Splenic Salvage After Intraoperative Splenic Injury During Colectomy

Stefan D. Holubar, MD; Jeffrey K. Wang, MD; Bruce G. Wolff, MD; David M. Nagorney, MD; Eric J. Dozois, MD; Robert R. Cima, MD; Megan M. O’Byrne, MA; Rui Qin, PhD; David W. Larson, MD

Objective: To determine the optimal surgical management of splenic injury encountered during colectomy.


Setting: Mayo Clinic in Rochester, Minnesota, a tertiary care center.


Main Outcome Measures: Overall 30-day major morbidity and mortality and overall 5-year survival.

Results: Of 13,897 colectomies, we identified 59 splenic injuries (0.42%). Of these, 33 (56%) were in men; there was a median age of 68 years (range, 30-93 years) and a median body mass index of 25.5 (range, 15-54). Thirty-seven injuries (63%) occurred during elective surgery, 6 (10%) occurred without splenic flexure mobilization, and 5 (8.4%) occurred during minimally invasive surgery. Injury was successfully managed by primary repair in 10 (17%), splenorrhaphy in 4 (7%), and splenectomy in 45 cases (76%). Four injuries (7%) were unrecognized and resulted in reoperation and splenectomy. Multiple attempts at splenic salvage were performed in 30 (51%); of these, 21 (70%) required splenectomy. More than 2 attempts at salvage was associated with splenectomy ($P=0.03$). The 30-day major morbidity and mortality rates were 34% and 17%, respectively. Sepsis was the most common complication, with no confirmed episodes of postsplenectomy sepsis. Median survival after splenic injury was 7.25 years. There was no significant association between the surgical management of splenic injuries and short- or long-term outcomes.

Conclusions: Splenic injury is an infrequent but morbid complication. Splenic salvage is frequently unsuccessful; our data suggest that surgeons should not be reluctant to perform splenectomy when initial repair attempts fail.

Arch Surg. 2009;144(11):1040-1045
METHODS

After institutional review board approval, the Surgical and Medical Indexes, which are prospectively maintained databases of surgical procedures and medical diagnoses based on International Classification of Diseases, Ninth Revision and Hospital International Classification of Diseases Adapted codes, respectively, were used to perform a search for all patients who underwent a colon resection and had a splenic injury, splenorrhaphy, or splenectomy. We also used multiple free-text search terms to identify these injuries, including splenic laceration, splenic puncture, splenic injury, splenic repair, iatrogenic splenectomy, and incidental splenectomy. Our search was limited to 13,897 adult (≥18 years) general surgery or colorectal surgery service patients from 1992 to 2007. All operative reports for patients identified as having had both a colectomy and splenectomy or splenic injury during the same operation were reviewed; patients who underwent splenic surgery for blunt or penetrating trauma or as part of an oncologic en bloc resection or pancreatic procedure were excluded.

Retrospective medical record review was performed and demographic, operative, and outcome variables were abstracted, including methods of splenic repair; whether or not the procedure was elective; the age-adjusted Charlson comorbidity index score; and surgical Apgar score. Charlson et al11 developed a scoring system (with a higher score being worse) that is now one of the most widely studied methods of estimating risk from death due to comorbid disease and has been shown to be a valid predictor of adverse outcome after colectomy for cancer.11,12 The surgical Apgar score is a 10-point scoring system (with a lower score being worse) that predicts major complication or death within 30 days of the index operation based on 3 intraoperative data: estimated blood loss, lowest mean arterial pressure, and lowest heart rate.13 Based on the operative description, all splenic injuries were graded according to the 1994 revision of the American Association for the Surgery of Trauma Spleen Injury Scale.14 Our primary end point for comparison between patients who had splenic salvage and those who had splenectomy was a composite variable of any major postoperative morbidity (defined as Clavien grade ≥3)15 or mortality within 30 days; our secondary end point was long-term survival (ie, 1- and 5-year all-cause mortality). The Clavien grading scheme classifies postoperative complications from 1 to 5 based on the management of the complication, with minor complications that require no intervention, such as wound infections that are opened at the bedside but do not require antibiotics being grade 1; those that require medical therapy, grade 2; those that require interventional radiologic, endoscopic, or surgical intervention, grade 3; those that require intensive care unit management, grade 4; and those that result in death, grade 5.

