The Incidence of Complications in Endoscopic Anterior Thoracolumbar Spinal Reconstructive Surgery
A Prospective Multicenter Study Comprising the First 100 Consecutive Cases

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Study Design. A prospective multicenter study on 100 consecutive surgical procedures.

Objectives. A prospective multicenter study was performed to evaluate the early perioperative complications in 100 endoscopic spinal procedures—78 video-assisted thoracic surgical procedures and 22 laparoscopic lumbar instrumentation and fusion procedures.

Summary of Background Data. Endoscopic procedures have been widely applied in general surgery for appendectomy, cholecystectomy, liver resection, Nissen fundoplication, colon resection, and hernia repairs. Video-assisted thoracic surgery is widely used for pleural biopsy, lung resection, and sympathectomy. This is the first large series to date investigating the safety and potential complications using endoscopic surgery for anterior decompression or fusion of the thoracolumbar spine.

Methods. Video-assisted thoracic surgical procedures included multilevel anterior thoracic releases for deformity, 27 patients; anterior thoracic discectomies with spinal canal decompression, 41 patients; pyogenic vertebral osteomyelitis decompression, 2 patients; and vertebral corpectomy for neurologic decompression, 8 patients. Mean operative time was 2 hours, 34 minutes (range, 45 minutes to 6 hours), and mean length of stay was 4.97 days (range, 2–21 days).

Anterior laparoscopic interbody stabilization and fusion at L4–5 or L5–S1 was performed in 22 patients. The mean operative time was 4 hours, 17 minutes (range, 2 hours, 40 minutes to 9 hours), and the mean length of stay was 5.6 days (range, 1–23 days).

Results. The most common video-assisted thoracic surgical complications were transient intercostal neuralgia (six patients) and atelectasis (five patients). The most common laparoscopic complication was bone graft donor site infection (two patients). There were two endoscopic cases that were converted to open procedures, one for extensive pleural adhesions and one for a common iliac vein laceration.

Conclusions. The endoscopic spinal approaches proved to be safe operative procedures in 100 consecutive cases. There were no permanent iatrogenic neurologic injuries and no deep spinal infections. [Key words: endoscopy, laparoscopy, thoracoscopy, VATS] Spine 1995;20:1624–1632.

The goal of this preliminary study is to analyze the perioperative early complications of endoscopic surgery to evaluate the feasibility of VATS and laparoscopic surgical approaches. It is not the intent or goal of this study to evaluate the incidence of obtaining an endoscopic spinal fusion or to evaluate postoperative instability because that requires 2 years or more follow-up time. The present study is an article concerning complications, not an outcome study of an intervention.

Materials and Methods

This prospective multicenter study performed from 1990 to 1994 evaluates the early perioperative complications in the first 100 consecutive patients undergoing endoscopic spinal reconstructive procedures—78 video-assisted thoracic surgical (VATS) procedures from T3 to T12 and 22 laparoscopic lumbar instrumentation and fusion procedures. The VATS procedures were performed at one of three institutions—The Scoliosis and Spine Center of Baltimore, Maryland, 20 patients; The Department of Orthopaedic Surgery, Kaiser Permanente, Sacramento, California, 20 patients; and The Texas Back Institute, Dallas, Texas, 38 patients. There were 22 laparoscopic-assisted lumbar fusion instrumentation procedures performed at one of four institutions—Scoliosis and Spine Center,
Table 1. Endoscopic Spinal Reconstructive Procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic discectomies</td>
<td>41</td>
</tr>
<tr>
<td>Multilevel anterior discectomy for correction of scoliosis</td>
<td>20</td>
</tr>
<tr>
<td>Anterior release for kyphosis</td>
<td>4</td>
</tr>
<tr>
<td>Excision of hemivertebrae</td>
<td>3</td>
</tr>
<tr>
<td>Vertebral corpectomy for neurologic decompression</td>
<td>6</td>
</tr>
<tr>
<td>Pyogenic vertebral osteomyelitis decompressions</td>
<td>2</td>
</tr>
<tr>
<td>VATS total</td>
<td>78</td>
</tr>
<tr>
<td>Anterior interbody stabilization and fusion—L4-5 and L5-S1</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

VATS = video-assisted thoracic surgery.

