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Enterotomy and Mortality Rates of Laparoscopic Incisional and Ventral Hernia Repair: a Review of the Literature

Karl Andrew LeBlanc, MD, MBA, Melvin Joseph Elieson, MD, James M. Corder III, MD

ABSTRACT

Laparoscopic incisional and ventral hernia (LVIH) repair is becoming more popular throughout the world. Although individual series have presented their own information, few data have been collected to identify the risk of the most serious complication, enterotomy. A literature review has identified this to occur in 1.78% of patients who undergo this procedure. Large bowel injury represents only 8.3% of these injuries. Eighty-two percent of the time, these injuries will be recognized and repaired. In the majority of published series in which this occurred, the hernia repair was completed with a laparoscopically placed prosthesis, as only 43% were converted to the open procedure. Complications related to this approach are infrequent. The mortality rate of this operation was noted to be 0.05%. However, if an enterotomy occurred, it increased to 2.8%. A recognized enterotomy was associated with a mortality rate of 1.7%, but an unrecognized enterotomy had a rate of 7.7%. Careful technique and close inspection of the intestine at the completion of the adhesiolysis and the herniorrhaphy is recommended. If the hernia repair proceeds as planned following repair of enterotomy, continuation of antibiotics and the placement of an antimicrobial impregnated prosthesis are recommended. More study is necessary before firm recommendations can be made, as the majority of these events are most likely unreported. Safety concerns may require postponement of the hernia repair if an enterotomy occurs.

Key Words: Hernia, Laparoscopy, Enterotomy, Mesh.

INTRODUCTION

The use of the laparoscopic technique to repair incisional and ventral hernias (LIVH) has increased significantly throughout the world. The outcomes of LIVH repair have generally been shown to be superior to the open method of hernia repair. This is particularly true of open hernia repairs performed without mesh. As with all surgical interventions, certain risks can be disastrous if they occur. One such associated disaster is that of an enterotomy. The incidence of this complication has been reported to be from 0% to 14%. The current published data were reviewed to determine the incidence of enterotomy during laparoscopic incisional and ventral hernia repair and its associated mortality rate.

Little has been published to date to aid in the decision-making process when bowel injury occurs during LIVH repair. The rational concern of placing a prosthetic biomaterial into a contaminated field following bowel injury leads many surgeons to perform a compromised operation–opting to perform an open primary sutured hernia repair that has a significantly higher recurrence rate to avoid the risk of having an infected prosthetic biomaterial with its associated sequelae. The current published literature was also reviewed to ascertain the experience of surgeons and the results encountered when an enterotomy occurred.

METHODS

A literature search was conducted using the PubMed and Medline indices. Articles that involved laparoscopic incisional and ventral hernia repair were identified. Of those identified, case series with more than 50 patients in a series were included. Studies that compared open and laparoscopic techniques were also included to determine whether a true difference existed in the rates of bowel injury between the 2 approaches. Only the most recent article of any single author was included if it appeared that the series was reported earlier with the same patient cohorts. Retrospective, prospective, and randomized studies were all evaluated with the same methodology.

For the purposes of this research, an enterotomy was defined as a transmural injury that required suture closure,

Minimally Invasive Surgery Institute, Baton Rouge, Louisiana, USA (all authors).

Address reprint requests to: Karl A. LeBlanc, MD, MBA, FACS, Director, Minimally Invasive Surgery Institute, Baton Rouge, LA, and Clinical Associate Professor, Surgery, Louisiana State University School of Medicine, New Orleans, LA, 7777 Hennessy Blvd, Suite 612, Baton Rouge, LA 70808, USA. Telephone: 225 769 5656, Fax: 225 766 6996, E-mail: docmba2@aol.com

either laparoscopically or via a laparotomy. Nonsignificant serosal injuries were not considered an enterotomy for this study. An analysis was made to address the total number of patients who actually underwent the laparoscopic operation, including those who were converted to an open operation if an enterotomy occurred. Those who were converted for some other reason were not included in the totals to obtain a more accurate determination of the true incidence of this event. These were then divided into those that were recognized and those that were missed at the original operation. The repair of both the enterotomy and the hernia was also evaluated. Finally, the mortality related to the operation itself was recorded.

