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Splenic injury is an under-recognized adverse event of in-patient colonoscopy: a nationwide analysis

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Bibliography
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ABSTRACT

Background and study aims Splenic injury (SI) during colonoscopy is an underappreciated adverse event. Our aim was to examine the occurrence and outcomes of patients who developed SI after inpatient colonoscopy using a nationwide dataset.

Patients and methods Retrospective, observational study using the National Inpatient Sample (NIS) between 2012 and 2018. All patients with ICD9/10CM procedural codes for colonoscopy with or without SI were included. The primary outcome was the association between SI and inpatient colonoscopy. Secondary outcomes were inpatient morbidity, mortality, resource utilization, splenectomy rates, hospital length of stay and total hospital costs and charges. Comparative analyses were performed between patients with and without SI. Multivariate regression analyses were utilized.

Results A total of 2,258,040 of inpatient colonoscopies were included. Of these, 240 had associated SI and 25 patients required splenectomy (10.4%). The incidence of colonoscopy-associated SI remained relatively stable between 2012 and 2018 (0.033% versus 0.020%, respectively). The mean age of patients with and without SI was 63.7 and 64.1 years, respectively. The occurrence of SI was calculated as 10.63 cases per 100,000 inpatient colonoscopies. Patients who had associated SI displayed significantly higher odds of inpatient mortality (aOR: 14.45) and ICU stay (aOR: 10.11) compared to those without SI.

Conclusions Splenic injury confers significantly higher odds of inpatient mortality, and resource utilization. The incidence of SI related to colonoscopy remained stable during the study period. Although uncommon, SI should be considered when encountering patients with abdominal pain after colonoscopy.

Introduction

Splenic injury (SI) is an underrecognized and underappreciated adverse event (AE) associated with colonoscopy. The first case of SI as an AE of colonoscopy was reported in 1974 [1]. As of 2012, only 103 cases of SI after colonoscopy had been reported, with an estimated incidence of 1 per 100,000 colonoscopies [2]. Recent large studies have shown the incidence may be higher, between 1 in 22,222 (0.0045%) and 1 in 13,794 (0.00725%) for outpatient colonoscopies [3,4]. For inpatient procedures, however, the incidence has been reported to be higher, up to 1 in 6,000 colonoscopies [5,6]. The overall mor-

tality rate of SI following colonoscopy is estimated to be up to 5% [6–8].

Patients with SI present with abdominal pain in the left upper quadrant, usually within the first 24 hours following colonoscopy [9]. Referred pain to the left shoulder and/or signs of peritonitis may be present, and the majority of previously reported cases, up to 69% of patients, have required splenectomy likely representing reporting bias [2, 9]. Splenic artery embolization has been suggested as a potential non-operative treatment for SI in hemodynamically stable patients [10]. Although death from SI or splenic rupture after elective colonoscopy are rare, three cases have been reported [7].

Patient-dependent risk factors for SI associated with colonoscopy include the use of anticoagulation, splenomegaly, inflammation, adhesions from prior surgeries, and female sex [2, 7]. Procedure-dependent risk factors proposed to be associated with SI include inexperience of the endoscopist, external pressure to the abdomen, excess traction, and certain maneuvers (such as the "slide by" and "alpha" maneuver") [2, 5, 7]. In fact, most cases of SI have been reported in uncomplicated colonoscopies for routine surveillance [2]. It is believed that the most likely mechanism leading to SI involves tension on the splenocolic ligament or pre-existing adhesions as the colonoscope passes by the splenic flexure. The increased tension can cause tearing of the splenic parenchyma and rupture of the splenic capsule.

The incidence and outcomes of SI following an inpatient colonoscopy is uncertain. Therefore, we performed a retrospective, observational study to determine the occurrence and outcomes of patients who developed SI after an inpatient colonoscopy.

Patients and Methods

This is a retrospective observational study using the National Inpatient Sample (NIS) datasets from the years 2012 to 2018. This is the largest publicly available, all-payer inpatient dataset in the United States. The Healthcare Cost and Utilization Project (HCUP), which is a branch of the Agency for Healthcare Research and Quality (AHRQ), oversees and maintains this dataset. Each yearly dataset contains data for over 7 million hospital admissions, which is in turn a 20% stratified sample of over 4,000 non-federal acute care hospitals across 47 US states. After applying the discharge weights provided by the HCUP, it is representative of 95% of hospitalizations across the nation [11]. The dataset contains principal (primary reason for admission at the term of the hospitalization) and secondary diagnostic codes. In addition, procedural codes account for all interventional or surgical procedures performed during the hospitalization [12].