Baltimore, Maryland; Spine Center, San Francisco, California; Department of Orthopaedic Surgery, University of Wisconsin, Madison, Wisconsin; and Mona Kea Medical Park, Chicago, Illinois.

The distribution of endoscopic procedures is listed in Table 1. The most common surgical procedure was a VATS for thoracic discectomy and spinal canal decompression, 41 patients. There were three major types of anterior procedures for release of deformities: anterior multiple level discectomies (usually six levels), 20 patients; anterior release for kyphosis, four patients; and anterior resection of a thoracic hemivertebral, three patients. There were eight patients with fractures or tumors causing incomplete neurologic deficit who underwent anterior thoracic corpectomy and spinal cord decompression (Figure 1). Lastly, two patients underwent anterior decompression of pyogenic vertebral osteomyelitis.

The 22 laparoscopic procedures reported in this study comprised the first cases enlisted in the laparoscopic Bagby and Kuslich (BAK) protocol for the Investigational Device Exemption (IDE Study) filed with the United States Food and Drug Administration.4

To date, the BAK device is an investigational device and is approved for IDE in several medical centers for anterior laparoscopic insertion into the L4—5 and L5—S1 intervertebral disc spaces. There is a very strict protocol with specific indications, namely degenerative disc disease with neuroforaminal narrowing and radiculopathy. Radiographic criteria are concordant pain reproduction on discography and an abnormal magnetic resonance imaging. For inclusion into the BAK laparoscopic study, the patient needs to fit a particular psychologic profile, must not have had a previously attempted lumbar fusion, must not be a cigarette smoker, and needs to have internal disc disruption and collapse at either L4—5 or L5—S1.

The range in ages for the major groups of thoracoscopic and laparoscopic procedures followed the same trends as for their corresponding open procedures. The patients undergoing anterior release for scoliosis or kyphosis were the youngest, mean = 19.0 years (range, 2—44 years). The thoracoscopic discectomy patients were the next to youngest age group, mean = 41.4 years (range, 22—84 years). The patients undergoing corpectomy were older because six were performed for metastatic lesions causing incomplete neurologic deficits, mean = 51.9 years (range, 28—84 years). The patients undergoing laparoscopic lumbar procedures had a mean age of 40.6 years (range, 28—84 years).

In general, the indications for anterior thoracoscopic or laparoscopic surgery were identical to the analogous open thoracotomy or laparotomy spinal procedure. The only relative contraindications for anterior endoscopic surgery are multiple previous surgical procedures or empyema causing such extensive adhesions that portal placement cannot be accomplished with good visualization. Additionally, anterior instrumentation for thoracic stabilization has not been developed as yet for endoscopic applications. Cases with fractures or tu-

Figure 1. A right-sided VATS T7 corpectomy is shown. (A) The right T7 nerve root and the anterior aspect of the thecal sac are visualized after T7 VATS corpectomy. Cephalad is to the right and caudad is to the left. (B) The corresponding intraoperative view through a 30° thoracoscope is pictured. The anterior aspect of the spinal canal is well visualized as is an epidural plexus of veins anterior to the dural sac.
mors with 3-column spinal instability were not decompressed endoscopically. In our institutions, we have virtually supplanted thoracotomies and laparotomies with endoscopic procedures aside from cases requiring anterior instrumentation cases, such as anterior Texas Scottish Rite instrumentation for thoracolumbar scoliosis.

**Results**

**Video-Assisted Thoracic Surgery**

The planned procedure was accomplished in all but one patient, who required conversion to an open procedure because of scarring from a previous costotransversectomy (Table 2). The mean operative time was 2 hours, 34 minutes, (range, 45 minutes to 6 hours). The average chest tube duration was 1.44 days (range, 0–3 days). Forty-one of 78 (52.5%) patients were monitored in an intensive care unit (ICU) setting for the first night after surgery. There was an obvious institutional bias in this factor because in Baltimore the recovery room and the intensive care unit are a combined postoperative facility. When this factor is discounted, the normalized incidence of postoperative ICU use was 19 of 58 (32.8%) patients undergoing VATS. The mean postoperative length of stay was 4.97 days (range, 2–21 days).

