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Thoracoscopic Anterior Instrumentation and Fusion as a Treatment for Adolescent Idiopathic Scoliosis: A Systematic Review of the Literature

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Abstract

Study Design: A systematic review and meta-analysis on thoracoscopic anterior instrumentation and fusion as a treatment for adolescent idiopathic scoliosis (AIS).
Objective: The goal of this study is to determine the current status of thoracoscopic instrumentation and fusion as a treatment for AIS.
Summary of Background Data: Traditional surgical techniques for AIS have been open anterior thoracotomy with instrumentation and posterior spinal fusion and instrumentation. With the growing clinical interest in growth modulation surgeries, such as vertebral body tethering, there is a resurgence of interest in a thoracoscopic technique.
Methods: The most commonly used medical databases (PubMed, Medline, EMBASE, CINAHL, and the Cochrane library) were searched up to November 2016 using the search terms *VATS*, *thoracoscopic scoliosis*, and *thoracoscopic scoliosis instrumentation*.
Results: Thirteen studies met the strict inclusion criteria. Five hundred thirty patients were reported: 81.7% females, with the majority diagnosed as AIS. The mean operative time was 371.5 minutes, mean blood loss of 502.85 mL, and mean hospital stay of 5.9 days. Mean preoperative curve magnitude was 52.9°; postoperative curve magnitude was 17.9°, with a correction of 62.7%. Number of levels instrumented was 6.3, pulmonary function tests returned to preoperative values by 2 years postoperation, and the complication rate was 21.3%. Compared to thoracotomy, VATS had similar complication rates, blood loss, operation theater time, curve correction, and number of fused levels. Compared to posterior fusion, VATS has higher complication rates and operation theater time. Blood loss and percentage correction were similar. VATS had a smaller number of fused segments.
Conclusions: Advantages include less invasive, excellent curve correction, few levels fused, good satisfaction, and no long-term effect on pulmonary function. Drawbacks are increased operative time and incidence of pulmonary complications. With appropriate surgeon training and careful patient selection, this technique offers an acceptable alternative to the more traditional procedures.
Level of Evidence: Level II.

Keywords: Scoliosis; Thoracoscopy; Thoracoscopic spine surgery; Vertebral body tethering

Introduction

Posterior spinal fusion and instrumentation has been the gold standard for the surgical treatment of adolescent idiopathic scoliosis (AIS). However, for selective fusions, alternate anterior techniques like open thoracotomy with instrumentation and, more recently, thoracoscopic instrumentation and fusion can be used. Because most spine centers are well equipped to handle the posterior and open anterior approaches, these techniques have been more commonly used in the past. The major advantage of the open anterior approach over the posterior approach is that

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distal fusion levels can be saved, although, this seems to be at the expense of pulmonary function, which has been found to be significantly decreased even two years post-thoracotomy [1]. A less invasive anterior approach, thoracoscopic instrumentation and fusion, had been used primarily in the 1990s and 2000s [2]. The thoracoscopic technique has certain advantages such as minimally invasive approach with less muscle dissection, less postoperative pain, improved cosmesis, and having no significant effect on the pulmonary functions [2,3].

Given that so few surgeons are employing the thoracoscopic approach, there are very few reports in the literature that document its results. It is imperative that surgeons have a full understanding of the complication profile from thoracoscopic instrumentation and fusion surgery [4,5]. In this study, we systematically review the literature to develop a better understanding of the current status of thoracoscopic anterior instrumentation and fusion as a treatment for adolescent idiopathic scoliosis and to discuss it in the context of the common techniques currently used globally.

Materials and Methods

The most commonly used medical databases (PubMed, Medline, EMBASE, CINAHL, and the Cochrane library) were searched up to November 2016 by two independent reviewers using the search terms *VATS*, *thoracoscopic scoliosis*, and *thoracoscopic scoliosis instrumentation*. The inclusion criteria for this review were 1) studies with AIS patients, 2) thoracoscopic approach used for the treatment, 3) single-center studies, 4) literature in any language, 5) most comprehensive version in case of multiple publications by the same author, and 6) papers with level of evidence I to IV. Studies were categorized into levels of evidence according to guidelines by the Center for Evidence Based Medicine. A total of 13 articles were judged to meet inclusion criteria [6-18]. Of the 13 studies selected, there was 1 randomized trial (Level I) [15], 1 prospective comparative study (Level II) [8], 5 retrospective comparative studies (Level III) [6,10,11,16,18], and 6 clinical case series (Level IV) [7,9,12-14,17]. Two studies directly compared thoracoscopic anterior instrumentation and fusion to posterior spinal fusion [16,18]. Three studies directly compared thoracoscopic instrumentation to open anterior instrumentation using thoracotomy [8,11,15]. Various radiologic and clinical outcomes were studied.

Results

The study details and patient characteristics are summarized in Table 1.

Curve types

Eleven studies included only adolescent idiopathic scoliosis patients [6,8-16,18] (Table 2). Two studies also included a small proportion of neuromuscular scoliosis (8/100 patients in the Gatehouse study [7], and 2/11 in the Yu study) [17].

Although a few studies reported their methods for determining fusion level, this was highly variable and consistent methods were not reported. The number of levels fused was often based on a combination of radiographic analysis and clinical experience.

Surgical techniques

Criteria to perform thoracoscopic instrumentation and fusion included curve magnitude, type, and flexibility. All surgeries were performed in the lateral decubitus position with the convex side of the thoracic curve up. Three to six portals were used to access the spine. Discectomy was performed prior to screw insertion. Autologous bone graft, from the rib or posterior superior iliac spine, was the material of choice for spinal fusion, although femoral head allograft was also used in two studies [7,13]. Most authors used the Eclipse system (Medtronic, Memphis, TN) with vertebral screws and a 4.5-mm rod. Other systems used include MOSS-Miami (Depuy Synthes Spine, Raynham, MA), CD Horizon (Medtronic), and Frontier (Depuy Synthes Spine). Correction was achieved through a combination of compression and cantilever mechanics.

One paper looked at the optimal surgical technique to be employed in thoracoscopic instrumentation [6]. It showed that screw placement using the awl/staple method was associated with lower operative and fluoroscopy times, and lower postoperative incidence of screw pull-out when compared with the guide wire method. Further analysis of the Newton data by Hwan Yoon showed that using a 4.75-mm titanium rod leads to higher maintenance of initial curve correction, and a lower incidence of implant-related complications, when compared to a 4.0-mm stainless-steel rod [19].

Perioperative outcomes

From the 11 studies that reported it [6,7,10,12-17,19], the mean operative time was 371.5 minutes (range 280−876) and the mean estimated blood loss was 502.85 mL (range 267−1,218). Mean hospital stay reported in nine studies [7,8,10-13,16,18] was 5.9 days (range 2.4−11.3)

Radiographic outcomes

The mean preoperative Cobb angle was 52.9° (range 44.5°−60.5°). The mean postoperative Cobb angle was 17.9° (range 6.6°−26.0°). The average reported Cobb angle correction was 62.7% (range 51.0%−81.3%). The average number of levels instrumented was 6.3 (range 5.8−7.8). Sagittal plane parameters were not consistently reported.