



Bowel injury in lumbar spine surgery: a review of the literature

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Abstract: Although rarely documented in the medical literature, bowel perforation injury can be a severe complication of spine surgery. Our goal was to review current literature regarding this complication and study possible methods of avoidance. We conducted a literature search in the PubMed database between January 1960 and March 2016 using the terms abrasion, bowels, bowel, complication, injury, intestine, intra-abdominal sepsis/shock, perforation, lumbar, spine, surgery, visceral. Diagnostic criteria, outcomes, risk factors, surgical approach, and treatment strategy were the parameters extracted from the search results and used for review. Thirty-one patients with bowel injury were recognized in the literature. Bowel injury was more frequent in patients who underwent lumbar discectomy and microdiscectomy (18 of 31 patients, 58.1%). Minimally invasive surgery and lateral techniques involving fusions accounted for 10 of the reported cases (32.3%). Finally, 2 cases (6.5%) were reported in conjunction with sacrectomies and 1 case (3.2%) with posterior fusion plus anterior longitudinal ligament (ALL) release. Diagnosis was made mostly by clinical signs/symptoms of acute abdominal pain, post-surgical wound infection, and abscess or enterocutaneous fistulas. Significant risk factors for postoperative bowel injury were complex surgical anatomy, medical history of previous abdominal surgeries or infections, irradiation before surgery, errors related to surgical technique, lack of surgical experience, and instrumentation failure. The overall mortality rate from bowel injury was 12.9% (4 of 31 patients). The overall morbidity rate was 87.1% (27 of 31 patients). According to our review of the literature, bowel injury is linked to significant morbidity and mortality. It can be prevented with meticulous pre-surgical planning. When it occurs, timely treatment reduces the risks of morbidity and mortality.

Keywords: Bowel; complication; lumbosacral spine surgery; perforation injury

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Introduction

Bowel injury is considered a rare but serious complication of spine surgery associated with high morbidity and mortality rates due to severe intra-abdominal sepsis and shock. Bowel injury can be defined as trauma associated with the intestinal wall ranging from incomplete injury, such as a simple abrasion, to complete injury which includes

perforation of the bowel. It is estimated that the mortality for perforation injury-related intra-abdominal sepsis ranges between 7.5% and 36% (1-4). Recent advances in spinal instrumentation have led to the development of several new minimally invasive surgical (MIS) approaches such as anterior lumbar interbody fusion (ALIF), direct or indirect lateral interbody fusion (LIF), and transforaminal lumbar interbody fusion (TLIF). These procedures contribute to

minimizing the size and number of incisions and the extent of tissue retraction, as well as reducing surgical time, blood loss, and length of hospital stay (5-10). However, even with these new techniques and safeguards, cases of bowel perforation injury are reported in the current literature.

Our goal was to evaluate cases of bowel perforation injury concurrent with lumbar spine surgery as well as the causes and any possible means of avoidance.

Patient and methods

We performed a literature search in the PubMed database using the following terms: “abrasion,” “bowels,” “bowel,” “complication,” “injury,” “intestine,” “intra-abdominal sepsis/shock,” “perforation,” “lumbar,” “spine,” “surgery,” and “visceral.” These terms were used alone and in every possible combination. The search was limited to English language articles and abstracts published between January 1960 and March 2016. In each case, the diagnostic criteria, outcomes, risk factors, surgical approach, and the treatment strategy that was followed were recorded.

Results

Twenty-four publications were included in our analysis with a total of 31 reported cases of bowel injury (11-34) (*Table 1*). In one article, the authors described a case of abrasion of the rectum and symptoms of tenesmus without complete injury after an axial lumbar interbody fusion (AxiaLIF) procedure (33). Twelve publications described bowel injury following lumbar disc surgery or lumbar microdiscectomy (13,17-20,22,26,28-32). In one publication, bowel injury occurred during sacrectomy for tumor removal (34). There were 10 publications in which bowel injury was described after lateral approaches and MIS spinal procedures in the lumbar spine (11,12,14-16,21,23,24,27,33). Additionally, one study reported bowel injury after instrumentation failure in a procedure for a spinal deformity (25).

