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Video-Assisted Thoracoscopic Surgery for Thoracic Vertebral Biopsy

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Abstract: Although video-assisted thoracoscopic surgery (VATS) has been used as a diagnostic procedure for evaluating diseases of the chest cavity and pleura, its role in spinal disorders is still being defined. Within the past few years, important diagnostic and therapeutic applications pertaining to the spine have been recognized. When a computed tomography (CT)-guided needle biopsy is not diagnostic for a vertebral body and/or disk with a lesion of unknown etiology, and the only other alternative in obtaining tissue for diagnosis is via an open thoracotomy, VATS may have a useful role. We report the results and technique of VATS in six patients with various spinal disorders. We believe that the advantages of VATS compared to an open thoracotomy include decreased postoperative pain, improved pulmonary function, a shorter hospital stay, and a faster recovery time. In our series, VATS was diagnostic with a 48-hour inpatient stay in most cases. Although there is a steep learning curve, this technique performed with enhanced illumination and greater magnification has allowed optimal management of multiple diseases of the thoracic spine by the combined team of orthopaedic and thoracic surgeons.

Background

The first thoracoscopy was performed by H.C. Jacobaeus in Stockholm in 1910 using a cystoscope for the division of tuberculous adhesions [6]. Since then, laparoscopy was used extensively in the 1980s to perform cholecystectomies. Patients undergoing this “less invasive” laparoscopic procedure returned to work much more rapidly compared to patients undergoing a cholecystectomy via a minilaparotomy procedure (6.5 days versus 34 days) [14]. Advantages of laparoscopy included a reduction in postoperative pain, hospital stay, and recovery time with a quicker return to work. This success led to the increased interest and use of minimally invasive techniques in the treatment of thoracic disorders. In the early 1990s, video-assisted thoracoscopic surgery (VATS) was used with increasing frequency to treat various pulmonary conditions. This included treating pleural effusions [1] and recurrent spontaneous pneumothoraces [5], obtaining lung biopsies in patients with interstitial lung disease [18] or indeterminate pulmonary nodules [2], and evaluating mediastinal adenopathy [7]. As with the laparoscopic outcomes, the thoracoscopic technique was associated with the same positive findings, with a distinct advantage when compared to an open procedure through a thoracotomy. Because rib resection and/or the spreading of ribs associated with an open thoracotomy procedure is avoided when performing VATS, there is less immediate postoperative incisional pain. There is also a decreased incidence of chronic postthoracotomy pain and less postoperative respiratory difficulties including less chest tube output and less shoulder girdle dysfunction. There is less blood loss, a lower risk of infection from a smaller incision, and a more cosmetically favorable scar from three to four small portal sites [17]. As with laparoscopy, there is a shorter hospital stay, the technique is less costly, recovery time is faster, and patients return to work faster. Complications are rare, with intercostal neuralgia and atelectasis being the most common. There have been great strides in the use of VATS in treating spinal disorders. Obenchain [13] reported the first anterior laparoscopic lumbar diskectomy in 1991. In 1993, Mack et al. [13] initially reported on the application of thoracoscopic techniques in the thoracic spine. They performed VATS on various conditions that included the drainage of spinal abscesses, biopsy of veterbral bodies, diskectomy for a herniated nucleus pulposus, and anterior releases for kyphoscoliosis [10]. More recently, in 1995, McAfee et al. [12] reported good results with the use of VATS in performing thoracic corpectomies for spinal cord decompression. In 1998, Regan et al. [16] reported outcomes on the excision of thoracic disk herniations with a 12 to 24-month follow-up. They found that VATS resulted in a shorter hospitalization, less postoperative narcotic use, and an early recovery time in the treatment of spinal conditions. There was a 75.8% satisfactory outcome with relief of radicular and myelopathic symptoms. They did report a 13.8% complication rate including excessive bleeding, atelectasis, pleural effusions, and diaphragm rupture.

Purpose

Although VATS has been used as a diagnostic and therapeutic procedure for evaluating diseases of the chest cavity and pleura, its role in spinal disorders is still being defined.

