Laparoscopically Assisted Spinal Surgery

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ABSTRACT

Background: Spinal surgery is one of the newest frontiers of videolaparoscopic surgery, but requires the cooperative efforts of both the spinal surgeon and the laparoscopic general surgeon.

Data Base: We report our experience with 76 cases of laparoscopic spinal surgery, using both a transperitoneal and a retroperitoneal approach. Technical details and complications are described in detail.

Conclusions: Fifty-one patients had a transperitoneal approach with an average operating time of 117 minutes. Uncomplicated cases stayed 4.4 days. Five patients required conversion. All but one patient had L5-S1 level surgery. Twenty-five patients had a retroperitoneal approach with 150 minutes operating time and a 5.7 day stay. Conversions were minimized with a two-balloon technique. The retroperitoneal approach allows for multiple level surgery with virtually unlimited fusion devices. Laparoscopically assisted spine surgery affords all the benefits of minimally invasive surgery, without limitations for the spinal surgeon.

Key Words: Laparoscopy, Spine, Transperitoneal, Retroperitoneal.

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INTRODUCTION

Although general surgeons have been one of the last groups to embrace videoendoscopy, the gains seen since the first laparoscopic cholecystectomy have been nothing short of stupendous. Furthermore, this meteoric rise in general surgical applications has retrained virtually every general surgeon worldwide.

Advances now seem to come more slowly, but using a multi-disciplinary approach allows surgeons of different specialties to continue to expand their horizons. This spirit of cooperation is well demonstrated in the newly developing field of laparoscopically assisted surgery of the anterior spine. Obenchain published his sentinel case in 1991, and turned the theoretical advantages of laparoscopic lumbar discectomy into reality.[1] Animal and early clinical studies appeared in 1995.[2]

Although many spine surgeons, orthopedists and neurosurgeons have the technical skills and training to expose the anterior spine themselves, few have the laparoscopic expertise to perform these procedures using minimally invasive techniques. We have had an extensive experience with open anterior spine approaches, beginning with single-level transperitoneal L5-S1 exposures to multiple-level thoracoabdominal approaches. For the last six years, we have preferred totally extraperitoneal access utilizing either a left flank or left paramedian incision.

During the last two years, the authors have had experience with laparoscopically assisted exposure of the anterior lumbar spine--first, using transperitoneal techniques with two different operating systems, and, more recently, with a totally extraperitoneal gasless approach. As with all the early endoscopic procedures, experience and new technology makes these "techniques in evolution."

METHODS

Transperitoneal Approach:

The patient is placed in the supine position with arms crossed and secured across the chest, allowing for continuous cross-table lateral fluoroscopy. Shoulder braces are used to prevent sliding when steep Trendelenberg position

Table 1.
Transperitoneal Approach
August, 1994 - December, 1996

- 51 patients
  - 19 men
  - 32 women
- 50 out of 51 cases, single level, L5-S1
- Average age, 42 (15-82)
- Average weight, 173 lbs. (78.6 kg.)
- OR time average 117 min. (55-235)

Table 2.
Transperitoneal Indications

Pseudoarthrosis	41%	21
Degenerative Disc Disease	35%	18
Annular Tear	16%	8
Spondylolisthesis	8%	4

Table 3.
Transperitoneal Length of Stay

- Total study group LOS 5.3 days (3-17)
- 47 uncomplicated cases LOS 4.4 days
- 1/3 cases had simultaneous posterior instrumentation

Table 4.
Transperitoneal Conversion

Infantile Pelvis	1
Low Bifurcation	1
Iliac Vein Injury	1
Adhesions prior abdominal surgery prior disc surgery	2

is required. A Foley catheter is placed after induction of general endotracheal anesthesia. After establishment of pneumoperitoneum, a 10 mm trocar and 0 degree laparoscope are introduced at the umbilicus. Two 5 mm trocars are placed in the right hemi-abdomen: one opposite the umbilicus, the other in the right lower quadrant. The small bowel is moved out of the pelvis with the aid of steep Trendelenberg position and laparoscopic Kittner dissectors. A 10 mm trocar is placed over the L5-S1 interspace in the midline, and the sigmoid colon retracted superiorly and to the patient's left with a laparoscopic Babcock clamp. The peritoneum over the sacral promontory is incised vertically and the L5-S1 disc identified. All dissection is done vertically to avoid the hypogastric nerves; the middle sacral vessels are taken with bipolar cautery, and the disc space cleared widely with gentle mobilization of the common iliac veins. The center of the targeted disc is confirmed using fluoroscopy, and the entire spinal portion of the procedure is performed under X-ray control. The disc core is trephined and dilated, the "tubes" are docked onto the disc, and the discectomy and bone dowels or cage devices are placed and secured. Following the spinal surgery, the trocars are removed, and the larger fascial incisions are closed, followed by the skin incisions. When indicated, the patient is turned and a posterior procedure is performed.

