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# Video-assisted thoracoscopic treatment of spinal lesions in the thoracolumbar junction

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**Abstract**

*Background:* The endoscopic treatment of spinal lesions in the thoracolumbar junction (T11–L2) poses a great challenge to the surgeon. From November 1, 1995 to December 31, 1996, we successfully used a combination of video-assisted thoracoscopy and conventional spinal instruments to treat 38 patients with anterior spinal lesions. Twelve of them had lesions in the thoracolumbar junction.

*Methods:* The so-called extended manipulating channel method was used to perform vertebral biopsy, discectomy, decompressive corpectomy, interbody fusions, and/or internal fixations in these patients. The size of the thoracoscopic portals was greater than usual in order to allow conventional spinal instruments and a thoracoscope to enter the chest cavity freely and be manipulated by techniques similar to those used in standard open surgical procedures. In this series, the procedures were performed by using either a three-portal approach (2.5–3.5 cm) or a modified two-portal technique involving a 5–6 cm larger incision and a small one for introducing the scope.

*Results:* None of the operations resulted in injury to the great vessels, internal organs, or spinal cord. The total time for the operation ranged from 1.5 to 4.5 h (average, 3); and the total blood loss ranged from 50 to 3000 cc (average, 1050). One patient was converted to an open procedure due to severe pleural adhesion. Complications included two instances of transient intercostal neuralgia, one superfical wound infection, and one residual pneumothorax.

*Conclusions:* The video-assisted technique with the extended manipulating channel method presented in this report simplifies thoracoscopic spinal surgery in the thoracolumbar junction and makes it easier. It avoids division of the diaphragm, removal of the rib, and wide spread of the intercostal space, and it allows greater control of intraoperative vessel bleeding. Using this technique, the number of portals required during the procedure can be reduced. In addition, the technique reduces the endoscopic materials required, thus lowering overall cost. It is an effective and promising approach.

**Key words:** Video-assisted thoracoscopic surgery — Thoracolumbar junction — Spinal lesions

Standard open surgery techniques for spinal lesions in the thoracolumbar junction (T11–L2) usually require division of the diaphragm, resection of the rib, and wide spreading of the surgical wounds. These procedures may result in increased pain, prolonged postoperative rehabilitation, extensive scarring, and longer hospitalization [5, 6, 8, 11].

Endoscopic procedures are widely used in peripheral joints, as well as thoracic, urologic, gynecologic, and general surgery. The use of thoracoscopy to treat spinal lesions is a relatively recent development [7, 8, 12, 13]. Among the variety of video-assisted thoracoscopic spinal procedures that have been reported are biopsy, discectomy, anterior releasing procedures in scoliosis surgery, decompressive corpectomy, interbody fusion, and internal instrumentation [1, 7, 8, 11–13]. However, when this technique is used, many problems and complications can develop due to the limited trocar spaces and lack of suitability of endoscopic instruments [1, 6–8, 12, 13]. Problems are particularly likely to arise when the lesions are located in the thoracolumbar junction. Under one-lung ventilation, the high-riding diaphragm may occlude the lesion site; therefore, additional portals and special endo-equipment are needed to facilitate exposure. As many as four, five, or even more portals are common in these procedures [1, 8, 12, 13].

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**Table 1.** Clinical data for 12 patients with lesions involving the thoracolumbar function (T11–L2)

