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Review Article

Perspective on the true incidence of bowel perforations occurring with extreme lateral lumbar interbody fusions. How should they be treated?

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ABSTRACT

Background: What is the risk of bowel perforation (BP) with open or minimally invasive (MI) extreme lateral lumbar interbody fusion (XLIF)? What is the truth? Further, if peritoneal symptoms/signs arise following XLIF/MI XLIF, it is critical to obtain an emergent consultation with general surgery who can diagnose and treat a potential BP.

Literature Review: In multiple series, the frequency of BP ranged markedly from 0.03% (i.e. 1 of 2998 patients), to 0.08% (11/13,004), to 0.5%, to 8.3% (1 in 12 patients), up to 12.5% (1 in 8 patients). BPs attributed to different causes carry high mortality rates varying from 11.1% to 23%. For the 11 (0.08%) BP occurring out of 13,004 patients undergoing XLIF in one series, there was one (9.09%) death due to uncontrolled sepsis. In another series, where 31 BP were identified for multiple lumbar surgical procedures identified through PubMed (1960–2016), including 10 (32.2%) for lateral lumbar surgery including XLIF, the overall mortality rate was 12.9% (4/31).

Conclusion: The incidence of BPs occurring following XLIF/MI XLIF procedures ranged from 0.03% to 12.5% in various reports. What is the true incidence of these errors? Certainly, it is more critical that when spine surgeons' patients develop acute peritoneal symptoms/signs following these procedures, they immediately consult general surgery to both diagnose, and treat potential BP in a timely fashion to avoid the high morbidity (87.1%) and mortality rates (12.9%) attributed to these perforations.

Keywords: Bowel, Extreme lateral lumbar interbody fusion, Perforation, Real frequency, Validation, XLIF, Minimally Invasive (MI) XLIF

INTRODUCTION

What is the true risk of bowel perforation (BP) following open or minimally invasive (MI) extreme lateral lumbar interbody fusion (XLIF) [Table 1]?[1,2,5-22] Several studies identified vastly different frequencies of BP following XLIF/MI XLIF; the range varied from 0.03% (1/2988 patients), to 0.08% (11/13,004), to 0.5% (3/590), to 8.3% (1/12 patients), to 12.5% (1 of 8 patients) of cases.[7,10,15,16,21,22] Whatever the true frequency of BP with XLIF/MI XLIF, it is most critical that spine surgeons recognize that new postoperative peritoneal symptoms/signs of BPS so that general surgery can be immediately consulted to both diagnose, and potentially treat this medical error in a timely fashion.[19,22] Delays in diagnosing any type of BP are associated with high mortality

Table 1: Summary of literature.