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Important diagnostic and therapeutic applications pertaining to the spine have been recognized only within the past few years. When the only other alternative in obtaining tissue for diagnosis is via an open thoracotomy, VATS may have a useful role. This is seen with computed tomography (CT)-guided needle biopsies when lesions are inaccessible or the CT biopsy is not diagnostic. This article reports the results and technique of VATS in six patients who had biopsies performed after failed or deferred CT-guided biopsy attempts. Several cases are presented. We believe that the advantages of VATS compared to an open thoracotomy include less severe postoperative pain, improved pulmonary function, a shorter hospital stay, and a faster recovery time. In our series, VATS was diagnostic with a 48-hour inpatient stay in most cases. We have found that this technique, with enhanced illumination and greater magnification, has allowed a combined team of an orthopaedic and a thoracic surgeon to optimally manage multiple diseases of the thoracic spine.

Technique

VATS on the spine should be performed in a standard operating room. Some modifications for spinal procedures are needed from the standard thoracoscopic setup. After double-lumen endotracheal tube placement, the patient is positioned in the lateral decubitus position and secured. The lower extremities are gently flexed away. The operating table should be capable of Trendelenburg or reverse Trendelenburg positions in order to allow the deflated lung to fall away from the spine to increase visualization and decrease inadvertent injury during the procedure. The patient is prepped and draped for a standard posterolateral thoracotomy. In cases involving the upper thoracic spine, the up arm is flexed above 90 degrees and the entire axilla is included in the prep.

Both the orthopaedic and thoracic surgeons stand on the same side of the patient, the abdominal side, across from the video monitor. The third assistant, if necessary, stands on the back side of the patient and faces an opposing second monitor. The thoracic surgeon usually obtains and holds the exposure, the orthopaedic surgeon controls the orthopaedic instruments with both hands, and the third assistant may hold the camera and/or retract the lung [15].

Equipment includes the usual setup for a standard thoracoscopic procedure. This includes telescopes, cameras, illumination sources, monitors, insufflators, trocars, vascular clipping devices, graspers, retractors, bipolar electric cauteries, and various other pieces of equipment. The 30-degree angled telescope is used almost exclusively for spinal procedures. It allows safe passage of an instrument behind a structure at various angles with proper visualization [15] (Fig. 1a–d).

Three or four portals are used. After the lung is collapsed, the initial portal incision is placed blindly in the sixth or seventh intercostal space along the anterior axillary line. Therefore, prior to trocar placement, digital palpation of the incision site is performed to detect any pleural adhesions in order to avoid inadvertent lung injury. The 30-degree scope is placed and the remaining portals are introduced under monitored visualization. Additional portals are placed along the anterior axillary line as the working portals and one along the posterior axillary line for insertion of a lung fan retractor if needed (Fig. 2). A cross table anteroposterior radiograph is taken to confirm the correct level after counting the ribs endoscopically and placing a Verees or 10-in. spinal needle into the appropriate disk space. Following radiographic confirmation, several adequate biopsies are retrieved, proper hemostasis is obtained, and a chest tube is placed at the conclusion of the case (Fig. 3). On postoperative day (POD) 1, the chest tube is removed, the patient controlled intravenous analgesia (PCA) is changed to oral pain medications, and the patient is discharged home within 48 hours in most cases.

Results

Six patients underwent thoracic spine biopsy by VATS. All biopsies were diagnostic (Table 1). The mean operative time was 135 minutes (range 105–170 minutes). The mean estimated blood loss was 250 cc (range, 100–400 cc), excluding patient AK. Patient AK had a blood loss of approximately 1,200 cc due to bleeding from a segmental vein in a paravertebral soft tissue mass. The bleeding was difficult to control and the decision was made to convert this procedure to an open thoracotomy. Patient AK retained his chest tube until POD 4. In the same 48-hour hospital stay, he had a

