

Disparities in access to basic laparoscopic surgery at U.S. academic medical centers

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Abstract

Background Laparoscopy is the standard approach used for basic gastrointestinal procedures such as appendectomy and cholecystectomy. This study determined the disparities in access to laparoscopic surgery for these commonly performed procedures at U.S. academic medical centers.

Methods Using appropriate International Classification of Diseases, 9th ed, Clinical Modification (ICD-9-CM) procedure and diagnosis codes, 112,540 basic gastrointestinal procedures were identified from the University HealthSystem Consortium database over a 4-year period (2005–2009). During this period, 82,062 laparoscopic (72.9%) and 30,478 open (27.1%) procedures were performed. The odds ratios (ORs) for laparoscopic versus open procedures were calculated and stratified for age, gender, race/ethnicity, admission status, severity of illness, and primary payer status.

Results Univariate analysis showed that young age (OR, 1.33; 95% confidence interval [CI], 1.27–1.39), white race/ethnicity (OR, 1.07; 95% CI, 1.03–1.11), female gender (OR, 1.79; 95% CI, 1.75–1.84), minor severity of illness (OR, 1.49; 95% CI, 1.44–1.53), and commercial/private payer status (OR, 1.25; 95% CI, 1.21–1.29) increased the likelihood that a laparoscopic approach would be used for the procedures studied.

Conclusion A disparity in access to basic laparoscopic surgery exists at U.S. academic medical centers based on age, gender, race/ethnicity, severity of illness, and primary payer status.

Keywords Abdominal · Appendix · Cholecystectomy

For almost two decades, laparoscopy has been the standard approach for basic gastrointestinal procedures such as appendectomy and cholecystectomy. However, inequalities in access to laparoscopic surgical techniques are a public health concern because they may lead to disparities in quality of care and may result in adverse outcomes. Therefore, the Agency for Health Care Research and Quality has been producing the National Healthcare Quality Report and the National Healthcare Disparities Report in an effort to determine and address disparities in access to health care.

The disparities in access to a few gastrointestinal surgical procedures have been described previously, but the disparities in access to basic laparoscopic procedures have not been identified. In this study, using a large clinical database of U.S. academic medical centers, we determined the disparities in access to basic laparoscopic procedures including appendectomy and cholecystectomy. The odds of undergoing a laparoscopic versus an open approach for appendectomy and cholecystectomy were analyzed. The findings of this study will add to the body of literature regarding access to minimally invasive surgical techniques.

Materials and methods

Approval for use of the University HealthSystem Consortium (UHC) patient-level data in this study was obtained

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Data set

The UHC is an alliance of 97 academic medical centers and 153 of their affiliated hospitals, representing 90% of the nation's nonprofit academic medical centers. The UHC database is an administrative, clinical, and financial database that provides benchmark measures on the use of health care resources for the purpose of comparative data analysis between academic institutions. It contains discharge information on inpatient hospital stay including patient characteristics, length of stay, overall and specific postoperative morbidity, and observed-to-expected (risk-adjusted) in-hospital mortality. Severity of illness is assigned based on a combination of principal and secondary diagnoses to define different levels of severity and complexity of treatment.

To accomplish risk adjustment, the UHC uses regression-modeling techniques in combination with 3M Health Information Systems Agency for Healthcare Research and Quality comorbidity software and the UHC complication profiler to assign a severity of illness level as well as an expected length of hospital stay, costs, and probability of mortality to every patient in the database. The severity of illness level is assigned based on a combination of principal and secondary diagnoses to define different levels of severity and complexity of treatment. The four severity of illness categories are minor (i.e., low risk), moderate, major, and extreme severity. However, extreme severity of illness was excluded from the analysis and only three severity of illness categories were analyzed.

Study cohort

We analyzed the UHC hospital discharge records of all patients 18 years of age or older who underwent one of the two commonly performed basic gastrointestinal procedures: appendectomy or cholecystectomy. Hospital discharge records between 1 October 2005 and 30 September 2009 were reviewed. Analysis of these gastrointestinal procedures required the use of appropriate diagnosis and procedural codes as specified by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM).

Appendectomy and cholecystectomy were selected because they both are considered “basic” gastrointestinal procedures by the Accreditation Council for Graduate Medical Education and commonly performed at U.S. academic medical centers. Both procedures have laparoscopic and open ICD-9-CM procedural codes. All procedures were performed on an inpatient basis.

The ICD-9-CM procedural codes for laparoscopic (47.01) and open (47.0, 47.09) appendectomy for acute (540, 540.9) and perforated (540.0, 540.1) appendicitis were used. Perforated appendicitis included a subcategory for generalized peritonitis or peritoneal abscess. For laparoscopic (51.23, 51.24) and open (51.21, 51.22) cholecystectomy, the principal ICD-9-CM diagnosis codes for cholelithiasis with (574.0, 574.00, 574.01, 574.1, 574.10, 574.11) and without (574, 574.2) acute cholecystitis were used.