The surgical procedures involved in the bowel injuries were discectomy (13,17,18,26,30-32), microdiscectomy (19,20,22,28,29) extreme lateral interbody fusion (XLIF) (11), AxiaLIF (14,15,23,24,33), ALIF (12,21), anterior endoscopic spondylodesis at L5-S1 (27) posterior lumbar interbody fusion (PLIF) (16), posterior spinal fusion-anterior spine release through a retroperitoneal approach (25), and sacrectomy (34). An analysis of the types of surgeries that these patients underwent demonstrated that bowel injury was more frequent in lumbar discectomy

and microdiscectomy (18 of 31 patients, 58.1%). MIS and lateral techniques such as ALIF, XLIF, and TLIF were the second most common with 10 cases (32.3%). Sacrectomies (6.5%) and posterior fusion plus ALL release (3.2%) had the lowest number of reported bowel complications.

In all cases, timing of the injury was an important factor and played an important role in determining the diagnosis after injury. In most cases, bowel injury occurred during surgery and was noted at the time. Three cases of bowel injury were diagnosed postoperatively due to migration of instrumentation (16,21,27). Abrasion of the intestinal wall in one patient was the result of a migrated screw after a lumbosacral AxiaLIF procedure (33).

Because all reported cases involved the lumbosacral spine, we studied the operative levels and locations that were most commonly associated with bowel injury and found that bowel injury was most common at L5-S1 (15 of 31 patients, 48.4%), followed by the L4-L5 level (5 of 31 patients, 16.1%). Two cases were noted in conjunction with sacral surgery (6.5%) (34). In 6 cases (19.4%), the level was not identifiable in the reports (12,18,25,26). Seventeen cases of injury (54.8%) occurred in the small intestine, 9 (29.0%) in the rectum, and 5 (16.1%) in the cecum, sigmoid, or rectosigmoid area.

Time to diagnosis was categorized as intraoperative (3 of 31 patients, 9.7%) (12,18,23), less than 48 hours after surgery (12 of 31 patients, 38.7%) (11,13,17,18,20,22,29,31,32), 48 hours to 1 week after surgery (5 of 31 patients, 16.1%) (14,15,19,23,31), 1 week to 1 year after surgery (6 of 31 patients, 19.3%) (24,25,28,30,34), and more than 1 year after surgery (4 of 31 patients, 12.9%) (13,21,27,33). One article did not specify the time of bowel injury (26). Acute abdominal pain, hyperemesis, hypotension, and peritonitis with subsequent sepsis were the clinical findings in most patients (17,18,25,28,31). Other clinical findings included haemorrhage (15,34), tenesmus (33), edema, or inflammation at the site of the injury due to communication with the intestine; abscess (14,16,32); and discovering parts of instrumentation in the feces (21,27). Radiological evaluation plus computed tomography (CT) of the abdomen in these cases revealed intra-abdominal fluid and pneumoperitoneum, intestinal fistulas, or abdominal abscesses, and instrumentation close to the gastrointestinal tract. Also, rectal imaging techniques were used in some cases in which rectal injury was suspected (33). Patients underwent either restoration of the bowel injury immediately intraoperatively (12,13,18,23) or secondarily if the lesion was detected soon after the spine procedure

