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Open abdominal surgery: a risk factor for future laparoscopic surgery?

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Abstract

BACKGROUND: This study seeks to investigate the outcomes of laparoscopic procedures in patients with previous open abdominal surgery.

METHODS: Using data from the National Surgical Quality Improvement Program (2005 to 2009), we identified patients who had undergone laparoscopic cholecystectomy, Nissen fundoplication, Heller myotomy, splenectomy, Roux-en-Y, sleeve gastrectomy, gastric band, appendectomy, or colectomy. Patients were then classified as to whether adhesiolysis (AD) was also carried out. Bivariate and multivariate analysis was used to compare groups.

RESULTS: A total of 162,415 patients met our inclusion criteria, comprising 4,501 (3%) in the AD group and 157,913 (97%) in the nonadhesiolysis (NAD) group. Patient who had received lysis of adhesion were older, had 41% higher odds of overall complications, 17% higher adjusted mean lysis of adhesion ($P < .001$), and 26% higher adjusted mean operation duration ($P < .001$).

CONCLUSIONS: A history of previous open abdominal surgery increases the potential complication rate and hospital length of stay during subsequent laparoscopic surgery. The extent of this relationship deserves further investigation.

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Most surgeons would agree based on personal experience that reoperating on the abdomen can be challenging. Scar tissue and adhesions can prevent safe entry into the abdominal cavity, and predisposing the bowel or other intra-abdominal organs to a higher risk of injury. There is certainly no shortage of data describing this phenomenon.[1–5] However, with respect to laparoscopic surgery, the challenges of previous adhesions are unique. The initial entry is still fraught with risk, but lysis of adhesions can be performed under "direct" vision and with magnification.[6,7] At our center, we have observed that patients with previous laparoscopic surgery requiring reoperation showed significantly less scarring than their counterparts who had a history of prior laparotomy. In fact, on numerous occasions, the resultant adhesions from previous open abdominal surgery proved deceptively troublesome by impeding safe entry into the abdomen, reducing the working space within, placing the bowel and other organs in peril, and consequently extending the length of the procedure and hospital stay. Through this experience, we sought to investigate more fully the relationship between previous open abdominal surgery and subsequent laparoscopic surgery.

The authors declare no conflicts of interest.

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Methods

We used data from the American College of Surgeons National Surgical Quality Improvement Program (2005 to 2009) databases. The American College of Surgeons National Surgical Quality Improvement Program collects data on preoperative risk factors, intraoperative characteristics, and 30-day postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures in both inpatient and outpatient settings at participating hospitals.

Using the American Medical Association's Current Procedural Terminology codes, we identified all patients who have undergone at least one of the following: laparoscopic cholecystectomy (47,562), laparoscopic Nissen fundoplication (43,280), laparoscopic Heller myotomy (43,279), laparoscopic splenectomy (38,120), laparoscopic Roux-en-Y (43,644), laparoscopic sleeve gastrectomy (43,775), laparoscopic gastric band (43,770), laparoscopic appendectomy (44,970), or laparoscopic colectomy (44,210, 44,206) for colon neoplasm (International Classification of diseases, 9th Edition, Clinical Modification [ICD-9-CM] diagnosis codes 153.x or 211.3). We then stratified the study cohort into 2 groups based on whether laparoscopic adhesiolysis (AD) (identified by the Current Procedural Terminology code 44,180) was also performed during the primary procedure: AD group and nonadhesiolysis group (NAD).

Patients' information retrieved include age, sex, race/ethnicity, behavioral risk factor (current smoker within 1 year of operation), body mass index (BMI) (categorized as normal weight, overweight, obese, or morbidly obese), preoperative functional status (categorized as independent, partially dependent, or totally dependent), and comorbidities. Comorbidities were classified into 4 groups: cardiac (including congestive heart failure within 30 days before surgery, a history of myocardial infarction 6 months before surgery, previous percutaneous coronary intervention, previous cardiac surgery, or history of angina within 1 month before surgery); renal (including acute renal failure or preoperative dialysis); pulmonary (including history of severe chronic obstructive pulmonary disease, current pneumonia, ventilator dependent, or coma >24 hours); and diabetic (diabetes mellitus). Additionally, information on the level of attending surgeon involvement (categorized as in the database into attending in the operating room, attending alone, or attending not present) as well as the duration of surgery were also retrieved.

