The effect of surgical approach on short-term oncologic outcomes in rectal cancer surgery

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Background. *Although evidence to support the use of laparoscopic and robotic approaches for the treatment of rectal cancer is limited, these approaches are being adopted broadly. We sought to investigate national practice patterns and compare short-term oncologic outcomes of different approaches for rectal cancer resections.*
Methods. *The 2010 National Cancer Database was queried for operative cases of rectal cancer. Approach was classified as open, laparoscopic, or robotic. Patient, tumor, and hospital characteristics and surgical margin status were evaluated. Propensity score matching was used to compare outcomes across approaches.*
Results. *We identified 8,712 patients. Laparoscopic and robotic approaches were more common in privately insured and wealthier patients at high-volume centers ($P < .001$). Open approaches were used for tumors with higher histologic grade and pathologic stage ($P < .001$). A minimally invasive approach was associated with fewer positive margins and shorter hospital stays. After propensity score matching, the laparoscopic approach was associated with a 2.0% lesser ($P = .01$) and robotic surgery with a 3.8% lesser ($P = .004$) incidence of positive margins compared with open surgery.*
Conclusion. *An open approach is often used in rectal cancers with higher pathologic stages. Matched patient analysis suggests minimally invasive approaches are associated with improved R0 resections.*
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PATIENTS WHO UNDERGO minimally invasive surgery (MIS) for colorectal cancer resections often have improved postoperative pain control, shorter hospital stays, and earlier return of bowel function; they also return to work sooner.[1-4] These benefits come at the expense of longer operative times,[1-3] higher cost,[5,6] and a substantial learning curve for practicing surgeons.[7] Despite the evidence for improved short-term outcomes, the oncologic efficacy and safety of MIS for rectal cancer resections continues to be debated. The CLASICC Trial demonstrated increased margin positivity in patients undergoing laparoscopic anterior resections compared with open resections, and although this difference did not translate into increased recurrence rates, this possibility of a lesser oncologic procedure does raise concerns as to the safety of MIS for cancer resections.[2,8]

Although some randomized, controlled trials (RCTs) have supported equivalent oncologic outcomes with laparoscopic resections compared with open resections,[1-3,9] these studies were often limited by sample size and by the number of patients that required abdominoperineal resections. Additionally, the MIS procedure in these trials was performed by expert surgeons, and it is unclear whether their results will apply to procedures performed on a national level. Although the safety

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and efficacy of MIS for rectal cancer resection continues to be debated, the use of these approaches is increasing.[10] We, therefore, sought to characterize practice patterns in the use of MIS for rectal cancer resections as well as determine whether oncologic outcomes are comparable or improved compared with open surgery.

METHODS

A retrospective analysis was performed using the 2010 National Cancer Database (NCDB) participant user file for rectal cancer. The NCDB is a joint project of the Commission on Cancer of the American College of Surgeons and the American Cancer Society. The NCDB captures hospital registry data from facilities accredited by the Commission on Cancer and includes approximately 70% of all cancer cases in the United States, as well as data on diagnosis, treatment, and outcomes.[11]

All patients who underwent operative resection for stage I–III rectal cancer with a low anterior resection (LAR; Surgical Procedure code 30 or 40) or abdominoperineal resection (APR; Surgical Procedure code 50) were identified. Those patients with cancers of the rectosigmoid junction were excluded. The operative approach was categorized as open, laparoscopic, or robotic based on intent to treat. Surgical margin status was characterized as negative when coded as "no residual tumor, all margins are grossly and microscopically negative" and positive when coded as "microscopic residual tumor," "macroscopic residual tumor," or "residual tumor, NOS [not otherwise specified]." For analyses investigating factors associated with positive surgical margins, patients with pathologic stage 0 after neoadjuvant chemoradiation were excluded. Hospitals were divided into quartiles based on operation volume.

We first compared patient demographics, hospital characteristics, tumor features, adjuvant therapy, and operative procedures across surgical approaches (open, laparoscopic, or robotic). Chi-square tests were used to compare categorical variables. Continuous variables were compared using analysis of variance with a Bonferroni correction, and continuous variables were compared using Wilcoxon rank-sum tests or Kruskal–Wallis tests as appropriate. These techniques were also used to compare oncologic outcomes (resection margin status and lymph node harvest) and postoperative outcomes (duration of stay, 30-day readmission, and 30-day mortality) for all patients with rectal cancer and stratified subsequently to compare patients who underwent LAR or APR.

Because the status of surgical resection margin is among the most important predictors of patient outcome after rectal cancer surgery,[12,13] a stepwise logistic regression was performed to identify predictors of positive surgical margins. To account for patient clustering in greater volume hospitals that may preferentially offer minimally invasive techniques, we constructed a hierarchic, logistic regression model using the significant predictors from our multivariate regression as fixed effects and the individual hospital identifiers as a random effect.

Treatment effects. To control for differences in case mix among patients treated with open surgery versus laparoscopic or robotic surgery, we calculated the estimated treatment effect on patients using Stata's "teffects psmatch" command.[14] Briefly, propensity scores with optimal matching and a caliper value (0.03) were used to match patients based on age, sex, insurance status, hospital volume, operation (APR vs LAR), neoadjuvant therapy, tumor grade, size, and pathologic stage. Matching was done on a pairwise basis to estimate the treatment effect of laparoscopic versus open surgery, open versus robotic surgery, and laparoscopic versus robotic surgery. Results are reported as percent difference in rates of a positive margin. Standard errors and 95% CIs were calculated using the independent and identically distributed sampling assumption, which estimates the standard errors based on estimated treatment probabilities and ensures that the outcome and treatment status of each individual are unrelated to the outcome and treatment status of all the other individuals in the population.[14-16]

All statistical analyses were performed using STATA 13.1 software (College Station, TX), all *P* values reported are 2-tailed. Our institution's institutional review board determined this study as exempt.

RESULTS

There were 8,712 patients identified who met inclusion criteria (5,935 open, 2,337 laparoscopic, and 440 robotic). Of these, 59% were male, the median age was 63 years (range, 18–90) and 87% were Caucasian. Approximately two-thirds of cases (68%) were performed open, 27% laparoscopically, and 5% with a robotic approach. The surgical treatment in 77% of patients was LAR and in 23% was APR. Neoadjuvant chemoradiation was administered to 50% of patients.

Table I depicts the factors associated with surgical approach. Patients who underwent MIS were younger, wealthier, more likely to have private insurance, tended to travel further for the operation and were cared for at greater volume centers (Fig). An open approach was chosen more often for