Potential differences in baseline characteristics between patients with splenectomy and patients with splenic salvage was assessed using univariate analysis with Fisher exact tests for categorical data and Wilcoxon rank-sum tests for continuous data. Univariate analysis using a Fisher exact test was also used to identify variables associated with adverse short-term outcomes after splenic injury. Differences in long-term survival between clinically important subgroups were assessed using log-rank tests and Cox proportional hazards models. Kaplan-Meier curves were plotted, and the corresponding 1- and 3-year survival rates are reported with 95% confidence intervals. Statistical significance was set at α = .05, and P ≥ .05 was considered statistically nonsignificant. The software SAS, version 9 (SAS Institute, Cary, North Carolina), JMP, version 7 (SAS Institute, Cary, North Carolina), and S-PLUS, version 8 (Insighful Corporation, Seattle, Washington) was used to perform all analyses.

RESULTS

DEMOGRAPHICS

During a 16-year period, splenic injury occurred during colon resection in 59 patients at our institution (0.42%). Operative indications included cancer in 20 (34%), diverticulitis in 15 (25%), and inflammatory bowel disease in 14 (24%). Baseline characteristics are presented in Table 1. Patients who underwent splenectomy and patients who underwent splenic salvage did not differ significantly with respect to age, sex, body mass index, Charlson comorbidity index score, or need for emergent/urgent surgery.

SPLENIC INJURIES AND THEIR MANAGEMENT

Most splenic injuries had splenic flexure mobilization (90%), most were in colorectal service patients (62%), and a minority (5 injuries [8.5%]) occurred during laparoscopic surgery, 2 of which were converted (40%). Most injuries (63%) occurred during elective surgery. Injury resulted in splenectomy in 45 patients (76%), splenorrhaphy in 4 (7%), and primary repair in 10 (17%). A total of 35 patients (59%) received blood products intraoperatively. The most common methods of managing splenic injury included thrombin and Gelfoam (Pfizer Inc, New York, New York) in 16 (27%), packing in 12 (20%), and electrocautery in 9 (15%); other methods included using Surgicel (Ethicon Inc, Johnson & Johnson, Cincinnati, Ohio) in 7 (12%), pledged sutures in 7 (12%), Avitene...
The relationship between perioperative variables, including the surgical management of splenic injuries, and major short-term adverse outcomes is presented in Table 2. Nonselective surgery (P = .04), intraoperative transfusion requirement (P = .03), and a surgical Apgar score lower than 5 (P = .01) were all associated with major short-term complications. However, the initial and final management of the splenic injuries was not associated with major short-term adverse outcomes.

**LONG-TERM SURVIVAL**

The median overall survival of this cohort was 7.25 years. Overall, survival in patients with splenic injury was decreased compared with those without splenic injury (P = .003) (Figure 1). In terms of overall 5-year survival (Table 3), there was no statistical difference between patients who had immediate splenectomy compared with those who had attempted splenic salvage, between patients who had splenic salvage compared with those who had splenectomy (Figure 2), or between patients who did or did not have cancer (Figure 3). On univariate analysis (Table 3), a statistically worse survival was observed when any of the following criteria were present: age 65 years or older (P = .03), age-adjusted Charlson comorbidity index score of 5 or greater (P = .004), or the need for emergent/urgent surgery (P = .002). On multivariate analysis (Table 3), only emergent/urgent surgery (hazard ratio, 2.75; P = .009) remained independently associated with decreased long-term survival, while a Charlson comorbidity index score of 5 or more showed a trend toward significance (P = .06).

**Comment**

The results of this study suggest that patients who sustain splenic injury during colectomy are at increased risk of short- and long-term morbidity and mortality regardless of the method of surgical management of the injury. The incidence of intraoperative splenic injury has been reported to be the cause of as much as 40% of all splenectomies. While a variety of operations contribute to the overall incidence of intraoperative splenic injury, left upper quadrant procedures account for the highest percentage. Of 13,897 colon resections at our institution in a 16-year period, 59 splenic injuries were reported, yielding a rate of 0.42%, or 1 splenic injury in...
every 236 colon operations. This incidence is in accordance with other studies. Langevin et al\(^6\) reported the incidence of splenectomy following splenic flexure mobilization was 1.15%.