Outcomes investigated include 30-day mortality and postoperative complications. Postoperative complications were further identified as overall, wound infection, respiratory, cardiovascular, septic, and renal complications. Respiratory complications included pneumonia, unplanned intubation, pulmonary embolism, or ventilator use for greater than 48 h. Wound infection complications included superficial surgical site infection (SSI), deep incisional SSI, organ space SSI, or wound disruption. Cardiovascular complications included cardiac arrest or myocardial infarction. Renal complications included acute renal failure, progressive renal insufficiency, or urinary tract infection. Overall complications included any of the above complications or a return to the operating room.

Bivariate analyses were conducted using Pearson's chi-square test for categorical variables and Student *t* test for continuous variables. Multivariate logistic regression analyses were performed to assess the odds of postoperative complication and mortality, comparing the AD with NAD, while adjusting for patient demographics, BMI, preoperative comorbidities, functional status before surgery, smoking history, and attending involvement. Multivariable Poisson regression analyses were also carried out comparing AD with NAD on postoperative length of hospital stay and operative time, also controlling for patient demographics, BMI, preoperative comorbidities, functional status before surgery, smoking history, and attending involvement.

All statistical analyses were done using STATA/MP version 12.0 (Stata Corp, College Station, TX). Statistical significance was defined as P value less than .05.

Results

A total of 162,415 patients were studied. The majority was female (67.3%). Whites accounted for 69% of the population, Hispanic 9.9%, Blacks 9.5%, and 8.4% lacked ethnicity data. The majority of patients were between the ages of 25 and 64 years (76.9%). Over 90% (91.5%) of the study population was overweight or obese; 18.1% were smokers. Additionally, 34.8% had pre-existing cardiovascular disease and 1.9% had pulmonary disease, while .4% suffered from renal disease. The most common laparoscopic operations were cholecystectomy (36.5%), appendectomy (29.5%), and Roux-en-Y gastric bypass (17.5%). We found that 2.8% of patients had lysis of adhesions (AD group). In total, the overall complication rate was 4.8% and major complication rate was 2.8% ($P < .05$). The majority of the latter were SSIs (2.1%; $P < .05$). The odds ratios for AD and overall and major complications were 1.4 (95% confidence interval 1.2 to 1.6) and 1.5 (95% confidence

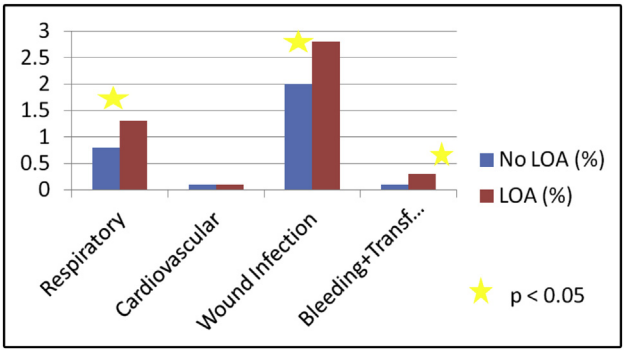

Figure 1 Incidence of postoperative complications.

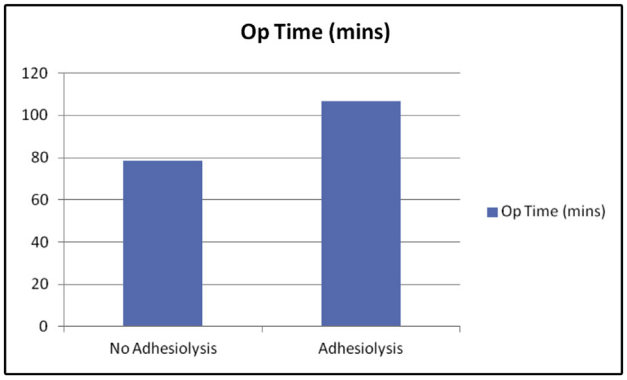

Figure 2 Comparison of operative times.

interval 1.3 to 1.7), respectively (Fig. 1). AD had higher incidences of sepsis (1.4% vs .8%), respiratory complications (1.3% vs .8%), SSI (2.7% vs 2%), and blood transfusion requirement (.3% vs .1%) ($P < .05$). Patients in the AD group had longer mean operating times (106.8 vs 78.4 minutes) and length of stay (LOS) in hospital (2 vs 1.5 days) ($P < .05$) (Figs. 2 and 3). The overall mortality was .2%; patients in the AD group did not have a statistically significant mortality rate.