**Laparoscopic Lumbar Interbody Fusion and Stabilization**

The mean operative time was 4 hours, 17 minutes (range, 2 hours 40 minutes to 9 hours). The mean length of stay was 5.6 days (range, 1–23 days).

**Intraoperative Estimated Blood Loss**

The operative estimated blood loss was specific to the type of spinal procedure listed in Table 3. The anterior thoracic releases for deformity had a mean intraoperative blood loss of 94 cc (range, negligible to 300 cc). Thoracic discectomy and spinal canal decompression had a mean estimated blood loss of 400 cc (range, 250–2500 cc). The most extensive procedures were anterior thoracic corpectomies with bleeding from raw cancellous bone surfaces and epidural vessels, and the mean estimated blood loss was 1175 cc (range, 250–2800 cc; Figure 2). The lumbar interbody BAK and fusion procedure never required a transfusion, even in a patient with an intraoperative common iliac vein injury. Aside from this patient, the majority of the operative blood loss resulted from the harvesting of bone graft from the iliac crest donor site rather than the spinal procedure. The mean laparoscopic estimated blood loss was 194 cc (range, 50–800 cc).

**Complications**

**Video-Assisted Thoracic Surgery**

The major complications are listed in Table 4. The most common complication was six cases of postoperative intercostal neuralgia. The etiology was thought to be a combination of factors—electrocauterization of the head of rib before excision, the use of rigid 10-mm thoracoports rather than flexible intercostal portals, or compression of a spinal nerve with a Kerrison rongeur (Rock Surgical, Baltimore, MD). In six of the patients, the pain and paresthesias were transient and resolved by 6 weeks after surgery.

There were five patients with postoperative atelectasis significant enough to prolong the patient’s hospitalization, and one patient had a loculated pleural effusion that resolved by 1 month after surgery.

One patient had a thoracoport penetrate the elevated right hemidiaphragm at the beginning of the operative procedure (Figure 3). This was an 84-year-old woman with a previous empyema, causing extensive pleural adhesions. The 10-mm hole in the diaphragm was successfully repaired thoracoscopically with endoscopic staples, and there was no postoperative sequelae.

There were no permanent iatrogenic spinal neurologic injuries. One patient undergoing a thoracic release for scoliosis from T5 to T10 developed transient leg weakness from occult spinal stenosis at T12–L1. This fully resolved by 6 weeks after surgery. To prevent this complication, we no longer “jackknife” the patient for operative positioning.

The lumbar interbody BAK and fusion procedure never required a transfusion, even in a patient with an intraoperative common iliac vein injury. Aside from this patient, the majority of the operative blood loss resulted from the harvesting of bone graft from the iliac crest donor site rather than the spinal procedure. The mean laparoscopic estimated blood loss was 194 cc (range, 50–800 cc).

**Table 3. Intraoperative Estimated Blood Loss**

<table>
<thead>
<tr>
<th>Endoscopic Procedure</th>
<th>Number of Patients</th>
<th>Mean (cc)</th>
<th>Range (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple anterior discectomies, scoliosis or kyphosis release</td>
<td>27</td>
<td>94</td>
<td>(negligible to 300)</td>
</tr>
<tr>
<td>Thoracic discectomy and spinal canal decompression</td>
<td>41</td>
<td>400</td>
<td>(25–2500)</td>
</tr>
<tr>
<td>Thoracic corpectomy and spinal cord decompression</td>
<td>8</td>
<td>1175</td>
<td>(250–2800)</td>
</tr>
<tr>
<td>Lumbar interbody BAK fusion procedure</td>
<td>22</td>
<td>194</td>
<td>(50–800)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>98</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note, the group with two patients with pyogenic vertebral osteomyelitis was too small to analyze. BAK = Bagby and Kuslich.*
Figure 2. This 38-year-old woman presented to us with a dense paraparesis secondary to a T12 burst fracture instrumented elsewhere. The anterior posterior (A) and lateral (B) myelogram show high grade block of contrast. The patient underwent endoscopic T12 anterior corpectomy performed through four thoracic portals without need of CO2 insufflation. The mean estimated blood loss of 1175 cc (range, 250–2800 cc) in the eight corpectomy patients was the highest of any of the four groups of anterior endoscopic surgery. (C) The preoperative axial computed tomography image at the T12 fracture is shown. The corresponding postoperative computed tomography image (D) shows that the spinal canal has been well decompressed using endoscopic techniques.