Young age groups were defined by the ages 18–64 years, and elderly groups were defined by the age of 65 years. The most common race/ethnicities were analyzed including whites, Hispanics and blacks (other race/ethnicities were not included in the analysis). Elective, urgent, and emergent admission statuses were studied for all procedures. The primary payers analyzed included commercial/private insurance and Medicare/Medicaid.

Main outcome measures

The main study outcome was the overall number of laparoscopic versus open surgeries performed for the two gastrointestinal procedures studied as a surrogate of access to these surgical techniques. The odds ratio for performance of a laparoscopic versus an open procedure was calculated and stratified for age, gender, race/ethnicity, admission status, severity of illness, and primary payer status. We determined the likelihood of a patient undergoing a laparoscopic versus an open approach as determined by the odds ratio.

Statistical analysis

We compared the in-hospital outcomes including length of hospital stay, in-hospital morbidity, and risk-adjusted (observed-to-expected) mortality ratio between laparoscopic versus open surgery for appendectomy and cholecystectomy. Differences in group means were identified by Student's *t* test, and differences in group proportions were identified by chi-square (χ^2) analysis. Data are expressed as mean \pm standard deviation. Univariate analysis was performed, and the 95% confidence interval (CI) of the odds ratio (OR) was obtained. Statistical analysis was performed using Epi-Info statistical software, 2008 version 3.5.1 (CDC, Atlanta, GA, USA). A *p* value less than 0.05 was considered significant.

Results

Demographics

A total of 112,540 basic gastrointestinal procedures were performed at U.S. academic medical centers over the study

Table 1 Distribution of basic gastrointestinal procedures

Procedure	<i>n</i>	%
Appendectomy		
Laparoscopic	43,239	68.3
Open	21,074	31.7
Cholecystectomy		
Laparoscopic	38,823	80.5
Open	9,404	19.5

period. The distribution of laparoscopic and open techniques for all procedures is shown in Table 1. Of these procedures, the great majority were performed via a laparoscopic approach ($n = 82,062$, 72.9%) compared with an open approach ($n = 30,478$, 27.1%). A total of 64,313 appendectomies and 48,227 cholecystectomies were performed.

More younger patients ($n = 72,708$, 73.7%) than elderly patients ($n = 9,355$, 67.6%) received laparoscopic procedures. The number of women undergoing laparoscopic procedures ($n = 45,842$, 78.4%) was significantly higher than the number of men receiving the same procedures ($n = 36,219$, 66.9%). Whites ($n = 44,295$, 73.3%) underwent laparoscopic procedures more frequently than blacks ($n = 9,857$, 71.9%), but the approach did not differ significantly between blacks and Hispanics ($n = 17,357$, 72.8%).

The numbers of laparoscopic elective ($n = 8,305$, 72.8%), urgent ($n = 13,305$, 73.7%), and emergent ($n = 59,925$, 72.9%) procedures were comparable. As expected, the majority of appendectomies and cholecystectomies were performed on an emergent basis (overall, 73.6% of the time).

A significant proportion of low-risk patients (minor severity of illness: $n = 48,983$, 77.1%) had laparoscopic techniques for the procedures analyzed compared with those who had higher risks (moderate severity of illness: $n = 27,483$, 69.3%; major/extreme severity of illness: $n = 4,741$, 63.2%). Similarly, those with moderate severity of illness underwent laparoscopic surgery more frequently than those with major or extreme severity of illness. Patients with commercial/private insurance ($n = 39,965$, 75.5%) underwent laparoscopic procedures preferably compared with those who had Medicare/Medicaid ($n = 25,244$, 71%) as the primary payer.

In-hospital outcomes

Laparoscopic surgery offered a significantly shorter hospital stay and a lower overall in-hospital morbidity rate than open surgery (Table 2). The risk-adjusted (observed-to-expected) mortality ratio was comparable between the surgical techniques for either procedure.

Table 2 In-hospital outcomes by procedure

Procedure	LOS (days)	Morbidity (%)	Risk-adjusted mortality ratio
Laparoscopic appendectomy	2.3 ± 2.5*	6.0*	1.0
Open appendectomy	3.5 ± 4.1	10.1	0.8
Laparoscopic cholecystectomy	3.4 ± 4.0*	8.7*	1.0
Open cholecystectomy	6.9 ± 6.2	26.2	0.8

Data are presented as means ± standard deviation, and the mortality ratio is risk adjusted (observed to expected)

LOS length of hospital stay

* $p < 0.05$ vs. open procedure respectively

Overall odds ratio for laparoscopic versus open surgery

Univariate analysis demonstrated that young subjects were 33% more likely to undergo a laparoscopic approach for a basic gastrointestinal procedure than the elderly (Table 3). Female gender was associated with a 79% greater likelihood that a laparoscopic approach would be used than male gender. Whites were 7% more likely to have a laparoscopic approach than blacks but had an odd ratio similar to that of Hispanics, whereas no difference existed between blacks and Hispanics.