Author Journal Date	Design	Population	Findings	Findings	Conclusion
Bielecki *et al.*[3] Tech Coloproctol 2002	LBP Morbidity MOR Peritonitis	59 Pts Emergent OR	16.9% MOR 18 Primary Anastomosis 11.1% MOR	22.2% MOR 36 Resection NO Anastomosis 5 Non Resections	"Radical aggressive approach is recommended for most patients with LBP"
Biondo *et al.*[4] Am J Surg 2002	212 Pts Emergency OR Left Colon Perf 1992-2000	Perforations: 133 (63%) Divertic 79 (37%) NonDivertic Divertic	Most Common Cause LBP -Distal Colon Peritonitis	Causes 13 Iatrogenic 30 Tumor 20 Ischemia 16 Other	27 (34%) Primary Resection + Anastomosis 18 (23%) MOR
Tormenti *et al.*[21] Neurosurg Focus 2010	8 AE MIS XLIF versus 4 Open TLIF Adult Scoli	2007–2009 F/O 1.5 Mos 1/8 (12.5%) BP XLIF LBP	Deficits 2/8 (25%) XLIF/TLIF Motor	Deficits 6/8 (75%) Sens Thigh Pares	BP 1/8 (12.5%) MIS XLIF XLIF LBP Intraop Repair
Marquez-Lara *et al.*[14] Spine 2014	NIS Data 2002–2011 543,146 Lumbar OR 414 SE (0.8/1000)	Sentinel Events Wrong Site OR Vascular Injury BP 0.06/1000= 30/543, 146 Bowel Perf	Mortality BP 20X Greater with Sentinel Events 14.6 versus 0.7 per 1000 Cases	Highest Mortality for BP and Vascular Injuries	Risk Death with SE: BP/Peritoneal Injury 200.9 X Greater versus Those with No Complications
Khajavi *et al.*[12] Eur Spine J 2015	MIS XLIF 160 Pts DSpond 68 DDD 20 ASD 26 Post Lam 46	Avg Age 61 66% F 37% Smokers 23% DM F/U 19 mos	197 Levels XLIF Avg 1.2/Pt No Pseud No Instrument Failures	1 (0.6%) Major AE No BP 12% Minor 14% Sens 9% Iliop Motor	XLIF Significant Improvement Outcomes Low AE
Balsano *et al.*[2] Eur Spine J 2015	Case Report 1 Bowel Perf XLIF	Bowel Injury 70-year-old	L3-L4 And L4-L5	Lateral Transpsoas Approach	XLIF Fusion 1 Bowel Perf
Uribe *et al.*[22] Eur Spine J 2015	13,004 MIS-LIF- 25 Ortho 15 Neuro Pros XLIF Avoid Posterior Element Disruption	11 (0.08%) Bowel Perf Literature BP: ALIF 1.7% TLIF 1.2%	Data 10 of 11 BP Avg Age 59 All Fusions 10 BP-Surgeon Experience 0-10 None 11-50 Cases (3 Surgeons) Over 50 cases (7 Surgeons)	Surgery 11 Patients 6 Laparotomies (Debride/Colectomy) 3 Colostomy 2-Insufficient Data When-BP Surgery 4 Intraoperatively 6 Early Postop (Days 2 (1 case), 3(2 cases), 5(1 case), 1 (no date)	Outcomes 10 5 Full Recovery 1 Colostomy 1 Died Sepsis 1 Colon Repair 2 Lost F/O
Isaacs *et al.*[10] Spine 2016	2 Year Outcomes MIS XLIF versus MIS TLIF DSpond+ST 24 mos F/U	1-2 Adjacent Levels L1-L5 Prospective Randomized Observational	29 XLIF 26 TLIF More Canal Area MIS TLIF 43.1 mm versus XLIF 4.1 mm	100% Fused XLIF versus 96% Fused TLIF CT Bridging bone	Both Significant Neurological Improvement
Epstein *et al.*[5] SNI 2016 S656	AE of XLIF Symp MVI Bowel Perf Sterile S Instr Fail	Deficit 4% Symp XLIF versus 15% ALIF 1 Sterile S	3 MVI XLIF 1 Fatal 1 RH/Life Threatening 1 LP Injury/Sens	3 LBP 45% Risk Cage Overhang	3 Bowel Perf Literature Review (2 Cases) 1 Communication

(*Contd...*)

Table 1: (*Continued*).