RESULTS

The results as shown in **Table 1**[1–34] and include all studies that were identified as defined above. The comparative series are relatively easily identified from those of Holzman[22] and those that follow his series in **Table 1**. These generally had a smaller patient sample than the series preceding them. It is interesting to note that of the 21 published noncomparative series, only 5 of them reported no enterotomies. Only 2 of these 5 had an experience that exceeded 100 patients. The 13 comparative series, in contrast, had 6 series that experienced an enterotomy. It should be noted that the average number of patients included in these latter comparative series was only 39 patients.

The incidence of incidental enterotomy in 3925 laparoscopic incisional and ventral hernia repairs was determined to be 1.78%. It was further determined that 82% of these injuries will be noted at the time of the operation, representing an incidence of 1.50% of the total number of patients. The more critical fact is that an enterotomy will not be recognized 18% of the time that it occurs. The overall incidence of unrecognized enterotomy is 0.33% in over 3900 patients. Unfortunately, this devastating complication (recognized or unrecognized) will result in the death of 2.8% of patients in which it occurs. It is somewhat reassuring to note, however, that the overall mortality of this procedure is only 0.05% in these series. Given the fact that many of these patients have had multiple prior procedures and comorbidities, this is a very low rate.

The management of recognized enterotomies and the method of hernia repair following the recognition of an enterotomy were also examined **(Table 2)**.[2,3,5,7–10,12,13,15–17, 20,22,24,29,30] Several of the articles were unclear as to the management of enterotomies (ie, conversion to laparotomy or laparoscopic repair) or the method of hernia repair following enterotomy. Therefore, **Table 2** lists only those studies in which these could be determined. It is somewhat surprising that only 43% of the cases listed in **Table 2** were converted to an open method to facilitate repair of the intestinal injury. The subsequent method of hernia repair was not always influenced by a conversion to a laparotomy. In 3 instances, an intestinal injury was repaired with the open method, then the intestine was returned to the abdominal cavity and the hernia was repaired laparoscopically as planned either immediately or after an interval delay.[7,10,17]

A frequent factor used to determine whether to proceed with repair of the hernia with a laparoscopically placed prosthesis following bowel injury was the presence or absence of gross spillage of intestinal contents. If there was minimal to no contamination, the hernia repair was performed as planned.[5,15,20,24] Large bowel injury represented 6/72 or 8.3% of these intestinal injuries. Of these 6 colonic injuries, 4 of these were repaired primarily, and the hernia repair was completed as planned.[10,12] One of the 2 other colonic injuries was converted to laparotomy for repair of the colotomy and hernia.[17] The sixth injury was unrecognized initially and was later treated with laparotomy, ileostomy, and patch removal with primary hernia repair (this hernia repair later failed in the follow-up period).[13]

Definitive laparoscopic hernia repair, following repair of enterotomy (whether repaired laparoscopically or open) was delayed 16% of the time. Most commonly, this delay was between 3 days to14 days, although it was as long as several months in a few instances. None of the articles offered evidence to support the interval of time delayed before hernia repair.

The unrecognized enterotomy is the most problematic event during this procedure. As noted earlier, this will occur in 18% of these injuries, representing an incidence of 0.33% in total number of patients at risk **(Table 1)**. The detection of this complication can be difficult, but it is usually noted on either the first or second postoperative day and based upon clinical suspicion, sometimes tachycardia alone. Occasionally, a computed tomographic (CT) scan was used to confirm the diagnosis.[21] Generally, not unexpectedly, the management was laparotomy, repair of the injury, and removal of the prosthetic biomaterial.[6,9,13,17,21,24,30] Even immediate recognition of a bowel injury and prompt repair during the initial operation did not always prevent further problems. Two series (ie, Berger and Ramshaw) had one patient each who required reoperation because the initial repair performed at the time of the hernia repair became insecure and subsequently leaked intestinal contents into the abdominal cav-