**Laparoscopic Complications**

There were no complications from pneumoperitoneum or CO2 insufflation used exclusively in laparoscopic cases (not used in thoracoscopy; Figure 4).

In 22 anterior lumbar laparoscopic BAK procedures, there was one with a vascular injury that occurred during the operative exposure of the L5–S1 intervertebral disc space below the “crotch” of the aortic bifurcation. It was only the second BAK implantation done at this particular institution, and the complication occurred during the use of a retractor. Pins were being embedded into the body of the L5 vertebrae to perform retraction of the posterior peritoneum and iliac vessels.

Unfortunately, during implantation of the retractor, a flange on the pin on the patient’s left side impinged on the left iliac vein, causing a small tear. Hemorrhage was controlled using direct pressure using a laparoscopic instrument, and open conversion to a mini-laparotomy was performed. Simple repair of the tear was performed

<table>
<thead>
<tr>
<th>Procedure Type</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracoscopic Intercostal neuralgia (all transient)</td>
<td>6</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>5</td>
</tr>
<tr>
<td>Excessive epidural blood loss, more than 2500 cc</td>
<td>2</td>
</tr>
<tr>
<td>Conversion to open thoracotomy caused by previous costotransversectomy</td>
<td>1</td>
</tr>
<tr>
<td>Penetration of right hemidiaphragm from thoracoport in patient with previous empyema</td>
<td>1</td>
</tr>
<tr>
<td>Transient paraparesis related to spinal stenosis at a different vertebral level and operative positioning</td>
<td>1</td>
</tr>
<tr>
<td>Laparoscopic Conversion to open laparotomy for repair of left common iliac vein</td>
<td>1</td>
</tr>
<tr>
<td>Bone graft donor site infection</td>
<td>2</td>
</tr>
<tr>
<td>Postoperative upper gastrointestinal bleed in patient anticoagulated with Coumadin up to 2 weeks before surgery</td>
<td>1</td>
</tr>
</tbody>
</table>

No cases of permanent iatrogenic neurologic deficit.
No cases of spinal wound infection.
Figure 3. From a thoracoscopic portal in the sixth intercostal space, a hole in the right hemidiaphragm is visualized (A). The underlying liver was not injured but is visible. The diaphragm was inadvertently entered by a blunt 10-mm thoracopert placed too inferiorly in resection of a T11 tumor (B). The diaphragm was repaired thoracoscopically using a hernia stapler without long-term sequelae. To prevent this complication, the first portal should be placed in the midaxillary line in the sixth or seventh intercostal space. All subsequent portals are placed under thoracoscopic visualization from within the chest cavity.

with minimal blood loss (800 cc estimated blood loss for the entire procedure). The procedure was completed through a 4-inch Pfannenstiel incision. The patient was discharged 6 days after surgery with no long-term sequelae.

Figure 4. An illustration is shown of a loop of small bowel being forced up a laparoscopic trochar. This is not a complication, provided the surgeon visualizes each trochar endoscopically before an instrument is placed into the abdomen. Another important technical rule is to always visualize the portals at the end of the laparoscopic case after the CO2 pressure has been reduced. Venous hemorrhage can be tamponaded off by the intraoperative CO2 pneumoperitoneum. Inspecting each portal site at the end of the laparoscopic procedure reduces the chances of postoperative intra-abdominal hemorrhage and hypotension in the recovery room.