Comments

The results derived from our analysis were not surprising. Most surgeons would agree that adhesions do complicate otherwise "routine" procedures and as such warrant extra care and attention. The details of these complications are not well described in the literature however, and this provided the impetus for our study. Much of the established data reaffirmed the consequences of adhesions following surgery with respect to bowel obstruction.[5,8,9] Indeed, readmission for bowel obstruction (usually multiple), with associated costs and morbidity, is of immense importance to both the patients and the hospitals involved.[10,11] We found the implications during subsequent laparoscopic surgery to be intriguing.

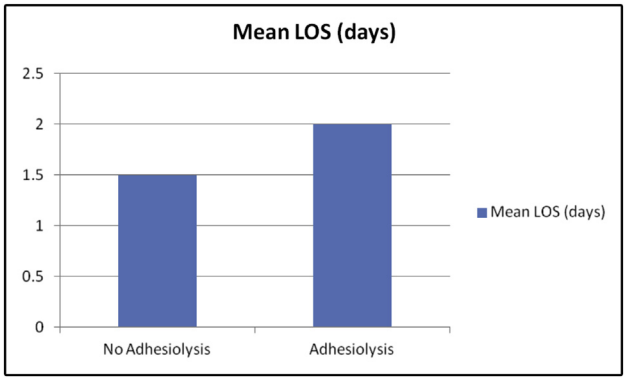

Figure 3 Comparison of LOS.

The use of abdominal adhesions as a proxy for previous open abdominal surgery is a unique methodology. The available national databases share a common limitation, in that past surgical history of individual patients is unrecorded. Within the confines of a retrospective study, this often presents an immense challenge. Our proxy was designed to circumvent this limitation, but admittedly is not without flaws. In our opinion, the foundation on which the proxy is established is solid; it lies in the connection between open surgery and subsequent abdominal adhesions. A prospective study by Menzies and Ellis[12] cited a 93% incidence of adhesions attributable to previous laparotomy, with a 10% incidence of adhesions without prior surgery. Szomstein et al[13] in a review study quoted an overall incidence of 67% to 93%. Undoubtedly, adhesions within the abdominal cavity can occur as a result of factors besides open surgery—previous laparoscopic surgery, intra-abdominal inflammation or infection, congenital, idiopathic, and so on. These were accounted for in our methodology. Laparoscopic surgery has a much lower incidence of adhesions than open (roughly 33%) and is less likely to cause significant adhesions that would require extensive AD.[13,14] AD can only be coded concurrently with another laparoscopic procedure if it is "significant" and adds "major time and complexity to the primary procedure."[15] Therefore, the patients in our study had significant adhesions that are statistically less likely to have been because of laparoscopy. Additionally, inflammatory conditions such as diverticulitis can cause adhesions. We tried to exclude such patients, using only colon resections associated with cancer. Undoubtedly, the accuracy of these measures is not perfect. The large sample size used was considered an advantage.

Our data show that patients with previous laparotomy endure longer operating time, LOS, and more complications. The longer operating time is a reflection of the requirement for AD. Furthermore, complications arising from AD such as bleeding or enterotomy would account for the extended LOS on average. Postoperative pain following extensive AD should be anticipated by the surgeon. In fact, it was postoperative pain warranting overnight admissions, in otherwise "routine" laparoscopic ventral hernia repair patients, that first piqued our interest in this area. Unfortunately, within the confines of our methodology, we were unable to assess postoperative pain in our population. More serious complications of AD including enterotomy and organ injury can be juxtaposed with the increased LOS as well as the increased incidence of sepsis and wound infection complications. Additionally, the higher incidence of respiratory complications may be a reflection of multiple factors—extended period of general anesthesia, extended period of carbon dioxide pneumoperitoneum, postoperative atelectasis, or hospital-acquired pneumonia.[16] Overall, the potential for adverse events in this patient population is increased and surgeons can benefit from this knowledge by preparing their patients preoperatively during the counseling and consenting process.

Conclusion

The analysis of the data regarding complications during laparoscopic surgery following previous open abdominal surgery was performed using a proxy devised specifically for this study. Despite the limitations of our methodology, we advocate its validity. Our results show that previous open surgery complicates future laparoscopic surgery by increasing the incidence of postoperative complications as well as increasing the operating time and overall LOS for patients.

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