Author Journal Date	Design	Population	Findings	Findings	Conclusion
Segawa *et al.*[18] J Spine Surg 2017	MicroEnd XLIF 96 Pts One Surgeon	84 1- Level 9-2 Level 3-3 Levels Avg 1.2 Levels/pt	Average Age 61 years Range 22-83 F/U 18 mos	3 (3.1%) AE 2 End Plate Fractures 1 Deep SSI No Bowel Perf No MVI	MicroEnd XLIF "… one solution for severe visceral and vascular injuries related to XLIF"
Pereira *et al.*[16] J Clin Neurosci 2017	XLIF for ST DSpond 23 Pts 91% ST 35% Prior Surgery	Retrospective VAS ODI 48% Sens-LS 1 RH Treatment No Surgery	XLIF Pros Restore Disc Height Improved Radiculopathy No BP	61% Improved Cobb Angle 11% Correction Lordosis	XLIF "…suited to treating complex … degenerative disease"
Fujibayashi *et al.*[7] Spine 2017	2 Years Japan 2988 Cases XLIF 1995 OLIF 1003 71 Sites	Retrospective Survey 2013–2015 Response Rate 86.1%	540 AE 474 (84.8%) Analyzed AE 18% 5.15 Sens 4.3% Motor	0.03% Vascular Injury 0.03% Lower Bowel Perf LBP 0.7% SSI 2.2% Reop	More BP/Peritoneal Laceration OLIF
Paterakis *et al.*[15] J Spine Surg 2018	12 XLIF Deg. Scoli w/wo Instr. Fusion	2008–2017 Retrospective. VAS, ODI Cobb-Angle	All 12 F Avg age 64.5 F/U 28 mos	XLIF-Improved Pain, Scoliosis Lordosis	1 (8.3%) of 12 LBP-Bowel Perf Primary Anastomosis
Siasos *et al.*[19] J Spine Surg 2018	31 BP Lumbar OR 1960-2016 10/31-32.3% XLIF, ALIF TLIF 15-L5S1 16-L45	18/31 (58.1%) Lumbar Disc Symptoms-Signs-Sepsis, Abdominal Pain, Vomiting, Hypotension Peritonitis	Time to Diagnosis 3 Intraop 12<2 Days- 5-2-7 Days 4-1 Week-1 yr	Abdominal Pelvic CT-Fluid in Abdomen, PneumoP, Abscess Instruments Close to Bowel Timely Treatment Reduced Mortality	MOR 4/31 (12.9%) Morbidity 87.1% (27)
Tamburrelli *et al.*[20] Eur Spine J 2018	MIS XLIF Lysis/ Spond XLIF+PLF (Percutaneous PS Fusion)	Correction Vertebral Slip 56.3% VAS Improved form 7.1 to 2.2	ODI Improved 36.8% to 24.1% SF 36 Physical Health 83.2% 1 yr	CT 1 yr-No Loosening "XLIF"… good correction of the listhesis…	XLIF for Lysis/Spond Reliable and Safe
Li *et al.*[13] World Neurosurg 2019	Learning Curve for 1st 30 Cases (2014) OLIF versus XLIF	Lumbar OR Disc, Stenosis, DS, Infection, Trauma, Tumor Findings Same OR Time, LOS, EBL F/O 24 mos	Avg Age XLIF 58.4 OLIF 56.1 XLIF 24 1-Level, 4 at 2 Levels, 2 at 3 levels XLIF Levels 5 L23, 9 L34 24 L45	AE OLIF 33.3% (9 Cases) 3 Vascular 0 BP Other 1 Cage in canal, 2 Root injuries, 1 Sympathetic Chain Injury, 1 cage Displacement, 1 End Plate Injury	Lower AE XLIF 10% 3 Cases (1 Infection, 1 End Plate Injury. 1 sensory) 0 Vascular 0 BP
Epstein[6] SNI 2019	Review AE XLIF-20 Studies 1080 XLIF	Deficits 30-40% Nerve Injury: 12.3%Lumbar PL, Ilioinguinal Iliohypogastric Genitofemoral LFC, SUBC, Symp	Deficits .04% Vascular Other: BP, Ileus, Sterile S 7.5% Pseud SUBS, Reop	Literature Review 12.3% Plexus Injuries 0-75% Sens UT 40% Motor UT 34% Thigh Pain	"Most XLIF studies are limited by study design, sample size, and potential conflicts of interest"

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Table 1: (*Continued*).