| Case no. | Sex | Age (yr) | Final diagnosis (level) | Operative procedures[a] | Total operating time (h)[b] | Total blood loss (cc) | Incisions in chest (no.) |
|---|---|---|---|---|---|---|---|
| 1 | F | 40 | Thoracic disc herniation (T11–T12) | 2 | 3.5 | 400 | Lt (3) |
| 2 | M | 73 | Metastatic hepatoma (T11) | Conversion to open | — | — | — |
| 3 | M | 52 | Acute burst fracture (T11) | 3 + 4a + 5 | 4.5 | 1,000 | Lt (3) |
| 4 | M | 75 | Metastatic laryngeal Ca (T12) | 3 + 4b | 2.5 | 1,500 | Rt (3) |
| 5 | F | 66 | Metastatic adenoca, unknown primary (T12) | 3 + 4b + 6 | 3.0 | 650 | Rt (3) |
| 6 | F | 38 | Metastatic breast Ca (T11) | 3 + 4b + 6 | 3.0 | 1,300 | Rt (3) |
| 7 | M | 45 | Metastatic renal cell Ca (T11) | 3[c] | 2.0 | 3,000 | Rt (3) |
| 8 | F | 65 | Metastatic adenoca, unknown primary (T11) | 1 | 1.5 | 50 | Rt (3) |
| 9 | F | 34 | Neglected old burst fracture (L1) | 3 + 4a + 5 + 6 | 4.0 | 1,200 | Lt (2) |
| 10 | M | 64 | Osteoporotic burst fracture | 3 + 4b + 5 | 2.5 | 500 | Lt (2) |
| 11 | M | 24 | Ankylosing spondylitis with discitis (T10–T11) | 3 + 4a + 5 | 3.5 | 450 | Lt (2) |
| 12 | F | 43 | Metastatic adenoca, unknown primary (L1) | 3 + 4c + 5 | 3.5 | 1,500 | Lt (2) |

[a] operative procedures: 1, biopsy; 2, discectomy; 3, corpectomy; 4, interbody fusion: a (autograft), b (allograft), and c (polymethylmethacrylate); 5, anterior instrumentation (Reduction-Fixation fixator system, Trifix, San Leandro, CA, USA); 6, posterior instrumentation (Harrington rodding techniques).
[b] total operating time: not including posterior procedures.
[c] partial corpectomy only.

We report a new approach that uses the so-called extended manipulating channel method [2] to treat spinal lesions located in the thoracolumbar junction endoscopically. This method allows for the use of a combination of video-assisted thoracoscopy and conventional spinal instruments during surgery. The series presented here comprises 12 patients.

## Patients and methods

From November 1, 1995 to December 31, 1996, we used video-assisted thoracoscopic surgery (VATS) to treat 12 patients with anterior spinal lesions in the thoracolumbar junction (T11–L2) (Table 1). There were six women and six men; their ages ranged from 24 to 75 years (average, 52). The patients and their families were informed that an open thoracotomy might be necessary if video-thoracoscopic surgery was not successful.

The location of the pathology in the involved vertebra often determines the approach. In this series, either a right- or left-sided approach was feasible. For lesions involving the L1 body or L1–L2 disc, we prefer a left-sided approach because the aorta is located just left to the midline and more space is available next to the vertebral surface. Using the so-called extended manipulating channel method [2], the number of incisions was usually sufficient using either a three-portal (Fig. 1) or a modified two-portal technique (Fig. 2).

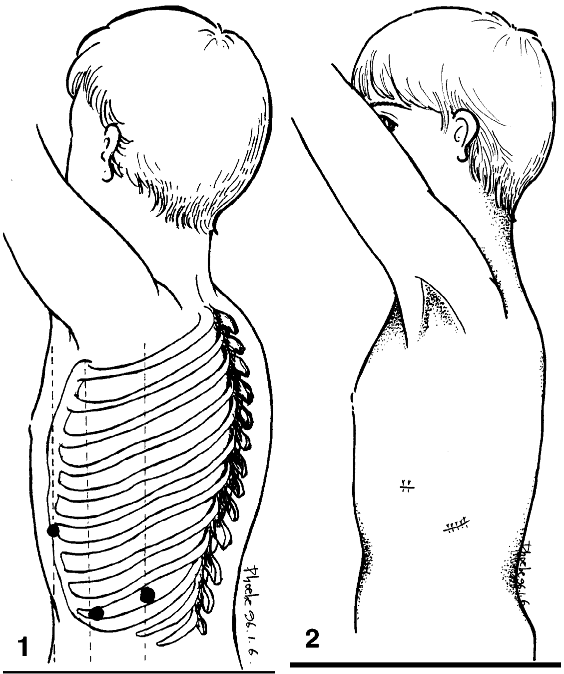


**Fig. 1.** Video-assisted thoracoscopic surgery for spinal lesions in the thoracolumbar junction (T11–L2) using the so-called extended manipulating channel method with a three-portal approach (2.5–3.5-cm incision wounds).