Discussion

Perhaps the most important factor to minimize complications in endoscopic spinal surgery is to work with an experienced general surgical laparoscopic or thoracoscopic specialist. The majority of cases in this study were performed at institutions with regional teaching facilities for minimally invasive surgery. There are four factors that are different for endoscopic procedures compared with conventional “open” procedures, which help diminish complications.

Minimally invasive surgery or VATS procedures within the torso require special considerations to successfully and safely perform operative procedures in either the thoracic or the abdominal cavity and in adjacent tissues. The first key element is the ability to visualize the operative site and the areas surrounding the operative location. Visualization primarily requires a port of entry (either through the thoracic or abdominal wall), which requires a camera, a videoscope, and appropriate light source. The second important factor is creation of a workspace to perform the operative procedure. The technique to produce a workspace will vary depending on whether the operative procedure is to be performed in the thoracic cavity, the mediastinum, the abdominal cavity, or the retroperitoneum. The third factor important to minimally invasive procedures is the use of instrumentation that will allow the surgeon to accomplish the same technical goals as are accomplished in open surgery. The most important set of equipment in the endoscopic room is the “emergency set” of equipment and retractors necessary if the procedure has to be converted to an open case. A fourth, and final, issue is the provision of anesthetic support to help to maintain a
steady state for the surgeon during the operative procedure.

**Methods to Avoid Complications in Spinal Thoracoscopy**

Complications resulting from anesthesia or one-lung ventilation are covered in full-length endoscopic textbooks. Failure to collapse the lung on the operative side usually results from improper placement of the double lumen or univent tube. The position of the tube needs to be rechecked with a bronchoscope after positioning the patient in the lateral decubitus position. It is not uncommon for the tube to shift when the patient is being repositioned, so the ability to collapse the lung needs to be shown before trochar incisions are made.

The sixth or seventh intercostal space in the midaxillary line is the safest place for the first thoracoscopic portal. This is the only portal that is made without thoracoscopic visualization inside the chest, and, in some respects, it is the most dangerous. With the lung collapsed, the central tendon of the diaphragm can migrate as high as the eighth intercostal space. Although the disposable thoracoscopic 12-mm portals are blunt tipped, we had a case where the initial portal penetrated the right hemidiaphragm. The underlying liver was exposed and visible thoracoscopically. Fortunately, there was no visceral injury, and the diaphragm was successfully repaired using a laparoscopic hernia stapler. This underscores the importance of making the first thoracoscopic portal in the sixth or seventh midaxillary line. The correct technique is to enter the chest using the same gentle technique as with chest tube insertion—a
blunt Kelly rides over the cephalad portion of the rib, avoiding the neurovascular bundle. The most common complication was six cases of intercostal neuralgia. It was probably attributable to rigid thoracic trochars. The largest diameter trochar used in the chest should be 12 mm. There is only a fixed amount of intercostal space. As the surgeon levers and torques large spine instruments, it is possible to exert pressure on the intercostal nerves. Fortunately, in all of our cases, the intercostal neuralgia was transient and resolved spontaneously within 6 weeks. In the past year, we have switched exclusively to the Ethicon flexible thoracic portals (Ethicon Endosurgery, Cincinnati, OH) to minimize the incidence of intercostal neuralgia. Another useful step is to avoid monopolar cautery at the inferior margin of the rib when skeletonizing the head of the rib before removal. Electrocautery injury to the intercostal nerve has been observed by this mechanism.

Every time the scope is placed down a portal, it must be done gently and slowly—sometimes this is difficult in a lengthy procedure when the scope is being repeatedly cleaned. The lung can be inadvertently reinflated, and direct injury to the lung parenchyma has been observed in laboratory training sessions.

Once the first portal is made, the 10-mm, 30°-angled scope is inserted, and subsequent ports are made under thoracoscopic visualization inside and direct vision outside the chest. It is important to take down all adhesions between the chest wall and the visceral pleura before inserting a portal in the area. The lung can be tented and plastered to the chest wall (Figure 5). Usually endoshears can easily take down the adhesions, but with extensive pleural scarring, the adhesions can be swept away by digital sweeping movements from the portal sites.