Author Journal Date	Design	Population	Findings	Findings	Conclusion
Rustagi *et al.*[17] Global Spine J 2019	590 XLIF 3 BP No BP for: 171 ALIF, 14 OAIF Avg Time to Diagnosis 4.7 Days (Range 3–7)	3 BP Due to XLIF-3 F, Avg age 74.3 Symptoms Abdominal Pain Distention Fever Nausea/ Vomiting Sepsis	Abdominal/ Pelvic CT- Extraluminal Trapped Air Loss Bowel Continuity Increased Bowel Wall Thickness	Levels/Surgery L45-1 L2-4 XLIF/L2-S1 PF-1 L2-L5 XLIF-1 3 BP Operations Ileocecotomy/Side/ Side Anastomosis (1) Colectomy/ Ileostomy (1) Colectomy/End/End Anastomosis (1)	Outcomes 3 Good Quoted Literature Visceral Injuries with Anterior Procedures 0–5%
Aoki *et al.*[1] Sci Rep 2020	Prevalence Lumbar Lysis and Spond with Deg ST	Lumbar Lysis Mostly Occurs in Adolescent Athletes	580 Pts 37 (6.4%) Lysis 19 (51.4%) of 37 Spond	90% DSpond age ≥60 s-Most No surgery	Majority Lysis/Spond 60/> Often Seen
Hiyama *et al.*[8] Sci Rep 2020	Preop versus Postop 62 MIS XLIF versus 44 MIS TLIF for DSpond+ST	F/U 12.6 mos XLIF Shorter OR 109 min versus 153 min TLIF	EBL Less XLIF 85.4 ml versus TLIF 258 ml; Same Outcomes	XLIF Preserved Facet Joints, Lamina, Parasp Musc	Higher Rate Improvement of LBP for XLIF versus TLIF
Hwang *et al.*[9] Asian Spine J 2021	Review BP versus PneumoP LLIF 2/140 Cases of BP (2016–2018) Study 90 LLIF APCT 48 h Postop	2 BP Cases: 75 yo L23, L45, L5S1-Colostomy 78 yo L45 LLIF Infection-2nd L34/ L45 LLIF- 5 Days BP-Colostomy	APCT Found 5 (5.5%) No BP but +PneumoP Symptomatic Abdominal Pain/ Fever Peritoneal Signs	Risk Factors-BP LLIF >3 Fusion Levels Surgery L23/L34 levels CT 48 h: PneumoP May Lead to Peritonitis	Recommend Routine 48 hr Postop APCT Rule Out BP versus PneumoP

Deg. Scoli: Degenerative Scoliosis, Instr.: Instrumented, F: Female , XLIF: Extreme Lateral Lumbar Interbody Fusion, Retrospect: Retrospective, VAS: Visual Analogue Scale, ODI-Oswestry Disability Scale, w/wo: with/without, mos: Months, AE: Adverse Events, MP: Meralgia Paresthetic, BP/Bowel Perf: Bowel Perforation, Anas: Anastomosis, Neurol: Neurological, Symp: Sympathectomy, MVI: Major Vascular Injuries S: Seroma, Instr Fail: Instrumentation failures, RH: Retroperitoneal Hematoma, IP: Iatrogenic Pseudoaneurysm, DCom: Direct Communication, Inj: Injuries, Pl: Plexus, LFC: Lateral Femoral Cutaneous, SUBC: Subcostals Postop: Postoperative, Pseud: Pseudarthrosis, SUBS: Subsidence, Reop: Reoperations, Sens: Sensory, UT: Up to, LP: Lumbar Plexus, Ant: Anterior, PS: Pedicle Screw, MI/MIS: Minimally Invasive, TLIF: Transforaminal Lumbar interbody Fusion, LAP: Lapatoromy, BR: Bowel Resection, Pares: Paresthesias, LIF: Lateral Interbody Fusion, SSI: Surgical Site Infection, OLIF: Oblique Lateral Interbody Fusion, SS: Spinal Disease, Lysis: Spondylolysis, Spond: Spondylolisthesis, Deg: Degenerative, Pts: Patients, DSpond: Degenerative Spondylolisthesis, MI/MIS: Minimally Invasive, EBL: Estimated Blood Loss, Parasp: Paraspinal, Musc: Muscles, ST: Stenosis. F/O: Followed, DDD: Degenerative Disc Disease, ASD: Adjacent Segment Disease, Post Lam: Post Laminectomy Syndrome, DM: Diabetes, Avg: Average, Micro End: Microendoscopic. LBP: Large Bowel Perforation, Divertic: Diverticulitis, MOR: Mortality, MIS-LIF: Minimally Invasive Lateral Interbody Fusions, ALIF: Anterior Lumbar Interebody Fusion, GI: Gastrointestinal System, OAIF: Oblique Anterior Lumbar interbody Fusion, NIS: Nationwide Inpatient Sample, PneumoP: Pneumoperitoneum, LLIF Lateral Lumbar Interbody Fusion, APCT: Abdominal Pelvic CT, Neuro: Neurological,, PF: Posterior Fusion, SE: Sentinel Events, OR: Operation/ Surgery, Perf: Perforation, Ortho: Orthopedic, Neuro: Neurosurgery, yo: Year Old

rates ranging from 11.1-23%.[3,4] Notably, specific mortality rates for BP occurring in patients undergoing XLIF/MI XLIF ranged from 9.09% (1/11 BP in 13,004 XLIF patients) to 12.9% (4/31 BP occurring in a series of 18 patients following diskectomies/microdiskectomies, and 10 lateral procedures including XLIF).[19,22]

