Video-assisted thoracoscopic surgery (VATS) for the treatment of scoliotic rib hump deformity

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Abstract A retrospective study of 21 patients with idiopathic scoliosis who underwent endoscopic thoracoplasty was done. The objective of the study was to report and assess the morbidity and mid term outcomes of video-assisted thoracoplasty in idiopathic scoliosis. Patients with idiopathic scoliosis often present cosmetic complaints due to their rib deformity. This deformity may still exist after surgical correction of the main scoliotic curve. Endoscopic thoracoplasty has been reported as a safe method in limited cases of idiopathic scoliosis. Between 2002 and 2004, 21 patients underwent endoscopic anterior release and thoracoplasty for significant rib hump deformity associated with idiopathic scoliosis. Patients were operated on lateral position, with two endoscopic ports. Anterior release and rib resection were performed during the first stage, and instrumented posterior fusion was performed in a second stage. Patients were evaluated preoperatively, 1 week after surgery, 6 months after surgery and at their most recent follow-up with clinical and radiological measurement of the rib deformity. The mean age at surgery was 14.9 years old (range 13–17 years). The average Cobb's angle of the main scoliotic curve was 70° (range 60°–85°). Average follow-up was 25 months (range 23–32 months). The mean number of resected ribs was five ribs (range 4–7) and the mean length of the resected rib was 4.2 cm (range 2.2–7 cm). Average operating time of endoscopic

thoracoplasty (including anterior release) was 65 min (range 45–108 min). The mean preoperative height of rib hump deformity was 3.6 cm (range 2.5–5.5 cm). It was reduced to 1.5 cm at most recent follow-up. There was no significant thoracic pain necessitating medication postoperatively. No complications related to endoscopic anterior release and rib hump resection occurred in the series. Endoscopic thoracoplasty is a safe and reliable technique in idiopathic scoliosis. If indicated, the anterior release can be performed with video-assistance and the thoracoplasty can be performed on the same stage.

Keywords Scoliosis · Thoracoscopy · Thoracic deformity

Introduction

Of all the deformities caused by idiopathic scoliosis, the posterior rib prominence is generally the patient's main cosmetic concern. With rigid curves, the trunk does not always derotate, despite current advanced segmental spinal instrumentation systems.

Surgical correction of scoliotic rib hump deformity by an open procedure through the same incision used for posterior spine fusion has been previously described in the literature [4, 11, 12]. Thoracoplasty has been reported using a thoracotomy approach and associated to anterior spinal fusion for scoliosis [10]. Recently, minimally invasive endoscopic thoracoplasty has been reported in a very limited case series [7–9]. The goal of this study is to report the feasibility, the efficiency and the morbidity of video-assisted thoracoplasty, in patients with idiopathic scoliosis who underwent the procedure combined with an anterior release.

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Materials and methods

Patients

Twenty one consecutive patients, operated on between 2002 and 2004 meet the criteria, included in the study. The indications for anterior release/fusion were: large curve magnitude (thoracic Cobb angle $\geq 75^\circ$), diminished curve flexibility (side-bending thoracic Cobb measurement $\geq 50^\circ$), sagittal plane malalignment including severe thoracic lordosis ($T5-T12 \leq 10^\circ$), or thoracic hyperkyphosis ($T5-T12 \geq 50^\circ$) and patients who were highly skeletally immature (premenarcheal, Risser 0 or 1). The indications for thoracoplasty were a preoperative rib angle of more than 15° , or a curve flexibility of less than 20% on bending films.

The average age of the patients was 14.9 years (range 13–17 years). There were 5 males and 16 females. The follow-up period ranged from 23 to 32 months (average 25 months). The average preoperative thoracic Cobb's angle was 70° (range 60° – 85°), and the average $T5-T12$ kyphosis was 22° (range 5° – 56°). Before the operation, the mean clinical height of the rib hump deformity was 3.6 cm (range 2.5–5.5 cm) with a distance from midline of 6.2 cm (range 5–7 cm).

Operative technique

Before surgery, the patient's hump deformity was examined clinically and radiographically, to estimate the number of ribs and to decide which ribs had to be resected. After

intubation with a double lumen tube, the patient was positioned laterally with the rib hump side up. The upside arm was positioned in hyperflexion and adduction, so as not interfere with the surgeon's hand during the procedure. Two ports were established for the VATS, including one working channel port and one port for the thoracoscopy. They were located at the level of the apex of the deformity.

The first step of the procedure was an anterior release combined with fusion. Then, the ribs to be removed were localized by rib counting using the thoracoscope and by feeling the rib hump. Once identified, they were exposed using a monopolar cautery. We preferred to start the thoracoplasty by the caudal ribs to prevent bleeding that may have obscured caudal ribs (because of the scoliotic curve, the caudal ribs are in a more lower position than an apical rib, so bleeding from cephalad ribs may obscure the caudal ribs). We then performed a subperiosteal dissection with a thoracoscopic curved periosteal elevator. Careful attention was paid to the dissection of the inferior part of the ribs to avoid intercostal vessels. First medial then lateral osteotomies of the exposed ribs were performed (Fig. 1).

After the osteotomies were completed, each osteotomized rib segment was further mobilized and dissected with a thoracoscopic periosteal elevator and then extracted from the chest cavity with a thoracoscopic forceps. Subsequently, hemostasis was achieved, a chest tube was inserted through one of the portals under thoracoscopic control, and the lung was reinflated and checked for air leaks. The portals were closed in a layered fashion. Posterior fusion and instrumentation were performed during a second stage, 3–7 days later.

