut ends was stopped with bone wax. All patients were suggested to carry out the regular breathing training after the operation.

2.3. Pulmonary function tests

All patients underwent the pulmonary function examination preoperatively, 3 months after the operation and at the last follow-up using the portable lung function tester (Metalyzer 3B system, Cortex, Germany). Pulmonary function index included vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and the percentage of the measured value/predicted value (refer to the normal value in our hospital) (FVC%, FEV1%). In addition, postoperative pulmonary function change was evaluated using the following formula: the decrease ratio of pulmonary function parameter = (the postoperative pulmonary function parameter – the preoperative pulmonary function parameter)/the preoperative pulmonary function parameter × 100%.

2.4. Statistical analysis

All data were analyzed by SPSS 13.0 statistical software and expressed as mean ± standard deviation (SD). The postoperative and preoperative pulmonary function parameters were compared by t-test. The correlation between the postoperative decrease ratio of pulmonary function parameters and the postoperative recovery time was investigated with Pearson correlations analysis. Evaluation of the results of surgical interventions was carried out using a version of the questionnaire of the quality of life in MOS SF-36 (Chinese version). P < 0.05 was considered statistically significant.

3. Results

Sixty patients receiving spine posterior 3D correction and thoracoplasty were followed up for 13.7 ± 4.2 months. The average Cobb’s angle in the coronal plane was corrected from 99.1° ± 17.6° preoperatively to 49.8° ± 11.8° postoperatively, with the average correction ratio of (44.3 ± 12.6%). The average thoracic kyphosis Cobb’s angle was corrected from 59.5° ± 29.4° preoperatively to 31.7° ± 11.2° postoperatively in the lateral plane. No intra-operative pleura rupture, postoperative pleura effusion, pulmonary infection complications were observed. There were also no paralysis, respiratory failure, and death complications after the posterior scoliosis correction operation. All patients could work and sleep normally. Patients were suggested not to engage in strenuous exercise to recover pulmonary function after thoracoplasty and prevent looseness or breakage of internal fixation. The MOS SF-36 scores were significantly improved after the thoracoplasty and the postoperative scoliosis correction operation (total score 89 vs 41, P < 0.01).

The pulmonary function changes 3 months and 2 years after the operation are shown in Table 1. Three months after the operation, all the pulmonary function parameters decreased significantly compared with the preoperative parameters (VC, 1.88 ± 0.65 vs 1.62 ± 0.59; FVC, 57.6 ± 16.3 vs 47.1 ± 9.1; VC%, 1.88 ± 0.69 vs 14.4 ± 8.6; FEV1, 14.7 ± 8.9 vs 17.6 ± 5.0). However, there was no significant difference in VC, VC%, FVC%, FEV1, and FEV1% between preoperative pulmonary function parameters and the pulmonary function parameters 2 years after the operation (P > 0.05).

Correlations analysis between the postoperative decrease ratio of pulmonary function parameters and the postoperative recovery time revealed that the postoperative decrease ratios of all the pulmonary function parameters (VC, VC%, FVC, FVC%, FEV1, and FEV1%) were positively correlated with the postoperative recovery (Table 2). This result shows that the pulmonary function of the patients will be improved gradually with the time lapse.

4. Discussion

Scoliosis is a serious disease that can affect pulmonary function due to rib hump which can cause thoracic deformity, reduced diaphragmatic movement, and asymmetric breathing. Most investigators who have studied the impairment of pulmonary function in scoliosis generally agree that (1) a Cobb angle greater than 90° greatly predisposes to cardiorespiratory failure; (2) lung