FREQUENCY OF SPONDYLOSIS WITH ISTHMIC SPONDYLOLYSIS AND SPONDYLOLISTHESIS

In 2020, Aoki *et al.* reviewed 580 cases of lumbar spondylosis; 37 (6.4%) patients had spondylolysis, with 19 of 37 additionally demonstrating spondylolisthesis (51.4%) [Table 1].[1] They

emphasized that spondylolysis/spondylolisthesis defects were most typically reported in adolescent male athletes. Notably, these are the patients who may be specifically targeted for canal distraction/decompression with XLIF/MI XLIF supplemented with posterolateral fusions (PLF) performed utilizing pedicle screw instrumentation as these combined procedures offer preservation of the posterior elements.

XLIF SUPPLEMENTED WITH POSTERIOR LATERAL FUSION (PLF) WITH PEDICLE SCREW INSTRUMENTATION FOR SPONDYLOLYSIS/ SPONDYLOLISTHESIS

In select patients with isthmic spondylolysis/ spondylolisthesis, XLIF/MI XLIF may be combined with posterolateral instrumented pedicle screw fusions to provide simultaneous anterior indirect canal decompression with posterior stabilization/fusion (PLF).[20] This combination of procedures avoids disruption of the posterior elements (i.e. facet joints, laminae, spinous processes) [Table 1].[20] In Tamburrelli *et al*. (2018), MI XLIF were performed to address isthmic spondylolysis with spondylolisthesis, and were effectively supplemented with percutaneous pedicle screw fusions (PLF). This provided; "a reliable and safe option to the most common open procedures," that usually included TLIF, while allowing for "good correction of the listhesis."[20]

DIFFERENT FREQUENCIES OF BOWEL PERFORATIONS REPORTS FOR XLIF/MI XLIF

For multiple series, the incidence of BPs attributed to XLIF/MI XLIF ranged between 0.03% to 12.5%; this left us questioning the true incidence of this surgical error [Table 1].[2,7,9,15,17,19,21,22] Specifically, BPs occurred in one case report, and with higher numbers of cases reported in other clinical series [Table 1].[2,5,7,9,15,17,19,21,22] In 2015, Balsano *et al*. described a 70-year-old male who, following a L3-L4/ L4-L5 XLIF, developed a BP.[2] Tormenti *et al*. (2010) found 1 (12.5%) BP occurring after performing just 8 MI XLIF (2007–9).[21] Uribe *et al*. (2015) noted that out of 13, 004 MI XLIF, there were 11 BPs. [22] Surgeons in this study were experienced with XLIF/MI XLIF as they had performed between 11 to 50 cases or over 50 cases.[22] When Fujibayashi *et al*. (2017) looked at 1995 patients undergoing XLIF with another 1003 having oblique lateral lumbar interbody fusions (OLIF), there was just one case (0.03% of 2988 patients) of a BP.[7] Paterakis *et al*. (2018) later found that 1 of 12 patients (8.3%) undergoing XLIF for degenerative scoliosis sustained a BP (i.e. treated with a primary resection/anastomosis).[15] In 2018, Siasos *et al*. documented 31 BPs; 10 occurred after MI lumbar operations; (i.e. XLIF, anterior, lumbar interbody fusion [ALIF], and transforaminal lumbar interbody fusion [TLIF}), while 18 followed lumbar diskectomies/ microdiskectomies).[18] In 2019, Rustagi et al. found 3 (0.5%) of 590 XLIF resulted in BP.[17] Finally, Hwang *et al*. (2021) determined that 2 of 140 LLIF resulted in BP.[9]