Table 1.
Enterotomy and Mortality Rates

Reference	Enterotomy (%)	Recognized Enterotomy (%)	Unrecognized Enterotomy (%)	Mortality (%)
Toy[1]	2/144 (1.4)	2 (1.4)	0	0
Kyzer[2]	2/53 (3.6)	2 (1.4)	0	0
Roth[3]	2/73 (2.7)	2 (2.7)	0	0
Chowbey[4]	0/202	0	0	0
Birgisson[5]	2/66 (3.1)	2 (3.1)	0	0
Moreno-Egea[6]	2/55 (3.6)	1 (1.8)	1 (1.8)	0
Parker[7]	2/50 (4)	2 (4)	0	0
Bageacu[8]	3/159 (1.8)	3 (1.8)	0	0
Ben-Haim[9]	6/100 (6)	4 (4)	2 (2)	0
Berger[10]	4/150 (2.7)	3 (2)	1 (0.67)	1 (0.67)
Aura[11]	0/85	0	0	0
Gillian[12]	3/100 (3)	3 (3)	0	0
Eid[13]	2/79 (2.5)	1 (1.25)	1 (1.25)	0
Chelala[14]	0/120	0	0	0
Carbajo[15]	10/270 (3.7)	9 (3.3)	1 (0.3)	0
LeBlanc[16]	2/193 (1)	2 (1)	0	0
Heniford[17]	13/819 (1.6)	12 (1.5)	1 (0.1)	0
Bower[18]	0/99	0	0	0
Sánchez[19]	0/85	0	0	0
Franklin[20]	5/369 (1.3)	5 (1.3)	0	0
Frantzides[21]	2/208 (1)	0	2 (1)	0
Holzman[22]	1/21 (5)	1 (5)	0	0
Park[23]	0/56	0	0	0
Ramshaw[24]	2/79 (2.5)	1 (1.25)	1 (1.25)	0
Carbajo[25]	0/30	0	0	0
DeMaria[26]	0/21	0	0	0
Zanghi[27]	0/11	0	0	0
Chari[28]	1/14 (14.2)	?	?	0
Robbins[29]	1/32 (3.1)	1 (3.1)	0	0
Wright[30]	5/87 (5.7)	3 (3.4)	2 (2.3)	1 (1.1)
Moreno-Egea[31]	0/11	0	0	0
Gonzalez[32]	0/32	0	0	0
Raftopoulos[33]	0/50	0	0	0
McGreevy[34]	1/62 (1.6)	0	1 (1.6)	0
Total all Patients	72/3925 (1.78)	59/3925 (1.50)	13/3925 (0.33)	2/3925 (0.05)
Total for Enterotomies Alone		59/72 (82)	13/72 (18)	2/72 (2.8)

The upper figures in the total are the results based on all of the patients. The lower figures are those resulting from the enterotomies alone.

Table 2.
Method of Recognized Enterotomy Repair and Hernia Repair

Reference	Conversion	Method of Enterotomy Repair		Method of Hernia Repair	
		Open	Lap	Open	Lap
Kyzer[2]	2/2	2	0	2	0
Roth[3]	1/2	1	1	1	1*
Birgisson[5]	0/2	0	2	0	1, 1*
Parker[7]	1/2	1	1	0	2*
Bageacu[8]	3/3	3	0	3	0
Ben-Haim[9]	4/4	4	0	4	0
Berger[10]	2/3	2	1	0	2, 1*
Gillian[12]	0/3	0	3	0	3
Eid[13]	1/1	1	0	1	0
Carbajo[15]	1/9	1	8	1	8
LeBlanc[16]	2/2	2	0	2	0
Heniford[17]	2/12	2	10	1	7, 4*
Franklin[20]	0/5	0	5	0	5
Holzman[22]	1/1	1	0	1	0
Ramshaw[24]	0/1	0	1	0	1
Robbins[29]	1/1	1	0	1	0
Wright[30]	3/3	3	0	3	0
Total (%)	24/56 (43)	24/56 (43)	32/56 (57)	20/56 (36)	27/56 (48) 9/56 (16)*

*Delayed laparoscopic repair.

ity. Both repairs were performed laparoscopically during the original hernia repair.[10,24]

