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Multilevel anterior thoracic discectomies and anterior interbody fusion by using a microsurgical thoracoscopic approach

Case report

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A video-assisted thoracoscopic microsurgical approach was performed to treat a myelopathic patient with a severe kyphotic deformity caused by chronic nonunion of compression fractures of T7-9 vertebrae. The kyphotic deformity was treated by combined operative procedures. First, an anterior release was performed using a thoracoscopic technique, sectioning the anterior longitudinal ligament and performing multilevel thoracic discectomies. Next, a posterior reduction and internal fixation of the deformity was achieved using hook-rod instrumentation. Finally, bone graft harvested during the posterior approach was used for interbody fusion via a thoracoscopic approach.

Microsurgical thoracoscopic techniques potentially can be used in a variety of spinal surgeries. Compared to transthoracic and posterolateral approaches, this technique presents distinct advantages to treatment of anterior spinal pathology. The small incisions made into the intercostal spaces without retracting the ribs may reduce postoperative pain, shorten the length of hospitalization, and allow early return to activity.

The operative techniques used in this case are described in detail. This report demonstrates that thoracoscopic discectomies and interbody fusion are technically feasible and can be effectively performed with acceptable results.

Key Words * video-assisted thoracoscopic surgery * thoracic discectomy * thoracic spinal fractures * thoracoscopy * spinal endoscopy * spinal deformity * intracerebral disc herniation * thoracic spinal fusion

Video-assisted thoracoscopic surgery has been used by cardiothoracic surgeons to treat a variety of pathological lesions involving the thorax.[1,3-6] Several recent reports have focused on the feasibility of performing thoracic discectomies using a microsurgical thoracoscopic approach.[2,8] Microsurgical thoracoscopic approaches for spinal surgery have potential advantages for treatment of several types of pathology involving the ventral thoracic spine. In this report we describe a patient with a chronic

kyphotic deformity who was treated with an anterior release, posterior reduction and fixation, and anterior interbody fusion. The anterior surgical procedures were performed using microsurgical endoscopic techniques.

CASE REPORT

Case History. This 14-year-old girl developed a subacute myelopathy from a progressive kyphotic deformity. Initially, she had sustained compression fractures of T7-9 vertebrae without neurological injury during an automobile accident. She was treated surgically with open reduction and internal fixation using a posterior approach with universal hook-rod instrumentation. The patient was thin and the hardware was prominent beneath the subcutaneous tissues. Three weeks postoperatively she presented to our institution with an acute wound infection with an extensive purulent collection involving the hardware and bone graft. The *Staphylococcus aureus* infection was treated with wound debridement, removal of the hardware, and intravenous antibiotic medications. A custom-fitted thoracolumbosacral orthosis was applied and the patient was allowed to ambulate. Postoperatively, she remained neurologically intact. The infection resolved completely after a 6-week course of intravenous antibiotic drugs.

After removing the hardware, the patient's kyphotic deformity immediately increased from 15° to 25° and remained stable for 6 months while she wore the orthosis. During the next 6 months, she gradually developed a progressively worsening kyphosis. One year after treatment of the infection, the kyphosis had progressed to 70° (Fig. 1) and was accompanied clinically by a new onset of a myelopathy.

Fig. 1. Lateral radiograph of the thoracic spine demonstrating the 70° kyphotic deformity. There were compression fractures of T7-9.

The patient was also cosmetically disfigured, appearing severely hunchbacked. She developed hypesthesia, dorsal column dysfunction, a mild paraparesis (four-fifths), hyperreflexia, spasticity, clonus, and Babinski's signs. Magnetic resonance imaging demonstrated no retropulsed bone fragments from the fractured vertebrae; however, the spinal cord was draped over the acute kyphotic deformity. The spinal cord was stretched and tethered against the apex of the bone defect (Fig. 2). Operative treatment was advised to treat the myelopathy and to reduce the spinal deformity.

Fig. 2. Magnetic resonance image demonstrating that the spinal cord was stretched and draped over the apex of the kyphosis. No retropulsed bone fragments compressed the spinal cord.

Operative Approaches. A team approach was used joining a neurosurgeon and a cardiothoracic surgeon who was experienced in video-assisted thoracoscopy. A double-lumen endotracheal tube was used to deflate one lung temporarily during the operation. The patient was positioned in a left lateral decubitus position. An incision was marked for a thoracotomy in case open access was needed.