STUDIES NOT SPECIFICALLY REPORTING THE INCIDENCE OF BOWEL PERFORATIONS

Four clinical series, involving between 23 and 96 patients per study, did not discuss BP as occurring following XLIF/ MI XLIF [Table 1].[8,10,16,18] In a prospective, multicenter combined randomized/observational series, Isaacs *et al*. (2016) looked at the 2 year outcomes for 1–2 adjacent-level L1-L5 MI XLIF (29 patients) versus MI TLIF (26 patients).[10] These were performed to address degenerative spondylolisthesis and stenosis; no bowel perforations were observed.[10] When Segawa *et al*. (2017) assessed the safety/ efficacy of microendoscopic 1–3 level XLIF performed in 96 patients, they reported no BPs or vascular injuries.[28] They attributed this to the introduction of the microendoscopy technique.[18] When Pereira *et al*. (2017) evaluated 23 XLIF, they too encountered no BPs.[16] Additionally, no BPs were cited in the Hiyama *et al*. series that compared the complications of 62 MI XLIF versus 44 MI TLIF.[8] Of interest, they also found that XLIF operations were nearly 1/3 shorter than TLIF, the average blood loss of MI XLIF was reduced by 2/3, while the XLIF/MI XLIF procedures offered the benefit of preserving the posterior elements.[8]

SIGNIFICANT INCIDENCE OF NEUROLOGICAL, VASCULAR, AND OTHER INJURIES WITH XLIF/MI XLIF

Many XLIF/MI XLIF studies cited high frequencies of new sensory (i.e. 5.15–75% including thigh paresthesias), new motor (5.15–40% - typically iliopsoas), and vascular (0.03–0.04%) injuries [Table 1].[6,7,12,13,16,18,21] Other postoperative complications included; 0.7% plus incidence of surgical site infections, end plate injuries/fractures, retroperitoneal hematomas, sterile seromas, postoperative ileus, pseudarthrosis, and the need for additional surgery.[7,13,16,18]

LEARNING CURVE FOR XLIF VERSUS OLIF

In Li *et al*. (2019), the learning curve for the first 30 cases of XLIF versus OLIF were studied in patients undergoing lumbar surgery for disc disease, stenosis, degenerative spondylolisthesis, infection, trauma, or tumor.[13] There was a 10% incidence of adverse events (AE) occurring within the early learning curve for 1-3 level XLIF versus 33.3% for OLIF. Patients were on average in their late fifties, and although none developed BP in either group in this series, 3 undergoing OLIF had major vascular injuries, while 3 patients having XLIF sustained minor

complications (i.e. 1 infection 1 end plate injury, and 1 new sensory deficit).

FREQUENCY OF BOWEL PERFORATIONS WITH XLIF/MI XLIF

Vastly different frequencies of BPs occurred in patients undergoing XLIF/MI XLIF, ranging from 0.03% to 12.5% [Table 1].[7,9,15,19,21,22] Most critically, when patients develop new postoperative peritoneal symptoms/signs (i.e. abdominal pain, hyperemesis, hypotension, peritonitis, and sepsis), spinal surgeons should immediately consult general surgeons to both diagnose and surgically manage BPs if diagnosed and warranted. In Siasos *et al.*, 3 cases of BP were diagnosed intraoperatively, while the remainder were diagnosed/operated on between 2 days and 1 week/1 year postoperatively[19] For 3 of the 590 patients in Rustagi *et al.* series, the diagnosis of BPs led to surgery performed an average of 4.7 days (range 3–7) postoperatively.[17]