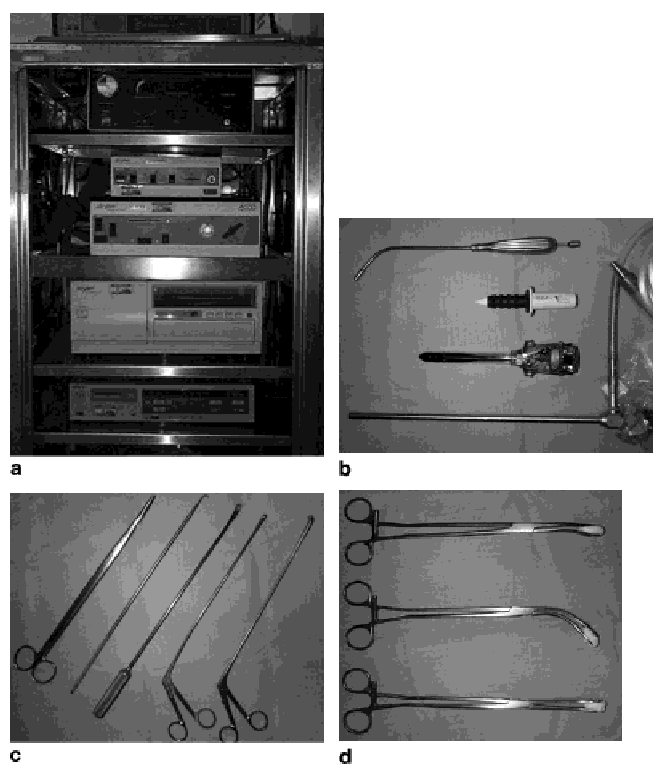

Fig. 1. a: Thoracoscopic equipment from top to bottom: insufflator, power source for motorized shaver and burr, fiberoptic light source, digital printer, and video input unit. **b:** 30-degree thoracoscopic telescope, trocars, and extra long suction tip. **c:** Standard thoracoscopic instruments. **d:** Long-angled sponge sticks used for blunt dissection.

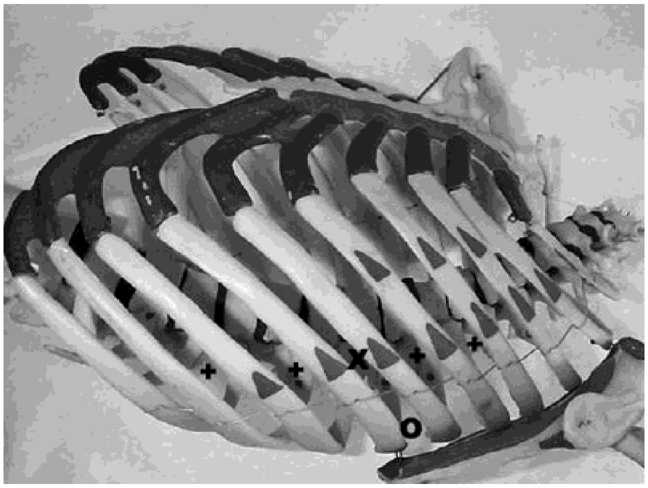

Fig. 2. X, primary portal located at sixth intercostal space along the anterior axillary line, (+), accessory working portals located along anterior axillary line, (O), posterior portal located along the posterior axillary line.

two-level corpectomy with fusion anteriorly and segmental instrumentation with fusion posteriorly as the definitive management. For the remainder of the patients, the chest tube was removed POD 1. Four of six patients were discharged from the hospital on POD 2. Patient AK had the hospital course described above and patient FL stayed one additional day to receive a central intravenous line (PICC line) for home antibiotic therapy. FL was discharged POD 3. All but one patient (AK) was converted from intravenous PCA to oral narcotics by POD 1.

Example cases

Case 1

A 40-year-old man presented to his primary care physician with approximately 3 months of midthoracic spine pain. He had no history of trauma and no past history of back pain. Review of systems revealed no constitutional signs or symptoms and no neurologic abnormalities. Past medical history was significant only for a seizure disorder, controlled with cabamazepine.

1. Laboratory studies: white blood cell count (WBC), 7.3; erythocyte sedimentation rate (ESR), 60; C-reactive protein (CRP), 16; electrolytes, normal.
2. Imaging studies (x-rays and magnetic resonance imaging [MRI]): T5-6 lesion.
3. CT-guided biopsy: nondiagnostic.
4. VATS biopsy result: *Staphylococcus aureus*.