Table 1 Publications regarding bowel injury in lumbar spine surgery

Authors, year	No. Pts.	Operative level	Surgical technique	Time to bowel perforation diagnosis	Location of perforation	Type of repair	Outcome
Balsano <i>et al.</i> , 2015 (11)	1	L3–L5	XLIF	Postop	Rectum	NA	Recovery
Bianchi <i>et al.</i> , 2003 (12)	1	NA	ALIF	Intraop	Small bowel enterotomy site	Defect closure	Recovery
Birkeland and Taylor, 1970 (13)	4	Three cases L5–S1, 1 case L4–L5	Lumbar disc surgery	1 day/immediate/several hours postop/2.5 years postop in cecum rupture	3 cases ileum/1 case cecum	Defect closure	3 recovery/1 death from sepsis
Bohinski <i>et al.</i> , 2010 (14)	1	L5–S1	AxialLIF	3 days postop	Rectum	Open drainage, diversionary colostomy	Recovery
Botolin <i>et al.</i> , 2010 (15)	1	L5–S1	AxialLIF	4 days postop	Rectum	Diverting ileostomy	Recovery
Cakmak <i>et al.</i> , 2010 (16)	1	L4–L5–S1	PLIF	1 year postop	Medial aspect of the cecum	Cecum was primarily repaired – a diverting ileostomy was fashioned	Recovery
Cases-Baldó <i>et al.</i> , 2011 (17)	1	L5–S1	Lumbar discectomy	4 hours postop	Rectosigmoid junction	Bowel resection and side-to-side anastomosis, with drainage	Recovery
Goodkin & Laska, 1998 (18)	3	NA	Lumbar discectomy	Intraop in 1 case, postop in 2 cases	1 jejunum /2 small intestine	Resection and repair	Recovery
Hoff-Olsen and Wiberg, 2001 (19)	1	L4–L5	Lumbar microdiscectomy	48 hours postop	Ileum-retroperitoneum	End-to-end ileum anastomosis	Death from sepsis
Houten <i>et al.</i> , 2004 (20)	1	L5–S1	Lumbar microdiscectomy	1 day postop	Two holes in the mid-jejunum	Small bowel resection and primary anastomosis of jejunum	Recovery
Keerthi <i>et al.</i> , 2012 (21)	1	L4–S1	ALIF	5.5 years postop	Rectum	Low anterior resection anastomosis of the rectum along with diversion loop ileostomy	Recovery
Kim <i>et al.</i> , 2010 (22)	1	L5–S1	Lumbar microdiscectomy	6 hours postop	Mid-jejunum	Resection and primary anastomosis of jejunum	Recovery
Lindley <i>et al.</i> , 2011 (23)	2	L4–S1, L5–S1	AxialLIF	Intraop, 4 days postop	Rectum	Diverting ileostomy, loop colostomy	Recovery
Mazur <i>et al.</i> , 2013 (24)	1	L5–S1	AxialLIF	3 weeks postop	Rectum	Loop ileostomy	Recovery

Table 1 (continued)

Table 1 (continued)

Authors, year	No. Pts.	Operative level	Surgical technique	Time to bowel perforation diagnosis	Location of perforation	Type of repair	Outcome
Nguyen et al., 2005 (25)	1	Severe thoraco-lumbar scoliosis	Posterior spinal fusion and anterior spine release via a retroperitoneal approach	2 months postop	Jejunum	Closure repair	Recovery
Pappas et al., 1992 (26)	1	NA	Lumbar discectomy	NA	Small intestine	Defect closure	Recovery
Ruf et al., 2011 (27)	1	L5-S1	Anterior endoscopic spondylosidesis	4 years postop	Sigmoid colon	Partial resection of the colon at the defect site with end-to-end anastomosis	Recovery
Schwartz and Brodkey, 1989 (28)	1	L4-L5	Lumbar microdiscectomy	19 days postop	Sigmoid colon	Defect closure	Recovery
Shakir and Paterson, 2011 (29)	1	L5-S1	Lumbar microdiscectomy	1 day postop	Small intestine	Defect closure	Recovery
Shaw et al., 1981 (30)	1	L5-S1	Lumbar discectomy	3 months postop	Ileum	Defect closure	Recovery
Smith et al., 1991 (31)	2	L5-S1	Lumbar discectomy	1 day and 2 days postop, respectively	Ileum	Primary closure	Recovery
Smith and Estridge, 1964 (32)	1	L5-S1	Lumbar disc surgery	Hours after surgery	Ileum-retroperitoneum	Defect closure	Recovery
Wilson et al., 2013 (33)	1	L5-S1	AxialLIF	1 year postop	Rectum (abrasion)	Removal of migrated AxialLIF screw	Recovery
Zileli et al., 2003 (34)	2	Sacrum	Sacrectomy	2 and 3 weeks postop, respectively	Rectum	Emergency colostomy	Death from sepsis

ALIF, anterior lumbar interbody fusion; AxialLIF, axial lumbar interbody fusion; intraop, intraoperative; NA, data not available; No., number; PLIF, posterior lumbar interbody fusion; postop, postoperative; Pts., patients; XLIF, extreme lateral interbody fusion.