Significant findings of the current study include the number of splenic injuries that occurred during laparoscopic colectomy and those that occurred without splenic flexure mobilization. Our reporting of splenic injury during laparoscopic colectomy is in contrast to a recent study that reported no injuries during almost 2000 laparoscopic colectomies and may be due to the large denominator in our series (many of which were laparoscopic during the second half of the study period).\(^{15}\) Clearly the same vigilance must be taken to avoid injuring the spleen whether a traditional open or minimally invasive approach is used. We also found that these injuries can occur in the absence of splenic flexure mobilization. In our cohort, as in other studies, most injuries were due to capsular tears. Although classic teaching is that these are retractor-type injuries, these injuries also likely occurred because of tension between the colon and the spleen. As our data show, injuries may occur as a result of tension

---

**Table 3. Survival Analysis of Variables Associated With Overall Survival**

| Variable                      | % Survival (95% CI) | P Value
|-------------------------------|---------------------|--------
|                               | 1-Year              | 5-Year | Univariate\(^a\) | Multivariate\(^b\) | HR (95% CI)\(^c\) |
| Age, y                        |                     |        |                 |                  |              |
| ≥65                           | 71 (58-88)          | 49 (34-70) | .03             | .15              | 2.01 (0.77-5.24) |
| <65                           | 85 (71-100)         | 66 (48-98) |                 |                  |              |
| Sex                           |                     |        |                 |                  |              |
| F                             | 72 (56-92)          | 43 (25-72) | .47             | ...              | ...            |
| M                             | 80 (67-96)          | 64 (48-85) |                 |                  |              |
| Colon cancer                  |                     |        |                 |                  |              |
| Yes                           | 77 (60-100)         | 50 (30-83) | .95             | ...              | ...            |
| No                            | 77 (64-91)          | 58 (43-79) |                 |                  |              |
| Charlson comorbidity index score |                   |        |                 |                  |              |
| ≥5                            | 66 (52-83)          | 43 (29-64) | .004            | .05              | 2.75 (0.98-7.73) |
| <5                            | 100 (100-100)       | 83 (64-100) |                 |                  |              |
| Surgery type                  |                     |        |                 |                  |              |
| Emergent/urgent               | 53 (36-79)          | 38 (21-66) | .002            | .009             | 2.75 (1.28-5.90) |
| Elective                      | 91 (81-100)         | 66 (49-88) |                 |                  |              |
| Surgical Apgar score          |                     |        |                 |                  |              |
| <5                            | 64 (41-100)         | 51 (28-96) | .61             | ...              | ...            |
| ≥5                            | 80 (69-93)          | 56 (42-75) |                 |                  |              |
| Splenic salvage attempted     | 76 (63-91)          | 52 (37-75) | .42             | ...              | ...            |
| Immediate splenectomy         | 78 (61-100)         | 59 (40-89) |                 |                  |              |
| Splenectomy                   | 74 (62-89)          | 54 (41-73) | .67             | ...              | ...            |
| Splenic salvage               | 86 (69-100)         | 50 (21-100) |                 |                  |              |

Abbreviations: CI, confidence interval; HR, hazard ratio; ellipses, not included in multivariate model.
\(^a\)Log-rank test.
\(^b\)Cox proportional hazards model.
\(^c\)Hazard ratio denotes increased risk of mortality at 5 years.

---

**Figure 2.** Impact of splenic salvage vs splenectomy after splenic injury.

**Figure 3.** Impact of colon cancer diagnosis on survival after splenic injury.
to not only the omentum and transverse or left colon, but to any part of the colon as well.

Over the past few decades, the management of splenic injury secondary to trauma has evolved from splenectomy to splenorrhaphy to nonoperative management. For nontraumatic and iatrogenic splenic injuries, splenic salvage is the preferred treatment, thereby preserving the immunologic functions of the spleen. Numerous techniques of splenic salvage have been reported, including packing, use of fibrin sealant, U-stitching, inferior pole dearterialization, and splenorrhaphy with materials such as Dexon mesh (Syneture; Tyco Healthcare, Mansfield, Massachusetts). In our cohort of patients, primary repair of splenic injuries was frequently unsuccessful despite these techniques; less than one-quarter of our patients retained their spleens after intraoperative injury. This is likely attributable to the need to stop ongoing blood loss, treat hemodynamic instability, and proceed with the index operation.