**Fig. 2.** A modified two-portal approach for lesions in the thoracolumbar junction (T11–L2) using an extended manipulating channel measuring 5–6 cm and a small incision (2.5 cm) for introducing the thoracoscope.

### *Case illustration*

A 24-year-old man (case 11) suffered from ankylosing spondylitis of >6 years' duration. Due to severe hip pain and flexion deformity, he underwent bilateral total hip replacements 3 years earlier. He presented to us with progressive mid-back pain of 3 months' duration and urine retention of 1 week's duration. Plain radiographs demonstrated irregular and sclerotic changes at the bony endplates adjacent to the T10–T11 disc space (Fig. 3). The urodynamic study revealed a detrusor hyporeflexia, and the magnetic resonance imaging (MRI) showed a widening and decreased signal intensity of the T10–T11 disc, with mild cord compression at that level (Fig. 4). Prior to the operation, video-assisted thoracoscopic discectomy, interbody fusion, and internal fixation were chosen as the course of treatment.

Under general anesthesia and following intubation with a double-lumen endotracheal tube, the patient was put in the right lateral decubitus position. The operative table was flexed to open the flank region. Skin was draped and prepped for a posterolateral thoracotomy, so that in the event of intraoperative complication or if thoracoscopic surgery was not possible the procedure could be converted. With selective collapse of the left lung, the chest was entered carefully through a stab incision. The initial trocar incision was located at the seventh intercostal space (ICS) along the anterior axillary line. An 11-mm trocar was used to introduce the operating thoracoscope (0°, 10 mm; Stryker, Kalamazoo, MI, USA).

The lesion site was identified and displayed on the video monitor. Then a larger manipulating channel measuring 5–6 cm in length was created under the guidance of the scope; it was made at the level or slightly behind the posterior axillary line at the T9–T10 ICS (Fig. 2). The diaphragm was grasped and pushed down gently with a traditional sponge forceps (9.5″, Foster type; Edward Weck, Research Triangle Park, NC, USA) that had been introduced through the manipulating channel. The lung was also removed from the lesion site with the sponge forceps.