The comparison studies revealed enterotomies in both the open and laparoscopic patients **(Table 3)**. As in **Table 2**, only those series that incurred an injury are listed. The numbers in the individual cells of the table indicate whether the enterotomy occurred via the open method and whether it was recognized or not. In other words, Holzman had only one enterotomy. This occurred in the laparoscopic group, therefore under "lap" and "recognized" the "1/1" indicates that he only had one and it was recognized. Under "lap" and "unrecognized", the "0/1" indicates that zero of the one enterotomies were unrecognized. He did not have a recognized or unrecognized enterotomy in the open group; therefore, "0/0" is indicated for each. The other series follow this same pattern. Overall, in these comparative series, the incidence of recognized enterotomy was 1.0% for the open procedure and 1.9% for the laparoscopic method. The unrecognized injuries occurred in 0.2% and 0.9% of the cases, respectively. As shown in the table, little difference existed in the percentage of enterotomies that were recognized and unrecognized in all of the comparative series based on the method of repair (eg, 83% vs 67% and 17% vs 33%). There were more in the laparoscopic group, but there was no statistical difference between the incidence of either the recognized or the unrecognized injuries between these 2 methods (P=0.44, Fisher's exact test). The only death in these series, however, occurred following an unrecognized laparoscopic enterotomy.[30]

DISCUSSION

The original intent of this literature review was to establish the true incidence of enterotomy and its associated outcomes during the laparoscopic repair of incisional and ventral hernias. As shown in the data, this occurred in 1.78% of 3925 cases. Surgeon experience did not influ-

Table 3.
Comparative Enterotomy Rates

Author	Recognized		Unrecognized	
	Open	Lap	Open	Lap
Holzman[22]	0/0	1/1	0/0	0/1
Park[23]	1/1	0/0	0/1	0/0
Ramshaw[24]	0/1	1/2	1/1	1/2
Zanghi[27]	1/1	0/0	0/1	0/0
Chari[28]	1/1	2/2	0/1	0/2
Robbins[29]	0/0	1/1	0/0	0/1
Wright[30]	2/2	3/5	0/2	2/5
McGreevy[34]	0/0	0/1	0/0	1/1
Total, All Comparative Series (%)	5/6 (83)	8/12 (67)	1/6 (17)	4/12 (33)
Total, All Pts. (%)	5/480 (1.0)	8/428 (1.9)	1/480 (0.2)	4/428 (0.9)

ence the rate of enterotomy, as expected. Some of the smaller series had the lowest rate of enterotomy. This would indicate that the statistical probability of enterotomy increases with larger numbers of patients. This inversely proportional complication rate with surgeon experience might be due in part to the fact that the more experienced surgeons will likely attempt to manage more difficult patients thereby increasing the risk of this occurrence. The comparative series had relatively more enterotomies. This is likely due to the fact that these were early in the experience of the surgeons. Therefore, not surprisingly, inexperience probably plays a significant role in this complication as well. Consequently, surgeon experience may play a role in these procedures in the early stages of the learning curve but may not be as important with greater numbers of cases as these will undoubtedly be more difficult. In other words, this risk is always present and unavoidable but for potentially different reasons.

As anticipated, the small bowel proved to be the most frequently affected organ and was the site of injury 92% of the time. The method chosen to repair either the colon or small intestine was generally determined by the extent of the injury and the skill level of the surgeon. If one were proficient in performing a laparoscopic repair of the affected organ, then proceeding laparoscopically would be prudent. If not, then the obvious course should be to perform a laparotomy to repair the injury. Regardless of the method of enterotomy repair, only 2 patients in a single series had any adverse outcomes subsequent to concomitant laparoscopic hernia repair.[10] However, in both of these patients, the subsequent complications were not related to proceeding with repair of the hernia. Rather, one repair leaked postoperatively and the other was repaired open but had a second unrecognized injury to the small intestine that was initially missed laparoscopically and still missed following conversion to open. Therefore, if an enterotomy is recognized, either colonic or small bowel, and a sound repair can be effected either open or laparoscopically, these data suggest that the prosthetic repair of the hernia can safely proceed as intended. This, of course, would be contingent on the lack of any significant contamination. However, the small number of cases in these series makes such a firm statement difficult. Caution must be exercised if this course of action is taken. On the other hand, if significant contamination does exist, the repair can either be performed by the open tissue repair method at the initial operation or laparoscopically with the placement of a prosthetic biomaterial after delaying for several days. No scientific basis has been offered for the chosen number of days delayed before hernia repair following enterotomy with contamination. The usual time frame reported was generally within one week. The patient should probably be maintained on antibiotics during that time; however, there was only brief discussion regarding this recommendation in the literature.[17] We have preferred to wait just 3 days to 4 days to return to the operating theater to avoid the development of dense intestinal adhesions. In the few cases that this has been done, no adverse sequelae developed.