The patient was treated with six weeks of the appropriate antibiotic therapy.

Case 2

A 74-year-old man presented to his primary care physician with approximately 4 months of upper back and right shoulder pain. He had no history of trauma or past history of back pain. He had no fevers, chills, or neurologic signs or symptoms. He did lose 10 lb over the past six months in spite of a normal appetite. His past medical history was significant for high blood pressure for 20 years (controlled with medication), a history of tobacco use for 20 years, although he had quit about 30 years prior, and a history of significant asbestos exposure.

1. Laboratory studies: WBC, 8.0; ESR, 21; electrolytes, normal.
2. PPD: negative.
3. Imaging studies (x-ray and CAT scan): lytic lesion at T3. The lesion was believed to be inaccessible by the interventional radiologist.
4. VATS biopsy result: metastatic, poorly differentiated adenocarcinoma.

The patient was then referred for the appropriate work-up.

Discussion

For more than 50 years, thoracoscopic procedures have been used to diagnose and treat pulmonary pathology. However, the application of these techniques to diagnose and treat spine pathology is relatively new. The utility of thoracoscopy was greatly enhanced in 1990 by the addition of video to standard endoscopic equipment. Initially used for drainage of a vertebral abscess as reported by Mack et al. in 1992, VATS has been quickly applied to a variety of spinal procedures, including biopsy, diskectomy, anterior spinal release, corpectomy, thoracoplasty, and instrumentation [9,10].

Mack et al. [10] were the first to report the use of thoracoscopy to treat diseases of the spine. They performed thoracoscopy on a total of ten patients. Three underwent anterior release with diskectomy with one thoracoplasty, three underwent diskectomy for herniated nucleus pulposus, two had a biopsy for a collapsed vertebral body, one had a disk space abscess drained, and one underwent a disk space fusion. Since this initial report, there have been several others reporting a variety of applications of thoracoscopy to treat pathology of the spine [3,11,16]. Although many of the

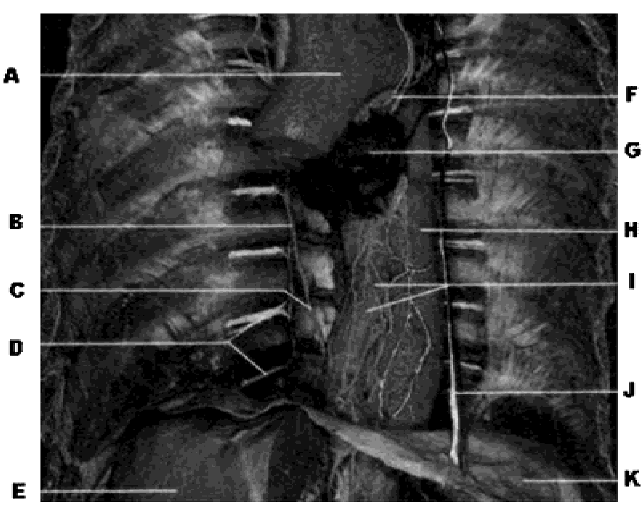

Fig. 3. (A) aortic arch, (B) intervertebral disk, (C) vertebral body, (D) segmental neurovascular bundle, (E) liver, (F) left recurrent laryngeal nerve, (G) superior vena cava, (H) thoracic aorta, (I) esophagus, (J) left phrenic nerve, (K) diaphragm.

techniques, indications, and procedures are still being defined, diagnostic and therapeutic biopsy for spinal lesions is considered a relatively straightforward indication for VATS, as in the cases presented in this article [17].

As with the introduction of any new surgical procedure, it is prudent to compare the new procedure to already proven procedures. Several authors have compared VATS to open thoracotomy and thoracoscopic approaches have been reported to have certain advantages over thoracotomy. These include enhanced visualization, less blood loss, decreased chest tube drainage, less severe postoperative pain, shortened stay in the intensive care unit, better postoperative ventilatory status, improved rehabilitation and shoulder girdle function, shorter hospital stay, and less expensive cost [8,16]. These advantages, however, have not been uniformly reported [4]. In addition to these potential advantages, there are several potential disadvantages. This procedure is extremely technical, requiring a high level of practice and skill, and often requires a thoracic surgeon to perform the procedure. Additionally, because this is a relatively new application of endoscopic technology, design and production of equipment and implants specifically for thoracoscopic spine surgery have yet to develop fully.