Table 3 Odds ratios for laparoscopic versus open surgery

Variables	OR	95% CI
Age		
Young vs. elderly	1.33	1.27–1.39*
Gender		
Female vs male	1.79	1.75–1.84*
Race/ethnicity		
White vs black	1.07	1.03–1.11*
White vs Hispanic	1.03	0.99–1.06
Hispanic vs black	1.04	0.99–1.09
Admission status		
Elective vs urgent	1.04	0.99–1.10
Elective vs emergent	1.00	0.96–1.05
Urgent vs emergent	1.04	1.00–1.07
Severity of illness		
Minor vs moderate	1.49	1.44–1.53*
Minor vs major	1.96	1.86–2.06*
Moderate vs major	1.31	1.24–1.38*
Primary payer		
Private vs Medicare	1.25	1.21 – 1.29*

Other race/ethnicities are not included

OR odds ratio, CI confidence interval

* $p < 0.05$ by chi-square analysis

The odds of a patient undergoing a laparoscopic versus open surgery were comparable for elective, urgent, and emergent admissions. Low-risk patients were 49% more likely to undergo laparoscopic procedures than moderate-risk patients and almost twice as likely to undergo laparoscopic procedures as patients with major risks. Finally, individuals with a commercial/private payer were 25% more likely to undergo laparoscopic surgery than those with Medicare/Medicaid insurance.

Odds ratio for laparoscopic versus open appendectomy

Univariate analysis also demonstrated that the odds ratio for the each analyzed procedure was comparable with those found in the overall surgical group. For appendectomy, young subjects were 53% more likely to undergo a laparoscopic approach than the elderly (OR, 1.53; 95% CI, 1.42–1.65). Female gender was associated with a 79% greater likelihood that a laparoscopy would be performed than male gender (OR, 1.79; 95% CI, 1.76–1.82). Whites were 27% more likely to undergo laparoscopic techniques than blacks (OR, 1.27; 95% CI, 1.20–1.34) and 32% more likely than Hispanics (OR, 1.32; 95% CI, 1.27–1.38).

The odds of a patient undergoing a laparoscopic appendectomy were comparable among elective, urgent, and emergent admissions. Low-risk patients were 52% more likely to undergo laparoscopy than moderate-risk patients (OR, 1.52; 95% CI, 1.46–1.57) and more than twice as likely as those with major risks (OR, 2.18; 95% CI, 1.99–2.39). Finally, individuals with a commercial/private payer were 44% more likely to undergo laparoscopic surgery than those who had Medicare/Medicaid insurance (OR, 1.44; 95% CI, 1.38–1.50).

Odds ratio for laparoscopic versus open cholecystectomy

Similarly, for cholecystectomy, young subjects were more than twice as likely to undergo a laparoscopic approach as the elderly (OR, 2.09; 95% CI, 1.99–2.20). Females were twice as likely to undergo a laparoscopy as males (OR, 2.16; 95% CI, 2.06–2.16). Whites were 66% more likely to undergo laparoscopy than Hispanics (OR, 1.66; 95% CI, 1.56–1.77), but blacks and Hispanics did not differ. The odds were similar for the performance of laparoscopic cholecystectomy among elective, urgent and emergent admissions. Low-risk patients were 79% more likely to undergo laparoscopy than moderate-risk patients (OR, 1.79; 95% CI, 1.69–1.88) and more than three times more likely than those with major risks (OR, 3.22; 95% CI, 3.01–3.45). Finally, individuals with a commercial/private payer were 52% more likely to undergo laparoscopic

surgery than those who had Medicare/Medicaid insurance (OR, 1.52; 95% CI, 1.43–1.59).

Discussion

This study aimed to determine disparities in access to two basic surgical procedures (appendectomy and cholecystectomy) performed at U.S. academic medical centers. The main study outcome was the odds of a patient undergoing a laparoscopic versus an open technique for the procedures studied. We found that disparities in access to basic laparoscopic surgery exist at U.S. academic medical centers according to age, gender, race/ethnicity, severity of illness, and primary payer status.