To avoid direct lung injury, all instruments need to be visualized, but in particular fan retractors need to be visualized when they are opened and closed. A fan retractor should never be extracted from the chest in a semi-opened position because the lung can be pinched within the fingers of the fan.

We do not use positive pressure CO₂ insufflation to collapse the lung in thoracoscopy. Krasna et al.⁷ found that pressure greater than 12 mm Hg is associated with mediastinal shift and rapid changes in cardiac output. Subcutaneous emphysema is more likely to occur when trochars are dislodged or incompletely pulled out of the chest cavity. Gas embolism and subcutaneous or even mediastinal emphysema have been reported—these complications can be avoided simply by doing all thoracoscopic cases as a gas-less procedure.

Significant injuries to the aorta, superior vena cava, or pulmonary vessels will require immediate conversion to open thoracotomy for control. For this reason, all patients are prepared for this possibility. All experienced endoscopic surgeons state that the most important surgical instruments in the thoracoscopic operating room are those instruments that are required for open thoracotomy.

Intrathoracic breakage of instruments, such as graspers and pituitary rongeurs, can occur. This is more common than with open thoracotomies because the working end of the instruments are identical, but the endoscopic instruments usually have 250–300-mm shaft lengths. This increases the frictional forces along the shafts as the sliding surfaces become stuck with bone fragments. Many of the disposable and semi-disposable endoscopic instruments are simply not durable enough to resect bone or disc tissue. One of our investigators had three pituitary rongeurs break within the thoracic cavity. Fortunately, the retrieval of the broken hardware was able to be accomplished endoscopically, and an open conversion was not required.

In a prospective study of 78 consecutive thoracoscopic cases, there were no infections, no permanent iatrogenic neurologic injuries, and no major vascular injuries.¹⁵ There was one patient who required conversion to an open thoracotomy because she had dense adhesions resulting from a previous costotransversectomy.

**Techniques to Avoid Complications in Spinal Laparoscopy**

One advantage of the anesthetic considerations of laparoscopy compared with thoracoscopy is that routine endotracheal intubation without one lung ventilation is more easily accomplished. There are still ventilatory risks with laparoscopic spine procedures because of the CO₂ pneumoperitoneum and the Trendelenburg position used in approaches to the lumbosacral junction. Any closed technique (as opposed to the Hasson⁵ or open technique) of establishing pneumoperitoneum involves percutaneous placement of a needle within the peritoneal cavity for CO₂ insufflation before the trocars or cannulas are placed. To avoid complications, it is important to elevate the umbilicus with towel clips before insertion of the Veress needle. Analogous to the thoracoscopic sequence of portal placement, the first 10-mm portal placed in the umbilicus is used for the laparoscopic camera. All subsequent trochar placements are done under endoscopic visualization. It is recommended to aim the sharp introducing trochars in a caudal direction toward the pelvis to reduce the chances of hitting the underlying bowel or great vessels.

The Hasson or open cannula system is used for direct open insertion of a blunt cannula. It is used in patients with unsuccessful Veress needle insertion or multiple previous laparotomies with abdominal adhesions. Analogous to thoracoscopic techniques, it is often useful to take down abdominal wall adhesions before inserting trochars in the lower quadrants. We frequently use endoshears to mobilize the uterus if endometriosis is extensive. It is important to have an unrestricted access to the L5–S1 intervertebral disc space through a suprapu-
bic portal, and to permit this, the uterine–abdominal wall adhesions should be released.

To prevent hemorrhage after surgery, we recommend supplementing endoscopic vascular clips with loop ligatures (Endoloops—Ethicon or Surgitie—US Surgical, Norwalk, CT). It is helpful to decrease the insufflation pressure from 20 mm Hg to 10 mm Hg before the end of the procedure to ensure all venous bleeding vessels have been coagulated.