Most active laparoscopic surgeons hold the opinion that a colonic injury poses a threat of infection too great to proceed with placement of a prosthetic biomaterial to

repair the hernia. However, in those series in which a recognized colonic injury occurred, some were repaired primarily with concomitant hernia repair as planned.[10,12,17] Others, however, chose to repair the colonic injury and performed either a primary tissue repair or a delayed laparoscopic repair of the hernia.[16,17] Based on these data, it may be permissible to repair the hernia with a prosthesis even in the presence of a colonic injury if an antimicrobial-impregnated prosthesis is used. However, as with small intestinal injuries, one must be certain that no contamination exists. But as noted earlier, more study in this area is warranted before any strong recommendations can be made regarding this approach, because only a small number of these patients heretofore have been reported.

Of the 34 intestinal repairs performed in association with a prosthetic hernia repair, whether repaired open or laparoscopically, only 2 patients experienced adverse consequences **(Tables 2 and 3)**.[10,24] Although even one anastomotic failure might be considered too many, it is somewhat comforting that a failure rate of 6%, as seen in these case series is within the range of expectation of such an intestinal repair. Unfortunately, one of these injuries resulted in the death of the patient.[10] There were, however, no adverse consequences (ie, mesh infection) related to concomitant hernia repair with a prosthetic biomaterial in any patient.

The only other death in these series was the result of an unrecognized enterotomy.[30] The causes of both deaths in these series were similar in that both patients experienced leakage of bowel content postoperatively. It can be said that the major cause of death following this procedure will be a consequence of enterotomy, whether it be colonic or small intestine, recognized or unrecognized. The mortality rate of this procedure (0.05%) is quite near that of other laparoscopic procedures, such as cholecystectomy. However, when an enterotomy does occur, the mortality increases to 2.8%. The mortality of a recognized enterotomy is 1.7% (1/59); however, the mortality rate of an unrecognized enterotomy is 7.7% (1/13), 4 and 1/2 times higher. Although this injury cannot be avoided in all cases, the surgeon should perform an inspection of the intestine and abdominal cavity following adhesiolysis and again upon completion of the herniorrhaphy in an effort to identify any missed injuries.

The comparative series did show that enterotomy will occur with both techniques and that some will be missed even with the open method. In these series, the only mortality was in the laparoscopic group. Due to the low rate of this event, a larger number of patients is needed to draw a firm conclusion as to the difference in the death rates between these 2 techniques.

We would be remiss if we did not acknowledge the fact that there are probably a few, or possibly, many deaths that are unreported subsequent to an unrecognized enterotomy during this procedure. There are undoubtedly numerous surgeons with varying degrees of experience that have not reported their personal series in the literature. Therefore, the true rate of enterotomy and mortality probably exists at a higher level than this literature review reports. The results of this analysis should serve to provide the reader with a synopsis of the currently published data upon which to base surgical decision-making. Although careful technique will not avoid all complications, vigilance and early identification of unrecognized enterotomies will minimize fatal results.

A thorough review of the current literature has revealed that the occurrence of an injury to the intestine during laparoscopic incisional and ventral hernia stands at 1.78%. Should this occur, the hernia repair could be completed laparoscopically (or open) with the use of a prosthetic biomaterial. The use of an antimicrobial impregnated product and systemic antibiotics is recommended. The overall mortality of patients undergoing this procedure is 0.05%. If an enterotomy occurs, the mortality increases to 2.8%. A recognized enterotomy is associated with a mortality rate of 1.7%, but an unrecognized enterotomy is associated with a rate of 7.7%. As always, careful and skillful technique should be performed. Despite excellent surgical skill, vast experience, and careful dissection, laparoscopic incisional and ventral hernia repair carries with it the risk of morbidity and mortality.

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