The Agency for Health Care Research and Quality produces the National Healthcare Quality Report and the National Healthcare Disparities Report (NHDR) in an effort to determine the disparities in access to health care [1]. These reports measure trends in effectiveness of care, patient safety, timeliness of care, patient-centeredness, and efficiency of care. The NHDR also summarizes health care quality and access among various racial, ethnic, and income groups and other priority populations such as children and older adults. However, these reports have failed to address the disparities in access to minimally invasive surgical techniques.

Currently, there are ample data showing favorable outcomes and supporting the use of laparoscopic versus open techniques for basic and advanced gastrointestinal procedures such as those analyzed in this study. Appendectomy and cholecystectomy, two of the most commonly performed gastrointestinal procedures in the United States, have been considered “basic” by the Accreditation Council for Graduate Medical Education if performed via a laparoscopic approach.

The racial/ethnic and socioeconomic disparities in access to various gastrointestinal procedures have been described previously [2–6]. Yet, the disparities in access to basic laparoscopic procedures such as appendectomy and cholecystectomy have not been identified. The likelihood of a patient undergoing a laparoscopic versus an open approach was significantly higher for low-risk patients, followed by patients who were female, younger in age, covered by private insurance, and of a white racial/ethnic background.

Laparoscopic surgery has been shown to provide additional clinical benefits compared with open techniques for various gastrointestinal procedures [7–12]. Laparoscopic or minimally invasive surgical techniques have been available since 1985, when the first laparoscopic cholecystectomy was performed by Mühe in Germany [13]. Soon thereafter, these laparoscopic techniques were adopted by U.S.

surgeons. The major differences between laparoscopic and open procedures are the method of access, the method of exposure, and the extent of operative trauma. Findings have shown that laparoscopic procedure is physiologically superior to open surgery because there is lower systemic stress, improved immunologic responses, and lower local tissue trauma [14–16].

Despite its proven clinical and physiologic benefits given its less invasiveness, laparoscopy often is viewed as a “cosmetic” procedure compared with open surgery, which may account for the increased number of young women undergoing these techniques. Notably, Medicare and Medicaid patients, who for the most part are older and of a lower socioeconomic status, were 21% less likely to receive laparoscopic procedures. Therefore, in addition to an age disparity, a socioeconomic disparity in access to basic laparoscopic surgery also may exist. Moreover, surgeons may have a misconception or hesitation about applying laparoscopic techniques for the elderly or individuals considered to be at “high risk”. In fact, studies have shown that even complex laparoscopic gastrointestinal procedures applied for the elderly are indeed as safe as open approaches [17].

Laparoscopic techniques require different instrumentation, operating room setup, and skilled operating room staff. Most of the basic procedures analyzed in this study were performed on an emergent basis. A great part of these procedures was performed after regular hours and mostly by trauma/emergency surgeons. Due to an increase in the number of expectant trauma management cases, trauma/emergency surgeons currently are performing emergency surgery, including the basic gastrointestinal procedures studied. It is possible that trauma/emergency staff finds it undemanding and straightforward to perform an open technique when the laparoscopy staff is not available and when other trauma-related issues may arise.

Although we did not find an increased likelihood that an open procedure would be performed on the basis of admission status; changes in trauma/emergency surgery care may partly explain some of the current disparities in access to emergent basic laparoscopic surgery. Nonetheless, a multivariate analysis may be required for an adequate answer to this hypothesis.

As described in other large database series, laparoscopy offered a shorter hospital stay and lower morbidity rate than open surgery for the procedures analyzed. Notably, patients who had an open appendectomy left the hospital 1 day later than laparoscopy patients and stayed twice as long if they had an open cholecystectomy. Similarly, the morbidity associated with open appendectomy was 1.6 times higher compared with laparoscopy and three times higher after open cholecystectomy. Nevertheless, both approaches appeared to be safe because the observed-to-expected mortality rate was 1.0 or less.

Our study had several limitations. First, as with the use of any large clinical database, the information provided by the participating institutions may have been incomplete or unknown. Second, this study was based on univariate analysis alone. The University Health System Consortium database allows the query only of data grouped by hospital and not individual patient data, which precludes multivariate logistic regression analysis and the control of confounders. Third, there may have been selection bias for laparoscopic versus open surgery based on the complexity of acute cholecystitis and acute/perforated appendicitis. However, we consider the results of this investigation as relevant and valid.

In summary, we identified disparities in access to laparoscopic surgery for basic gastrointestinal procedures such as appendectomy and cholecystectomy at U.S. academic medical centers according to stratification by age, gender, race/ethnicity, severity of illness, and primary payer status but not by admission status. In addition, it is feasible that socioeconomic disparities in access to basic laparoscopy also exist.

Disclosures J. Esteban Varela and Ninh T. Nguyen have no conflicts of interest or financial ties to disclose.

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