DIAGNOSTIC FINDINGS FOR BOWEL PERFORATIONS ON ABDOMINAL/PELVIC CT SCANS

Multiple studies also confirmed common findings on Abdominal/Pelvic CT scans (APCT) consistent with/diagnostic of BPs following XLIF/MI XLIF.[17,19] These findings included; fluid in the abdomen, pneumoperitoneum, instrumentation close to the bowel, extraluminal trapped air, loss of bowel continuity, and increased bowel wall thickness.[17,19] Of interest, Rustagi *et al*. (2019) noted: "The isolated presence of air/fluid in the retroperitoneal space is easily confounded by the presence of expected postoperative findings following TPIF (i.e. XLIF)."[17] Alternatively, after observing 2 instances of BP out of 140 patients undergoing LLIF, Hwang *et al*. (2021) prospectively performed APCT within 48 postoperative hours.[9] Out of 90 LLIF, they found that APCT studies performed in 5 patients (5.5%) with peritoneal symptoms had pneumoperitoneum; despite this, there were no documented BPs.[9] They further correlated an increased risk of BP with LLIF fusion of more than 3 levels, and surgery performed at the L2-L3, and/or L3-L4 levels.

TREATMENT OF BPs OF ALL ETIOLOGIES

High mortality rates are reported for BPs occurring due to many different factors (i.e. especially diveriticular disease, and non-diverticular disease exclusive of spinal surgery) [Table 1].[3,4] One series cited an 11.1% mortality rate where primary resections/anastomoses were possible, but a 22.2% mortality if these were not feasible.[3] The second study found an overall 23% mortality rate for BP, that included consideration of diverticular (133 patients) and non-diverticular-related (79%) perforations.[4]

HIGH MORTALITY RATE FOR BOWEL PERFORATIONS FOLLOWING XLIF/MI XLIF

High mortality rates (i.e. up to 12.9%) are reported for BPs occurring due to XLIF/MI XLIF.[14,17,19,22] This, therefore, warrants that patients presenting with new peritoneal signs following XLIF/MI XLIF should immediately undergo evaluation by general surgery to diagnose and potentially treat BPs. In Marzuez-Lara *et al.* (2014) National Inpatient Database involving 543,146 patients undergoing lumbar surgery, 30 patients had BPs/peritoneal injuries; they had a 20 fold greater mortality rate when compared to those without such intraoperative erros (i.e. 14.6 vs. 0.7/1000 cases).[14] In Uribe *et al.* (2015), 11 (0.08%) out of 13,004 patients following MI XLIF had BPs.[22] Repairs were performed intraoperatively (4 cases), or between postoperative days 2–5; the result was 1 death from sepsis, 5 full recoveries, one permanent colostomy, while 3 were lost to follow-up.[22] For the 31 BPs identified in Siasos *et al*. review (2018), including 10 due to XLIF, ALIF, and TLIF, surgery to address BPs were performed intraoperatively (3 cases), and up to 1 week/1 year postoperatively.[19] Further, when Rustagi *et al*. operated on 3 (0.5%) BPs out of a series of 590 patients undergoing XLIF, they were diagnosed and operated on an average of 4.7 days postoperatively, resulting in no deaths, but one permanent ileostomy.[17]

CONCLUSION

The incidence of BPs reported following XLIF/MI XLIF procedures ranged from 0.03% up to 12.5% in multiple studies.[7,8,15,17,19,21,22] Hence, it is apparent that the true incidence of BPs following these procedures is still not well defined [Table 1].[7,9,15,17,19,21,22] What is clear, however, is that patients who acutely develop peritoneal symptoms/signs following XLIF/MI XLIF should immediately undergo evaluation by general surgery to diagnose and potentially surgically treat BPs if warranted [Table 1].[3,4,14,17,19,22]

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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Commentary

Bowel injury in spinal surgery is an uncommon event but well documented for traumatic SCI with associated thoracolumbar fracture/dislocations, interbody spacer migration, and prominent anterior instrumentation. As more lateral, anterior, and redo lateral surgery is performed on an aging population and more spinal surgeons are doing their own approaches, bowel injury may increase. A low threshold for postoperative CT-abdomen/pelvis as a routine precautionary measure may be needed to minimize the potential missed bowel injury or to provide an earlier diagnosis of bowel perforation versus paralytic ileus. Early mobilization, minimization of postoperative narcotics, and optimization of intraoperative anesthesia during surgery can minimize the incidence of ileus in this patient group, but the quick diagnosis and management of bowel perforation is the key to minimizing morbidity and mortality. Early general surgery consultation should be sought in any spine surgery cases with a questionable abdominal exam or postoperative radiographic findings.

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