Fig. 1 **a** Exposing of the rib by a monopolar cautery, **b** dissection with a thoracoscopic curved periosteal elevator, **c** medial osteotomy (closer end of the rib to the vertebral column) then **d** lateral osteotomy of the exposed rib

Evaluation

Clinical and radiographic examinations were made before and after surgery. The rib hump deformity was evaluated by clinical measuring of the height of the apex and its distance from the midline. The coronal alignment was assessed using the standard Cobb measurement technique. The measurement of the rib hump deformity before and after surgery was based on the maximum deformity independent of the levels instrumented, the original preoperative Cobb levels and the apical rib hump prominence [3] (linear distance between left and right ribs on lateral radiograph at the rib deformity apex or the most prominent rib (Fig. 2). All measurements were done before surgery, 1 week after surgery, 6 months after surgery, and at latest follow-up.

Results

The chest tube was removed 4–5 days after surgery provided that there was less than 50 cc of drainage in 8 h interval measurement. The mean number of resected rib was five ribs (range 4–7) and the mean length of resection was 4.2 cm (range 2.2–7 cm) (Fig. 3). The average operating time (including anterior release) was 65 min (range 45–108 months). The mean hospitalization was 8.2 days

Fig. 2 Apical rib hump prominence (B/A) before and after thoracoplasty

Fig. 3 Removed ribs from 5.5 cm hump of 15 years old girl with thoracic scoliosis of 78°

(range 5–13 days). The mean amount of intraoperative blood loss was 246 ± 137 ml and the mean duration of chest tube drainage was 3.12 ± 1.3 days.

The mean preoperative height of rib deformity was 3.6 cm (range 2.5–5.5 cm) and 1.5 cm (range 0.6–2.2 cm) at latest follow-up. At final radiological measurement, there was a 62% reduction of rib hump deformity compared to initial evaluation (Fig. 4). There was no significant difference between primary (1 week) and later postoperative clinical and radiological measurements of mean rib hump height and apical rib hump prominence ($P = 0.23$ and 0.17, respectively) (Table 1). The average preoperative thoracic curve, which was 70° (range 60° – 85°), was corrected to 28° (range 5– 37°) at latest follow-up.

There was no significant postoperative thoracic pain, which needed antalgic treatment (the mean of VAS was 8 mm). No major complications, such as neurologic deficit or significant hemorrhage, occurred.

One of the first patients (patient no. 5) presented a hemothorax (2 months after surgery) related to a fall. To prevent this in the future, a protecting thoracolumbar orthosis was used for 3 months. The orthosis may prevent damage of the lung parenchyma by mobile end of the sectioned ribs and may help better molding of the thoracic cage. A mild pneumothorax occurred in patient no. 14 after the chest tube removal. It did not necessitate a specific treatment and disappeared spontaneously.

Discussion

Thoracoscopic techniques have been used in spine surgery since the early 1990s. Initial use included biopsy, thoracic discectomy, and release for spinal deformity. Later, the technique was adapted for thoracoplasty and spinal instrumentation for scoliosis and fracture treatment [7, 8, 13].

Fig. 4 Clinical and radiographic pictures of 14 years old girl before and 36 months after surgery

Table 1 Changes in height of thoracic hump deformity compared to preoperative baseline

	Rib hump ($\pm$ SD)			
	Pre-op	1 week post-op	3 months post-op	Latest follow-up
Clinical rib hump (cm)	3.6 ± 0.5	1.8 ± 0.5	1.7 ± 0.4	1.5 ± 0.4
Apical rib hump prominence	1.3 ± 0.1	1.12 ± 0.1	1.12 ± 0.08	1.1 ± 0.1

Endoscopic thoracoplasty offers several potential advantages over traditional open techniques, including decreased blood loss, decreased surgical morbidity to shoulder and chest wall musculature, and more precise localization of the ribs to be addressed. Precise rib localization is easier with VATS because the ribs can be counted by angling the thoracoscope to see all 12 ribs [8]. We used two standard thoracoscopic portals and by counting of the ribs internally and touching the hump externally, we did not need 3-D CT for planning the portals and to estimate the length of rib hump [5].

The reduction in soft tissue mobilization and elimination of rib cage muscle retraction should lead to significant reduction in postoperative pain as well as allow us to obtain our desired surgical results (there was no significant difference between height of hump deformity in 1 week and latest examination). The smaller incision should also improve cosmetics, a major concern for patients, as the primary indication for the procedure is correction of a cosmetic deformity.

One major potential complication seen with open thoracoplasty is increased pleural effusion from soft tissue elevation. This has not been experienced by our patients. No major complication occurred, which is consistent with the series of Mehlman et al. [7], Mummaneni et al. [8] and Schwab et al. [9]. On the other hand, Lonner et al. [6] reported one case of VAST thoracoplasty, where the

patient had a postoperative respiratory distress and was reintubated on the second postoperative day. They noted that the etiology of the respiratory failure might have been separation of the chest tube from suction apparatus. Al-Sayyad et al. [1] discontinued endoscopically harvesting ribs because of the inability to close the rib periosteum and persistent pleural effusion early in their series. In our series, intraoperative bleeding and duration of chest tube drainage were comparable to the open method [11].

With the thoracic pedicle screw instrumentation, the open anterior release and fusion is less mandatory [2] but in very young patients with Risser 0 or 1 and in severe lordoscoliosis, an anterior release and fusion may be necessary. Thoracoscopic anterior release in these cases will be the best choice and thoracoscopic thoracoplasty could be performed simultaneously if indicated. In the hands of an experienced surgeon, the endoscopic thoracoplasty is an excellent procedure providing the same efficacy as the open posterior thoracoplasty with less post-operative morbidity. There is however, a learning curve associated with the procedure. In addition, a team approach in which a surgeon and an anesthesiologist with experience in double lumen intubation, selective single lung ventilation and thoracoscopic surgery is crucial.

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