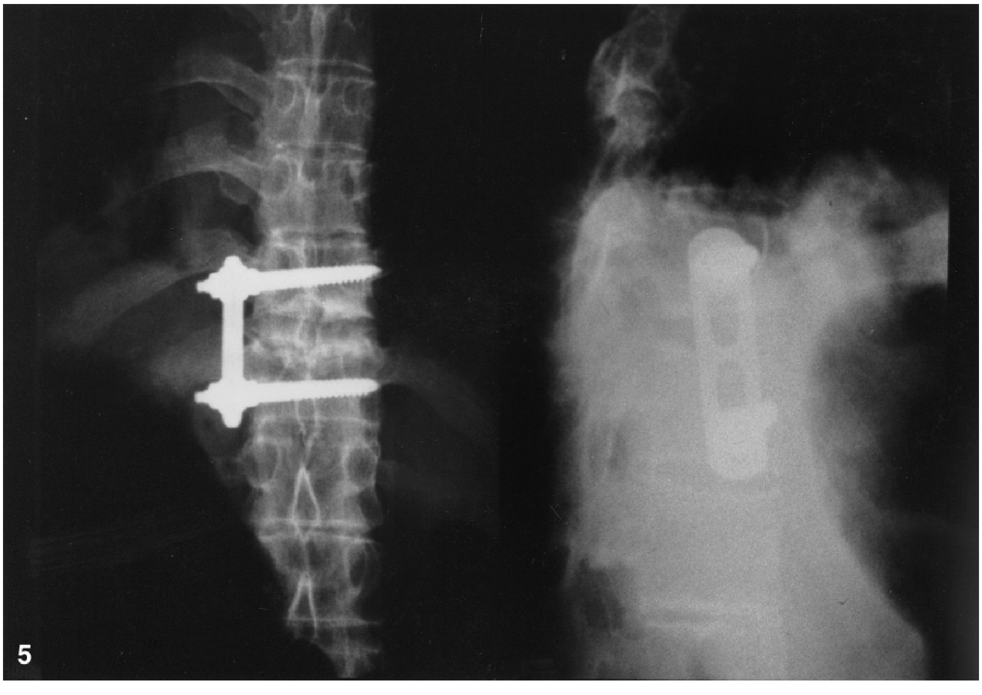

**Fig. 3.** Case 11. A plain antero-posterior radiograph of a 24-year-old man with ankylosing spondylitis and discitis at the level of T10–T11.

**Fig. 4.** Case 11. Magnetic resonance imaging of a 24-year-old man with ankylosing spondylitis and discitis at the level of T10–T11. MRI revealed a widening and decreased signal intensity of the T10–T11 disc and slight cord compression.

**Fig. 5.** Case 11. A 24-year-old man with ankylosing spondylitis and discitis (T10–T11). **A:** Antero-posterior and **B:** lateral radiographs taken after video-assisted thoracoscopic discectomy, interbody fusion with left iliac strut grafting, and internal fixation with the Reduction-Fixation fixator system.

The thoracoscope helped us to identify the lesion and establish its proximity to the aorta. The lesion site was ascertained by a C-arm intensifier. The intercostal arteries and veins were isolated using Debakey right angle forceps (10″; Edward Weck) and ligated with hemoclips. The discectomy at the T10–T11 level was then carefully performed under video monitoring using conventional disc rongeurs (8″; Cushing type; Lawton, Tuttlingen, Germany) and elongated bone curettes (15″; Howmedica, Rutherford, NJ, USA). With selective use of a 0° or 30° thoracoscope, the discectomy was performed posteriorly and down to the epidural space. Through another incision, a $2 \times 2 \times 1.2$ cm$^3$ tricoctical iliac bone graft was harvested from the left iliac crest. The graft was inserted and applied between the 10th and 11th thoracic vertebrae using a conventional bone impactor (12″; Trauma-fix; AST, San Leandro, CA, USA).

After that, a guide pin was introduced through the manipulating channel into the anterolateral aspect of the vertebral body. The direction of the pin was checked by a C-arm intensifier, and a vertebral screw was then inserted with a screw-holding device. The position and depth of the screw were checked again by the C-arm intensifier at the 10th and 11th instrumented vertebrae. A length of titanium plate (Reduction-Fixation fixator system; Trifix, San Leandro, CA, USA) was applied. The sandwich configuration of the two square-shaped washers between the screw and plate allows a variable angle anchorage. Upon completion of the procedure, a nut was loaded and tightened on top of the screw head (Fig. 5). Once hemostasis was assured, a single 32-F chest tube was inserted through the incision site at the anterior axillary line and guided under direct visualization to the apex of the chest. During completion of the procedure, the incision wounds were closed in layers using 3-0 nylon and an interrupted suture. A chest radiograph was taken immediately after the operation to make sure the lung was reinflated. The chest tube was removed on the 3rd postoperative day. The patient wore a protective Taylor-Knight brace for a period of 3 months.

## Results

The total time for the operation ranged from 1.5 to 4.5 h (average, 3); the total blood loss ranged from 50 to 3000 cc (average, 1050). The average number of portals made during the procedures was less than three (Table 1). There were no injuries to great vessels or visceral organs, and no further neurological deterioration was caused by the procedure. One patient (case 2) was converted to an open procedure due to a severe pleural adhesion from a previous hepatectomy procedure. Complications included two cases of transient intercostal neuralgia, one residual pneumothorax after chest tube removal, and one superficial wound infection. One patient (case 7) had massive bleeding (3000 cc) during the operation due to a metastatic renal cell carcinoma, so the procedure was limited to partial corpectomy only. Six patients had their surgery via a right-sided approach; the other six had a left-sided one.