Four separate skin incisions (1-2 cm in length) were made in the right thorax along the anterior and middle axillary lines in separate (fifth, seventh, ninth, and 10th) intercostal spaces. Four endoscopic portals (one rigid and three flexible) were inserted through the intercostal spaces into the thoracic cavity. A 30°-angled, 1-cm diameter, rigid rod-lens endoscope was used for illumination and magnification and to visualize the contents of the thoracic cavity and mediastinum. The endoscope was inserted through the first portal, which was placed in the seventh intercostal space. The insertion of the subsequent portals was directly visualized with the endoscope. Four portals were inserted to allow simultaneous access for the thoracoscope, retractors, suction and irrigation, drills, curettes, and other dissection tools. The portals were inserted over the superior surface of each rib to avoid the neurovascular bundle. An endoscopic fan

retractor was inserted to gently draw back the lung medially to expose the vertebral column. The second rib was located as the most cephalad identifiable visual landmark, and the ribs were sequentially counted caudally to provide correct anatomical localization. A spinal needle was inserted through the skin into the T7-8 disc space to allow exact radiographic confirmation of the level of pathology. After radiographic identification of the levels of pathology, the spine was exposed by dissecting the parietal pleura from the surfaces of T-7, T-8, and T-9.

The exposure and spinal dissection were performed with long, narrow endoscopic tools. The parietal pleura was elevated using a forceps and sharply dissected from the surfaces of the vertebrae and ribs of the T7-9 levels. Sharp microdissection was performed using curved endoscopic microscissors. The segmental vessels were identified over the midbodies of the involved vertebrae. The arteries and veins were isolated using a right-angle clamp. A right-angle endoscopic hemoclip applier was used to ligate the vessels, which were divided sharply with scissors (Fig. 3).

Fig. 3. Schematic drawing (left) and photograph (right) displaying the endoscopic operative view. (Within both drawing and photograph the superior aspect can be seen to the right, inferior to the left, posterior and lateral to the top, and anterior, medial to the bottom.) The segmental arteries and veins were mobilized and ligated with hemostatic clips. The T-8 vessels were held by endoscopic Debakey forceps. The T-7 vessels were already divided.

The rib heads were resected to expose the pedicles, neural foramen, and disc spaces. The proximal 2 cm of the eighth and ninth ribs were removed to allow discectomies at the levels of T7-8 and T8-9. The rib dissection and discectomies were performed using customized long-handled spinal instruments. Periosteal elevators and curettes were used circumferentially to free the muscular attachments from the ribs. The neurovascular bundles were dissected carefully from the inferior margins of the ribs to avoid bleeding and nerve root injury. A drill (Midas Rex, Fort Worth, TX) with a 25-cm long (R8) attachment was used to cut a channel in each rib just distal to the costotransverse articulation (Fig. 4 upper left and upper right). A pistol grip was attached to the drill handle to allow precise control of the drill. An osteotome was used to transect the rib fully. The ribs were then detached by sectioning the costotransverse and costovertebral ligaments (Fig. 4 lower left and lower right).

Fig. 4. Schematic drawing (upper left and lower left) and operative photographs (upper right and lower right) showing how the rib attachments were sectioned. Upper Left and Right: The ribs were cut distal to the costotransverse articulation with a high-speed drill. Lower Left and Right: The costovertebral articulation was detached by transecting the costovertebral ligaments with a periosteal elevator. The rib head and the proximal 3 cm of rib were removed en bloc.

Curettes and periosteal elevators were used to divide the ligaments attaching the ribs to the spine. Removing the ribs allowed the pedicles, neural foramen, and disc spaces to be identified clearly. Discectomies were performed by incising the annulus and removing the disc material (Fig. 5). The discs were removed using pituitary and Kerrison rongeurs. The anterior longitudinal ligament was sectioned at each level. After the anterior release was completed, a chest tube was inserted. The positioning of the chest tube was visualized directly with the thoracoscope. The portals were removed and the intercostal incisions were closed with sutures; the right lung was reexpanded. The thoracoscopic anterior release took 3 hours to perform and there was a blood loss of 100 cc.

Fig. 5. Schematic drawing (left) and operative photograph (right) showing a discectomy defect after removing the nucleus and sectioning the anterior longitudinal ligament. The pleura and azygos vein are visualized in the bottom of the photograph.