In terms of summarizing intraoperative hemodynamics, a recent report by Gawande et al described a score used to predict major complications or death within 30 days of an operation using only 3 intraoperative variables: estimated blood loss, lowest mean arterial pressure, and lowest heart rate. A rudimentary model that summarizes the intraoperative course is clinically desirable, and the surgical Apgar scale, which is scored from 0 to 10, with lower scores indicating more hemodynamic instability, can discriminate between groups at high and low risk of complications. On univariate analysis, we found a significantly increased rate of major complication or death within 30 days for those patients with surgical Apgar scores of less than 5; this effect was not sustained in the long-term and is likely eclipsed by other factors, such as comorbidities, advanced patient age, and urgency of surgery.

In our study, long-term survival was more dependent upon patient presentation and preexisting medical conditions than splenic injury alone. Five-year survival was independently associated with the need for emergent/urgent colectomy, with a trend toward decreased survival in those with a high comorbid burden (as measured by the Charlson comorbidity index). Multiple studies have shown that survival in patients with colon cancer who undergo splenectomy is worse. An unexpected finding of the present study was that those who sustained splenic injury had an equally poor survival regardless of whether or not they had cancer. Reasons for this are not readily apparent but are likely related to advanced age, high Charlson comorbidity index scores, and need for emergency surgery in those without cancer in this cohort. However, patients who sustain splenic injury, independent of whether or not they had cancer or the method of management (ie, splenic salvage or splenectomy), are clearly at risk.

This study is retrospective and has several important limitations. Selection bias may have influenced our results, as not all splenic injuries may have been reported; despite our robust method for identifying reported injuries, small injuries were likely not captured. On the other hand, any unreported injury was likely minor and clinically insignificant. Additionally, this study may be underpowered to detect differences in long-term survival rates between certain subgroups. However, this study, as a single-institution study that directly addresses the optimal management of splenic injuries encountered during colectomy, is relatively unique.

In summary, our results indicate that patients undergoing colectomy who sustain splenic injury are at increased risk of morbidity and mortality in both the short- and long-term, independent of whether or not the spleen is salvaged. This suggests that the most important factor in preventing adverse outcomes after splenic injury is prompt cessation of bleeding by whatever means necessary, including splenectomy. Splenic injury is an infrequent but morbid complication. Splenic salvage is frequently unsuccessful, and our data suggest that surgeons should not be reluctant to perform splenectomy when initial attempts at splenic salvage fail.

Accepted for Publication: October 20, 2008.

Correspondence: Bruce G. Wolff, MD, Division of Colon and Rectal Surgery, Mayo Clinic, 200 First St, SW, Rochester, MN 55905 (wolff.brucemayo.edu).

Author Contributions: Study concept and design: Holubar and Wolff. Acquisition of data: Holubar, Wang, and O’Byrne. Analysis and interpretation of data: Holubar, Wolf, Nagorney, Dozois, Cima, O’Byrne, Qin, and Larson. Drafting of the manuscript: Holubar, Wang, and Qin. Critical revision of the manuscript for important intellectual content: Holubar, Wolf, Nagorney, Dozois, Cima, O’Byrne, Qin, and Larson. Statistical analysis: Holubar and O’Byrne. Obtained funding: Holubar. Administrative, technical, and material support: Holubar and Wang. Study supervision: Holubar, Wolff, Nagorney, Dozois, Cima, Qin, and Larson.

Financial Disclosure: None reported.

Previous Presentation: This paper was presented at the Minnesota Surgical Society Spring Meeting; May 2, 2008; Minneapolis, Minnesota.

REFERENCES

11. Ouellette JR, Small DG, Termuhlen PM. Evaluation of Charlson-Age Comorbidity...


**Call for Papers**

**Maintenance of Certification**

During 2009, we are soliciting manuscripts on maintenance of certification. The editorial board has selected this topic as our year-long theme. Accepted manuscripts will be given priority publication. Please indicate in your cover letter that your manuscript is to be considered for this theme.