Although the literature seems to support the use of VATS in patients with the appropriate indications, this procedure is not without complications. Certainly, using a thoracoscopic approach to the spine for diagnostic biopsy poses fewer inherent risks than therapeutic interventions such as diskectomy, corpectomy, or instrumentation. Nevertheless, the surgeon must be aware of potential complications and be prepared to respond appropriately should a complication arise. Thoracoscopic spine surgery carries all the risks of open surgery including lung tissue trauma, alterations in respiratory function, dural tear, pneumothorax, spinal cord injury, and incisional pain [3]. There also may be complications unique to thoracoscopy, such as bleeding, which is difficult to control, necessitating emergent conversion to an open procedure. Additionally, difficulty may be encountered when operating on a thorax that has been scarred by previous procedures, making it difficult to maneuver the instruments. The most common complications with VATS reported by Mack et al. included intercostal neuralgia, atelectasis, and excessive hemorrhage defined as greater than 2,500 cc of blood loss.

The purpose of this article is to describe our technique and experience with six patients who underwent VATS. The indication for all of these patients was diagnostic biopsy alone. This is considered a straightforward indication for the application of VATS to the spine [16]. The patient setup, technique, and instrumentation are all similar to previously

Table 1. Summary of pertinent information

Patient	Age	Indication	Biopsy results	Adverse events	Hospital course	Length of stay
SB	35F	History of lymphoma and XRT Back pain MRI lesion at T9-10	Reactive changes due to radiation or trauma	None	CT and PCA discontinued on POD 1	Discharged POD 2
FL	40M	History of back pain x-ray/MRI lesion at T5-6 CAT scan-guided biopsy nondiagnostic	Osteomyelitis diskitis	None	CT and PCA discontinued on POD 1	Discharged POD 3
CA	47M	Midback pain x-ray/MRI lesion T9-10 Not accessible to CAT scan-guided biopsy	Osteomyelitis	None	CT and PCA discontinued on POD 1	Discharged POD 2
AK†	63M	Back pain x-ray/MRI lesion T9 CAT scan-guided biopsy inconclusive	Osteomyelitis	See text	Extended course to undergo definitive surgical procedure	Discharged POD 19
MP	67F	History of breast cancer Surveillance bone scan showed ↑ uptake T9 Not accessible to CAT scan-guided biopsy	Metastatic adenocarcinoma	None	CT and PCA discontinued on POD 1	Discharged POD 2
MV	74M	Upper back and shoulder pain x-ray/CAT scan lesion T3 CAT scan-guided biopsy nondiagnostic	Metastatic adenocarcinoma	None	CT and PCA discontinued on POS 1	Discharged POD 2

*XRT, radiation therapy; MRI, magnetic resonance image; CT, chest tube; PCA, patient-controlled analgesia; POD, postoperative day; CAT, computer-assisted tomography.
†See text for details.

published reports. The intraoperative experience of these cases, including operative time and estimated blood loss, compares favorably with data in the literature [11,16]. Additionally, the postoperative course of these patients, including chest tube removal, conversion to oral narcotics, and the length of hospital stay, also compares favorably with current reports [11,16].

Summary

In our experience, the use of VATS for the purpose of obtaining a diagnostic biopsy of the spine is an appropriate indication. We believe that performing the procedure as described, with the assistance of a thoracic surgeon, is a safe procedure, with the potential benefits outweighing the potential risks. However, before thoracoscopic surgery can be performed safely, the surgeon must be skilled in endoscopic techniques and should have ample practice, for example, in the cadaveric lab and/or with laboratory simulated surgery. Although biopsy is considered a straightforward indication for the application of VATS to the spine, indications and techniques for treating the spine thoracoscopically continue to evolve. The application of VATS to treat spinal pathology is likely to continue to advance as more surgeons become familiar and experienced in the technique, and as the technology improves and better instruments are developed.

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