The reduction and internal fixation were performed next using a posterior midline approach. The patient was placed prone on the operating table and a separate sterile operative procedure was performed. The patient's previous midline posterior thoracic incision was reopened and the vertebral column was exposed. Osteotomies were performed and the T7-8 and T8-9 facets were resected. Universal hook-rod instrumentation was applied. The instrumentation and fusion extended from T-4 through T-12. Reduction was achieved by contouring the rods, using manual reduction and in situ rod benders. A 40° reduction in the kyphosis was achieved (from 70° to 30°). Autologous iliac crest bone was used for a posterolateral fusion. Separate bone grafts were kept sterile for use in the anterior interbody fusion.

After the posterior procedure was completed, an anterior approach was performed for interbody fusion. The patient was positioned in a left lateral decubitus position and a separate sterile procedure was performed. The chest tube was removed and thoracoscopic portals were reinserted through the previous intercostal incisions. The right lung was deflated to allow access to the discectomy sites. The endoscope and fan retractor were reinserted. A drill (Midas Rex) with an R33 drill bit was used to remove the endplates at the T7-8 and T8-9 interspaces. Autologous blocks of bone graft were inserted into the interspaces (Fig. 6).

Fig. 6. Schematic drawings (upper left and lower left) and operative photographs (upper right and lower right). Upper Left and Right: Bone grafts were placed into the discectomy defects after the vertebral endplates were decorticated with a drill. Lower Left and Right: The bone grafts were compressed into the interspaces with a bone-graft impactor.

The bone grafts were sized so that they would be compressed between the vertebrae and provide a substrate for interbody fusion. The chest tube was reinserted through one of the existing portal incisions. The thoracic cavity was inspected, the portals were removed, and the incisions were closed. The amplitude and latency of the patient's somatosensory evoked potentials improved immediately after reduction of the deformity. This improvement was sustained postoperatively.

Postoperative Course. Postoperatively, the patient's leg strength and sensation improved progressively. She had mild pain at the sites of the thoracic incisions and moderate postoperative pain from the posterior incisions. There were no postoperative complications. The chest tube was removed on the 3rd postoperative day after a moderate amount of serous chest tube drainage ceased. There was no postoperative air leak from the lung. The patient was discharged from the hospital on the 5th postoperative day. At the time of discharge she was ambulating independently, had minimal discomfort at the site of the chest incisions, and had a normal chest x-ray film. She recovered normal motor function and had mild persistent hyperreflexia, but her spasticity disappeared. Nine-month postoperative radiographs showed that the reduction was maintained at 32° and that an osseous union had developed

(Fig. 7).

Fig. 7. Postoperative lateral thoracic radiograph demonstrating the hook-rod instrumentation and the reduction to a 30° kyphosis. The deformity was reduced by 40°.

DISCUSSION

Minimally invasive surgery has revolutionized many surgical specialties and has been used for a variety of surgical procedures. Video-assisted thoracoscopic surgery can be used for a wide variety of thoracic, mediastinal, and lung lesions.[1,3-7]

Video-assisted thoracoscopic approaches for the spine have the potential to be used to treat thoracic disc herniations, perform sympathectomies, biopsy thoracic vertebral body lesions, to perform vertebrectomies, resect tumors, decompress fractures, and release the anterior spinal ligaments for reduction of deformities. This technique also may be used for placement of bone grafts for interbody fusion, reconstruction of vertebral defects, and, potentially, internal fixation procedures.

Spinal endoscopic-assisted surgical techniques are relatively new and require that surgeons have both laboratory and clinical experience to develop the skills necessary to perform the operations. Standard spinal surgical tools also must be modified to perform spinal surgery using these techniques. The working distance from the chest wall to the surface of the spine ranges from 14 to 26 cm using the thoracoscopic approach.[2,7,8]

There are several potential advantages of thoracoscopic spinal surgery compared to open thoracotomy and to posterolateral approaches for treatment of thoracic vertebral body or disc lesions. The incisions are small and the ribs are not widely retracted. Postoperative pain is therefore reduced. Patient comfort,

recovery time, and cosmetic results may be improved. Potential disadvantages of thoracoscopy may include long operating times, inability to perform one-lung ventilation in patients with severe pulmonary pathology, restricted access to the spine, and the need to use long instruments that may hinder surgical control. Postoperative intercostal neuralgia is also a risk if the intercostal nerves are contused intraoperatively.

In this case report we demonstrate the feasibility of thoracoscopy for anterior thoracic spinal pathology; however, more detailed clinical studies need to be performed to ensure that this technique adds significantly to our surgical capabilities for anterior thoracic spinal pathology.

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