(15-17,19-22,24,29). The type of procedures patients underwent for bowel repair were defect closure, end-to-end anastomosis plus external drainage, resection plus anastomosis, and ileostomy/colostomy (12-15,17-26,28-32,34). There were also cases with chronic inflammatory findings (abscess or fistula) that were treated after the main surgery (16,27). The overall morbidity rate from bowel injury was 87.1% (27 of 31 patients). The mortality rate was 12.9% (4 of 31 patients) due to irreversible sepsis (13,19,34).

Discussion

Surgical approaches for the treatment of disease of the lumbosacral spine can be divided into percutaneous, endoscopic, and arthrodesis procedures (35,36). Percutaneous techniques were developed in the 1960s and 1970s (37,38). Endoscopic lumbar techniques were introduced in the 1980s and 1990s (39-41). Lumbar arthrodesis procedures, such as posterior fixation with pedicle screws, TLIF, ALIF, direct or indirect LIF, and AxiaLIF, have become increasingly more minimally invasive (42-45). Looking only at microdiscectomies over the years, between 1960 and 2000, there were five publications discussing bowel injury as a complication from surgery. In 2000-2010, there were eight publications reporting bowel injury; and from 2010 until March 2016, eight publications documented bowel injury in the medical literature as well. Looking at the evolution of MIS procedures for the lumbar spine, we found that bowel injury remains a rare complication, described mostly anecdotally in case reports.

Aside from direct injury to the intestines during surgical manipulations, migration and instability of a fusion construct was documented as having played an important role in a bowel injury event (16,21,25,27). With new advances and variability in MIS approaches, techniques, devices, and constructs, the risk of bowel injury appears to be increasing. Failure of interbody fusions or anterior displacement of cages can lead to bowel injury and spinal instability. Bowel injury rates would logically make sense as a marker of the learning curve for surgeons with each new lumbar spine procedure that is introduced, although this is not necessarily supported by the literature (18,31).

In recent years, registries including the Society of Lateral Access Surgery (SOLAS) and the International Spine Study Group have been working diligently toward recording the outcomes of surgical procedures and their associated complications, such as bowel injury. Uribe *et al.* compiled the results of a survey of the complications occurring during

lateral lumbar spine approaches performed by experienced (more than 100 cases) MIS-LIF surgeons participating in the SOLAS registry (46). These authors concluded that the rate of bowel injuries in more than 13,000 LIF cases was 0.08% (46). However, the existing registries do not represent all MIS procedures performed and their complications.

Additional important factors in the discussion of this issue are the medicolegal implications that can arise due to bowel injury. In their unique and noteworthy study, Goodkin and Laska analyzed the legal aspects of major complications associated with lumbar disc surgery (18). They concluded that, in such circumstances, surgeons are frequently required to defend themselves in court and the occurrence of malpractice lawsuits has become a growing concern when performing such approaches (18).

Furthermore, it is a reasonable finding that the lower lumbar spine levels are the most commonly involved levels in bowel injury during spine surgery. Degenerative changes and disc herniations are commonly seen at these levels because they tend to be symptomatic and are below the conus medullaris. Because of the high volume of cases at these levels, it is understandable that the number of reported complications is slightly higher than those reported at other spinal levels.

The diagnosis of bowel injury is established by the combination of clinical and imaging findings. Interestingly, bowel injury was reported in two cases when the disc specimen retrieved during the procedure was sent to pathology and gastrointestinal mucosa was found, indicating bowel injury (13,18). Clinical findings such as peritonitis, wound infection, abdominal pelvic abscesses, enterocutaneous fistulae, and more rarely, postoperative discitis may indicate the presence of a bowel injury (18,31). Imaging studies such as abdominal X-rays and CT can show free air and fluid in the peritoneal cavity or pieces of migrated instrumentation (47). Magnetic resonance imaging (MRI) can reveal enterocutaneous fistulae and abdominal pelvic abscesses.

Risk factors for bowel injury can be divided into two categories: factors related to the surgical approach and general predisposing factors. Factors related to the surgical approach reference the means by which the surgeon is accessing the disk space, patient positioning relative to how the disk space is being accessed, use of instrumentation, surgical anatomy, use of a microscope, and the surgeon's experience (13,18,31,48,49). General predisposing risk factors are: recurrent spine surgery, history of abdominal or rectal surgeries, preoperative irradiation, history

of abdominal infections, pelvic inflammatory disease, appendicitis, or diverticulitis, which can increase the presence of abdominal adhesions (14,15,31,50).