Extraperitoneal:

The patient is again placed supine with arms crossed upon the chest. A subumbilical incision is made, the anterior rectus sheath incised, the muscle retracted and the posterior rectus sheath identified. A kidney-shaped balloon dissector is placed to the left of the midline, aimed at the pubic symphysis and inflated. A small incision is then placed just medial to the tip of the left 12th rib and the retroperitoneal space entered, either with finger dissection or with an Optiview trocar. A second kidney-shaped balloon is placed in the preperitoneal space, aimed at the pubis and inflated. This balloon is removed and replaced by a balloon-tipped trocar allowing for insufflation of the retroperitoneum. A 5 mm trocar, placed just anterior to the anterior superior iliac spine, allows access for blunt dissection to connect the two extraperitoneal spaces created by the balloons. If bone harvest has been performed, this incision is utilized. The lifting devices are then placed along with the laparoscope in the 12th rib site, now using a gasless system. The iliac crest site is enlarged to 10 mm; gasless trocar and two Kittner dissectors complete the dissection of the targeted disc spaces. If necessary, fluoroscopy is used to confirm the operating site, but it is not necessary during the spinal operation. The spine surgeon's operating incision is made in the lower midline, allowing access for midline retractors as well as any conventional surgical instruments. A standard discectomy and fusion, using any desired open technique, can be accomplished. At the completion of the procedure, fascial incisions and skin are closed.

RESULTS

From August, 1994 to December, 1996 we performed 76 laparoscopically assisted anterior spinal discectomies and fusions done with two spinal surgeons. There were 51 per-

Table 5.
Transperitoneal Complications

Pulmonary Embolus	1
Ileus	1
Mechanical Small Bowel Obstruction	1
Bone Plug Displacement	1
Deaths	0

Table 6.
Transperitoneal Delayed Complications

Fungal Disc Infection	1
Bone Plug Displacement	2
posterior approach	
DVT with iliac vein impingement, plug removal and venorraphy	

Table 7.
Retroperitoneal Approach
August, 1994 - December, 1996

- 25 patients
  - 15 women
  - 10 men
- Average age, 39 (25-53)
- Average weight, 165 lbs., 75 kg. (111-212)
- OR time average 150 min. (120-180)
- LOS 5.7 days (4-10)
- 20/25 combined posterior approach
- 3/25 two-level procedure

formed with the transabdominal approach, and 25 in the last 12 months, retroperitoneally.

In the transperitoneal group there were 19 men and 32 women, with an average age of 42 years (15-82). Fifty of the 51 procedures were performed at the L5-S1 disc space; in only one patient was an L4-5, L5-S1 procedure completed. The average weight was 173 pounds (78.6 Kg.). All of the cases were performed either with the Danek or Spinetech systems, both relying on bone dowels for the fusion. There were no BAK devices (interbody fusion devices, SpineTech Co.) or cages used. The average operating time for the anterior approach was 117 minutes (55-235) **(Table 1)**. Pseudoarthrosis was the indication for operation in 44%, degenerative disc disease in 36%, annular tear in 12%, and spondylolisthesis in 8% **(Table 2)**. Half of the anterior group had prior spinal surgery. In nearly one-third of the cases, patients were turned, and a posterior procedure was performed. The average length of stay was 5.3 days for the entire study group (3-17), but only 4.4 days (3-7) for those patients with no complications **(Table 3)**.

There were five cases which required conversion to an open technique. In one extremely small woman, a virtually infantile pelvis was too small to accommodate laparoscopic instruments. Adhesions were responsible for two conversions, one case of dense adhesions from previous abdominal surgery, and one case of inflammation of the disc precluding safe dissection of the iliac veins. A low bifurcation of the great vessels and an injury to the right iliac vein were responsible for two more conversions **(Table 4)**.

Hospital complications included one case each of pulmonary embolus, ileus, mechanical small bowel obstruction and bone plug displacement **(Table 5)**. There were three late complications requiring re-operation. In two cases, bone plugs were displaced. In one patient, a posterior procedure was required; in the second, the displaced bone plug impinged on the left iliac vein causing deep venous thrombosis, necessitating plug removal and venorraphy **(Table 6)**. In one case, a positive fungal culture required an open anterior operation on the third postoperative day. There were no deaths.