## Discussion

Since its use was first reported for the treatment of a variety of thoracic lesions, VATS has become widespread [5]. Many procedural refinements and improvements in video optics and instrumentation have been developed since the initial report. VATS has only recently been applied in such thoracic spine procedures as biopsy, discectomy, anterior releases in scoliotics, decompressive corpectomy, and internal instrumentations [1, 7, 8, 11–13], so most spine surgeons are still somewhat unfamiliar with the technique. Although in some respects VATS is superior to open thoracotomy [3, 4, 6, 9, 10], it also has some disadvantages. First, the technique requires a learning curve to acquire the hand-eye coordination necessary to perform remote bone and soft-tissue dissection, as well as to establish proper orientation under the angled endoscope [1, 13]. Second, successful one-lung ventilation is required for the operation. The complete assistance of an experienced anesthesiologist is a prerequisite for proper ventilation. Third, high riding of the dome of the diaphragm to the eighth ICS may occur while the lung is collapsed [8]. Therefore, the initial portal for introducing the thoracoscope must be made at the sixth or seventh ICS. Fourth, many spinal lesions, including trauma cases, frequently occur in the thoracolumbar junction (T11–L2). It is far more difficult and a technically demanding to perform endoscopic surgery in this sensitive location.

The traditional trocar method in VATS surgery is time-consuming and fraught with difficulties in manipulating the instruments. Many problems arise due to limited trocar space and a lack of suitable endoscopic equipment. In this series, we used a technique known as the ‘‘extended manipulating channel method.’’ This method allowed us to use a combination of video-assisted thoracoscopy and conventional spinal instruments [2]. Using this approach, the instruments can be passed freely through the channels and manipulated in ways similar to the techniques familiar to surgeons accustomed to standard open procedures.

In the thoracolumbar junction (T11–L2), the endoscopic technique is complicated by the high riding of the dome of the diaphragm. With the VATS approach, the spine can be accessed as far as the T12–L1 disc space. Although endoscopic T12 corpectomy is no more difficult to perform than an open procedure, additional portals are required for the diaphragm’s retraction [8]. Therefore, a total of four, five, or more incisional wounds must be made [1, 8, 13].

Anatomically, the diaphragm originates in three locations: a sternal, a costal, and a vertebral part arise by means of crura and from the arcuate ligaments. The right crus arises from the sides of the bodies of L1–L3; the left crus arises from the sides of L1 and L2 bodies. The medial arcuate ligament extends from the side of L2 body to the tip of the transverse process of the first lumbar vertebra. The lateral arcuate ligament extends from the tip of the transverse process of the L1 vertebra to the lower border of the 12th rib. Therefore, both the crura and arcuate ligaments of the diaphragm are inserted below the T12–L1 disc space. When the lesion is located above the T12–L1 disc, it is usually unnecessary to dissect the diaphragm. However, in lesions below the T12–L1 disc, the spine is surrounded by the diaphragmatic crura, arcuate ligaments, and psoas muscles. This lower location of the lesion may increase technical difficulties for the surgeon when VATS is used and the instruments are manipulated from the diaphragm above the lesion. Regan and Ben-Yisbay recommend a combined thoracoscopic and laparoscopic method to approach lesions below the T12–L1 disc [12]. However, because of the potential hazard of penetration of the peritoneum, this approach requires both the exploration and transection of the diaphragm [12].

In this paper, we have reported the successful use of a combination of video-assisted thoracoscopy and conventional spinal instruments to perform endoscopic spine surgery at the thoracolumbar junction (T11–L2). Our technique decreases the number of portals required for the procedure. Using the ‘‘extended manipulating channel method,’’ we found that either a three-portal or a modified two-portal approach was sufficient. This technique makes thoracoscopic spinal surgery simpler and easier in this region. In most cases, there is no need to transect the diaphragm. For lesions below the T12–L1 disc level, the diaphragm can be detached easily from its lumbar origins, the crura, and the arcuate ligaments following ligation of the segmental vessels. We have no experience with Regan and Ben-Yisbay’s combined laparoscopic method [12]; however, it seems less likely to compromise the surgical objective in our patients. In addition, very few endoscopic materials were required for the procedure, resulting in a reduction of overall costs.

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