According to published data (*Table 1*), in posterior approaches such as lumbar microdiscectomy and PLIF, bowel perforation could be caused after penetration of the anterior longitudinal ligament (ALL). An existing defect in the anterior part of the annulus fibrosus and the ALL or the intraoperative rupture of the internal disc wall and the ALL during surgical manipulations could lead to bowel injury (48,51). Anatomically safe working zones were developed by spine surgeons in order to avoid the possibility of injury to the lumbar plexus and vessels (52). Unfortunately, the anatomical relationship of the bowel to the lumbar spine is not as accurately defined in the literature as it is with vessels and nerves because of the mobility of the intraperitoneal organs. For example, with the patients in a prone position, the small intestine can be located in front of the L5–S1 disc space (53). The peritoneum can be traumatized by instrumentation or surgical manipulations during the lateral transpsoas approach due to its close proximity to the psoas muscle, which can lead to bowel perforation (11). Kanemura *et al.* investigated the possibility for a colonic perforation during an XLIF procedure by calculating the distance of the descending and ascending colon from the lateral approach pathway (54). They concluded that in 30% of their patients there was a margin between the colon and the posterior pararenal space that could increase the risk of colon perforation. According to their study, perioperative abdominal CT could provide useful information for the avoidance of this complication (54). Surgeons must divide the peritoneum from muscle layers to reach the lumbar spine in anterior retroperitoneal approaches, creating an increased risk of bowel perforation by surgical manipulations due to micro-ruptures of the peritoneum (12). The presacral AxiaLIF technique carries the greatest risk for bowel perforation injury due to the anatomical relationship of the sacral bone to the rectum (14,15). A thinner presacral space in women predisposes them to an increased risk of rectal perforation (24). Other important risk factors are rectal prolapse and thin prerectal fat (50).

Another important observation is that some spine surgeons do not remove the instrumentation after the occurrence of a bowel injury. It has been described in the literature that these patients may have an increased risk of infection (18,28,30,32). However, in several published case reports, outcomes in regards to the fusion

surgery for these patients are favourable, and they do not have documented infections even with bowel injuries (11,12,14–16,21,23,24,27).

An important discussion relevant to the complication of bowel perforation is regarding methods of avoidance. The literature suggests that the primary means of avoidance is presurgical evaluation of imaging studies such as lumbar CT and MRI. These imaging studies provide useful information regarding sagittal vertebra length plus anatomical anomalies or variations that surgeons should recognize before surgery (6,13,14,53). In addition, unnecessary surgical manipulations should be avoided and the procedure should be confined to the disc space. Especially during a posterior lumbar microdiscectomy, the length of the operative disc space can be estimated using set measures to better appreciate an appropriate working depth (13). The status of the ALL can be checked with the application of normal saline in the disc space. If the same amount of saline returns and remains, rupture is less likely. Another important consideration is presurgical bowel preparation because it improves relaxation of the intestinal walls and decreases the possibility of a bowel injury (24). Also, obtaining a medical history and performing a thorough clinical examination can lead physicians to safer surgical approaches (14). The choice of instrumentation is important to provide a stable biomechanical construct in the lumbar spine (21). Furthermore, postoperative imaging can provide significant information about instrumentation complications related to pseudarthrosis and migration of instrumentation (21). Finally, in cases of large intestine and rectum perforation, there is a possibility for defect entrenchment and subsequent appearance of fistulas and abscesses (13,19,34). Treating bowel injury complications in a timely manner leads to more favourable outcomes and decreases mortality.

In conclusion, although bowel perforation in lumbar spine surgery has high percentages of morbidity and mortality, it is a rare event. Preoperative surgical planning based on clinical evaluation and medical history as well as the use of an optimal surgical approach could minimize the risks of such an event occurring. An awareness of potential complications and a higher level of suspicion allow surgeons to recognize and treat problems quickly. Early responses have been shown to improve clinical outcomes.

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Footnote

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