Twenty-five cases were performed with a balloon assisted retroperitoneal approach **(Table 7)**. In this group, three patients underwent a multi-level procedure, L4-5, L5-S1. Fourteen used a single balloon, and eleven used a two-balloon technique. In the 25 patients who had a retroperitoneal approach, operative times averaged 150 minutes (120-180) for the anterior portion. Two-thirds of the patients had combined anterior-posterior procedures. Initially, we used only one balloon to create the posterior and lateral space, while dissecting the peritoneum anteriorly by blunt dissection of the midline. It was this anterior dissection which was more difficult and which was responsible for all of our conversions--as once the peritoneum is violated and allows the small bowel into the preperitoneal space, all exposure is lost. Five (20%) required conversion to open, all because of tears in the peritoneum which could not be repaired. These tears were found in the initial single-balloon group; there have been no tears and no conversions in the double-balloon group **(Table 8)**. The average length of stay was 5.7 days (4-10). Ileus and partial small bowel obstruction were the only complications in this group. Injury to the left iliac vein was repaired in one patient, and the case was completed without conversion. There were no delayed complications and no deaths **(Table 9)**.

Table 8.
Retroperitoneal Approach Conversions

Single Balloon Technique		14
peritoneal tears	5	
Double Balloon Technique		11
peritoneal tears	0	

Table 9.
Retroperitoneal Approach Complications

Ileus	1
Partial Small Bowel Obstruction	1
Iliac Vein Injury, Repaired without conversion	1
Delayed Complications	0
Deaths	0

Table 10.
Conclusions

- Laparoscopy affords safe and efficient exposure of the anterior lumbar spine.
- Transperitoneal approach affords "tube" access to L5-S1.
- Retroperitoneal approach is facilitated by a two-balloon technique.
- Gasless laparoscopy affords multiple level access with unlimited instrumentation.

DISCUSSION

In collaborative spinal surgery, patient selection and indications for operation are entirely the responsibility of the spine surgeon. General surgical assessment should include the patient's suitability for a major intra-abdominal or major retroperitoneal procedure, as well as incision placement, weighing past surgical and medical history. Long-term results of spine surgery require a minimum of two years follow-up and are beyond the scope of a general surgeon's expertise. In laparoscopically assisted spine surgery, the general surgeon's responsibility is safe and efficient exposure of the spine **(Table 10)**. An ideal technique would also allow the average general surgeon to expose multiple levels of the lumbar spine quickly and safely. In even the most sophisticated orthopedic and neurosurgical reviews, outcome endpoints are difficult to measure.

Much like the development of laparoscopic hernia, the transperitoneal approach emerged first, as it is the easiest to learn. Unfortunately, the spine surgeon is limited in the gas environment to systems which use tubes in order to maintain pneumoperitoneum. By necessity, the discectomy is limited as are the choices of techniques to accomplish a stable fusion. Furthermore, with anterior exposure only the L5-S1 interspace is readily available. Although higher levels of exposure are possible, the incidence of major vascular complications increases as well. The retroperitoneal approach obviates all the complications of transperitoneal exposure, while allowing much easier access to multiple levels of the spine. Furthermore, the gasless environment allows spine surgeons to use all their conventional instruments, as well as time-honored techniques for performing the fusion, while utilizing newer hardware. Unfortunately, with the retroperitoneal approach, the peritoneum must be cleared beyond the rectus muscle to beyond the midline. However, any hole in the peritoneum allows small bowel to enter the retroperitoneal space, rendering the procedure impossible. We learned quite early that this medial dissection was the most difficult and that it was responsible entirely for conversions to an open approach. With the use of the two-balloon technique, the anterior peritoneal dissection is completed rapidly, just like the TEP (totally extraperitoneal) hernia technique: we have had no conversions to open after its adoption. Furthermore, the gasless approach allows for increased flexibility to handle complications during the dissection of the frequently diseased disc space. Bleeding from an iliac vein is relatively easy to control, using continuous suction and clip techniques impossible with pneumoperitoneum.

Once techniques have been finalized for the laparoscopically assisted surgery on the spine, prospective randomized trials will be needed. Unfortunately, the assessment of outcomes for spine surgery is difficult. Success of a fusion is, of course, only one endpoint. Alleviation of back pain and return to normal functioning are the most difficult to measure. Nevertheless, minimally invasive techniques will allow anterior procedures to be performed at multiple levels with decreased morbidity. These improved results will require the truly collaborative effort of the experienced laparoscopic general surgeon and the spine surgeon, willing to enter the minimally invasive arena.

References:

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