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Preoperative</th>
<th>Postoperative 3 months</th>
<th>Decrease ratio (%)</th>
<th>P value</th>
<th>Postoperative 2 years</th>
<th>Decrease ratio (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC (L)</td>
<td>1.88 ± 0.65</td>
<td>1.62 ± 0.59</td>
<td>14.4 ± 8.6</td>
<td>0.029</td>
<td>1.96 ± 0.77</td>
<td>5.7 ± 15.2</td>
<td>0.179</td>
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<tr>
<td>VC% (%)</td>
<td>57.6 ± 16.3</td>
<td>47.1 ± 9.1</td>
<td>14.7 ± 8.9</td>
<td>0.027</td>
<td>58.9 ± 15.5</td>
<td>2.24 ± 11.8</td>
<td>0.288</td>
</tr>
<tr>
<td>FVC (L)</td>
<td>1.88 ± 0.69</td>
<td>1.60 ± 0.77</td>
<td>15.7 ± 9.8</td>
<td>0.025</td>
<td>2.01 ± 0.86</td>
<td>6.6 ± 14.8</td>
<td>0.129</td>
</tr>
<tr>
<td>FVC% (%)</td>
<td>58.1 ± 16.7</td>
<td>48.3 ± 7.9</td>
<td>16.6 ± 8.5</td>
<td>0.022</td>
<td>59.6 ± 16.4</td>
<td>2.5 ± 11.1</td>
<td>0.263</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>1.72 ± 0.68</td>
<td>1.45 ± 0.20</td>
<td>13.2 ± 8.5</td>
<td>0.031</td>
<td>1.80 ± 0.78</td>
<td>7.7 ± 11.2</td>
<td>0.114</td>
</tr>
<tr>
<td>FEV1% (%)</td>
<td>54.6 ± 18.1</td>
<td>48.3 ± 9.9</td>
<td>12.9 ± 7.1</td>
<td>0.033</td>
<td>57.5 ± 18.3</td>
<td>5.5 ± 13.2</td>
<td>0.131</td>
</tr>
</tbody>
</table>

VC: vital capacity; VC%: the percentage of the vital capacity with measured value/predicted value; FVC: the forced vital capacity; FVC%: the percentage of the forced vital capacity measured value/predicted value; FEV1: the first second forced expiratory volume; FEV1%: the percentage of the first second forced expiratory volume with measured value/predicted value.
function abnormalities are detectable when a Cobb angle is greater than 50–60°, (3) lung function abnormalities are mainly of the restrictive type and (4) the duration of scoliosis correlates with the patients degree of disability. Recent study indicates that patients with the main thoracic curve >70°, proximal thoracic curves >30° or structural, or T5-T12 kyphosis <10° have significantly lower FEV1 or FVC. Therefore, in this research we chose the patients with thoracic curve >70° as a study object.

Although posterior 3D correction and thoracoplasty have been proved to correct the scoliosis, including razor back deformity, the thoracoplasty can destroy the thoracic integrity and respiratory muscle, leading to pulmonary function damage. The pulmonary function of the scoliosis patients are reported to be decreased by thoracoplasty in a short time. As expected, our research also showed that pulmonary function parameters significantly decreased 3 months after the operation, VC declined by 14.4%, VC% declined by 14.7%, FVC declined by 15.7%, FVC% declined by 16.6%, FEV1 declined by 13.2%, and FEV1% declined by 12.9%.

In addition, our results showed that the correlation between the postoperative decrease ratio of the pulmonary function parameters and the postoperative recovery time was positively correlated, that is, the pulmonary function decreased in the short time after the operation, but the pulmonary function improved gradually with the time lapse. As expected, our research showed that the pulmonary function parameters 2 years after the operation were slightly higher than the preoperative pulmonary function parameters, but the difference was not significant (P > 0.05). This outcome indicated that the pulmonary function had returned to the level before the operation. This is also in accordance with the previous studies.

In conclusion, we believe that the thoracoplasty can damage the pulmonary function in the short time after the scoliosis correction operation, but the pulmonary function can return to the level before the operation with the time lapse.

Ethical approval
None.

Funding
None.

Author contribution
Zhicai Shi and Yungang Wu participated in the design of this study, and they both performed the statistical analysis. Ningfang Mao and Zhiwei Wang carried out the study, together with Ye Zhang, collected important background information, and drafted the manuscript. Bo Ran and Ming Li conceived of this study, and participated in the design and helped to draft the manuscript. All authors read and approved the final manuscript.

Conflicts of interest
We have no conflicts of interest to state.

All the parts including research, manuscript and abstract are original and aren’t presented in any form before.

References