As a general rule, it is important to ensure compatibility between the shafts of the endoscopic spinal instruments and the laparoscopic trocars and cannulas. Unlike thoracoscopic procedures, there needs to be an airtight seal throughout the procedure or pneumoperitoneum will be lost, and visualization will be impaired. The insertion of osteotomes and sharp curettes needs to be done carefully, as we have had an osteotome cut the seal on the laparoscopic cannula. Curved curettes, in particular, need to be carefully withdrawn through the trochars because they can get stuck in the flapper valve mechanism. It is important before beginning the procedure to make sure all orthopedic spinal instruments are compatible with the laparoscopic trochars because they are usually manufactured by different companies.

There are several complications specific to the anterior laparoscopic approaches to the L5–S1 intervertebral discs that are worth emphasizing (Figure 6). In male patients, it is important to use bipolar electrocautery below the sacral promontory to avoid injury to the sympathetic plexus and retrograde ejaculation. Identify the peristalsis in the ureter bilaterally and confirm their location. We have seen anomalous ureters come very close to the junction of the common iliac vessels and the L5–S1 intervertebral disc. The most treacherous complication is laceration of the common iliac vein while attempting to expose the L5–S1 intervertebral disc space. We have observed this in the teaching laboratory and in one clinical case. Hemostasis was successfully achieved clinically but required conversion to an open laparotomy. There is more success in mobilizing the iliac vessels by ligating the small tethering branches and completely avoiding the tendency to stretch any veins regardless of their size. Orthopedic spinal implants are usually made for patients of average size. If a patient simply has too little room for two fusion cages between the iliac vessels, it is better to use just one fusion cage or just one large bone graft dowel rather than to unduly manipulate the iliac veins or the inferior vena cava.

Comparison to Published Literature

The landmark comparison of laparoscopic techniques versus open laparotomy was the publication of Reddick and Olsen’s series of 100 patients undergoing cholecystectomy in 1989 (Table 5). A huge array of general surgical procedures have been described laparoscopically—appendectomy, liver resection, Nissen fundoplication, splenectomy, selective vagotomy, nephrectomy, colon resection, and hernia repairs. The explosive enthusiasm and rapid technical advances with the commercial outpouring of resources is attributable to one procedure—laparoscopic cholecystectomy. The chief advantage of laparoscopic cholecystectomy compared with the open procedure is a more rapid return to work of patients (Table 5).

A similar comparison of open versus endoscopic thoracic discectomies is not possible at the current time. The four largest published series of open anterior thoracic discectomies or costotransversectomies are—Bohman and Zdeblick, 22 patients (1988); Otani et al, 23 patients (1988); Alband and Corkill, seven patients (1979); and Simpson et al, 23 patients (1993). In these combined series of 75 patients, there were two patients with transient iatrogenic paraparesis after open anterior thoracic discectomy and no reports of spinal infections after surgery. None of these four studies of open thoracic discectomies reported the length of stay, the intraoperative blood loss, the mean operative time, or chest tube duration.

Conclusions

The endoscopic spinal approaches proved to be safe operative procedures in 100 consecutive cases; there were no permanent iatrogenic neurologic injuries and no deep spinal infections. One VATS procedure was converted to an open thoracotomy because of extensive pleural adhesions from a previous costotransversectomy. One laparoscopic procedure was converted to a mini-laparotomy because of a left common iliac vein injury. There were no long-term sequelae in these two procedures.

Acknowledgment

The authors thank Michael Mack, MD, Chief of Video-Assisted Thoracic Surgery in Dallas, Texas, for assistance. His abilities allowed for the favorable clinical outcomes of many patients illustrated in this study.

References


Table 5. From Eddie Joe Reddick’s Original Series 1989*

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<tr>
<th>Patient Characteristics</th>
<th>Laparoscopic</th>
<th>Minilaparotomy</th>
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<tbody>
<tr>
<td>Mean age (yr)</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Postoperative length of stay (days)</td>
<td>1.98</td>
<td>2.80</td>
</tr>
<tr>
<td>Return to work (days)</td>
<td>6.5</td>
<td>34</td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>90</td>
<td>65</td>
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</table>

* From Reddick and Olsen [14].

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