Study population

To identify the population of interest, all adult patients with International Classification of Diseases, Ninth and Tenth Revisions, Clinical Modification (ICD-9 and ICD-10 CM) procedural codes for colonoscopy were included (45.23, 0DJD8ZZ). Only colonoscopies performed on the day of admission were included in the study. The population was divided into two cohorts by identifying patients who had associated diagnostic ICD codes for splenic injury (865.XX, S36.XXX, D78.2X, D79.3X) and splenectomy (41.5, 41.43, 07BPXX). Only splenic injuries occurring within the first 2 days after the index colonoscopy were included given most colonoscopy-associated splenic injuries manifest clinically within 48 hours. This exclusion was performed to exclude patients who may have had an unrelated splenectomy after 2 days following the index colonoscopy and excluding patients who may have had a splenectomy before actually undergoing a colonoscopy. All patients with SI and associated trauma-related diagnoses (blunt trauma, motor vehicle accidents, traumatic brain injury, etc.) or miscellaneous conditions that are associated with splenectomy, such as immune thrombocytopenic purpura (ITP), were also excluded. The trends in total number splenic injuries associated with colonoscopy were assessed from 2012 to 2018.

Variable Definition

Patient and hospital characteristics included in the database were examined and compared between the two cohorts. Patient characteristics included age, sex, race, median income in patient zip code and Charlson comorbidity index. Hospital characteristics included US geographic region (i.e. HCUP divides the United States into Northeast, Midwest, South and West regions), teaching status (i.e. "Teaching" vs. "Non-Teaching"), urban location, and hospital bed size [12]. Inpatient mortality, morbidity measures (i.e. shock, intensive care unit [ICU] stay and acute kidney injury) were also extracted from the dataset using respective ICD codes. For resource utilization, length of hospitalization (LOS), total hospitalization charges and hospital costs were examined. As multiple years of data were used, the Consumer-Price Index (CPI) was utilized to account for inflation and convert all currency values to 2018 $USD equivalents. To account for patient comorbidities, the Deyo adaptation of the Charlson Comorbidity Index was used, which has been validated for large database analysis [13].

Outcomes

The primary outcome was the occurrence of SI associated with inpatient colonoscopy, which was defined as an SI occurring within the first 2 days of the index procedure. Secondary outcomes included determining how many patients required a splenectomy, as well as determining associated morbidity measures and resource utilization in the two cohorts. Lastly, the trend in reporting of SI between the years 2012 and 2018 was investigated.

Statistical analysis

Discharge-level weights published by the HCUP were used to estimate the total number of patients undergoing colonoscopy, as well as the total number of patients who developed SI. General descriptive statistics were used to describe patient characteristics. Proportions and means were compared using Fisher's exact test and Student *t*-test, respectively. The occurrence of SI in patients undergoing inpatient colonoscopy was reported as a function of cases/100,000 colonoscopies. Multivariate logistic

▶ **Table 1** Cases and incidence of splenic injury over the study period, 2012–2018.

Year	Splenic injury cases	Percentage relative to total colonoscopies	Overall incidence
2012	40	0.033 %	1 in 3,030
2013	20	0.017 %	1 in 5,880
2014	25	0.022 %	1 in 4,545
2015	35	0.041 %	1 in 2,440
2016	60	0.023 %	1 in 4,345
2017	30	0.012 %	1 in 8,330
2018	50	0.020 %	1 in 5,000

regression yielded adjusted odds ratio for each of the outcome measures. Factors adjusted for included age, gender, ethnicity, median income in patient's zip code, Charlson Comorbidity Index, hospital region, location and bedsize. All statistical calculations were conducted using STATA, Version 14 (StataCorp LP, College Station, Texas, United States).

Results

A total of 2,258,040 inpatient colonoscopies (mean age 64.13 years, ± SD 17.93) were included in the study, with 240 patients having SI as an AE, and 25 (10.4.%) requiring a splenectomy. Twenty-five deaths occurred in the patients with associated SI, which amounted to an overall mortality of 10.4 %. The overall incidence of SI associated with inpatient colonoscopy was 10.63 cases per 100,000 (roughly 1 in 9,400) inpatient colonoscopies. The incidence remained relatively stable over the study period from 1 in 3,030 (0.033 %) to 1 in 5,000 (0.020 %) cases between 2012 and 2018, respectively (▶ **Table 1**).

Comparing the patients with and without SI, only the hospital's location where the colonoscopy was performed (urban versus non-urban) showed a statistically significant difference ($P<0.01$), (▶ **Table 2**). The mean age [SD] of patients with and without SI were 63.67 [21.52] and 64.13 [17.93] years, respectively, $P=0.15$. Comparatively, colonoscopies performed at hospitals in the South displayed a higher incidence of SI. A patient's race also seemed to display a higher incidence of SI. However, these differences were not statistically significant.

The presence of SI was strongly associated with inpatient odds of mortality (aOR 14.45, $P<0.01$), shock (aOR 6.13, $P<0.01$), and ICU stay (aOR 10.11, $P<0.01$), (▶ **Table 3**). Regarding resource utilization, SI was strongly associated with an additional $20,927 USD in costs ($P<0.01$), $ 86,813 USD in charges ($P<0.01$) and an extra 4.7 days in total length of stay ($P<0.01$), (▶ **Table 4**). Crude means comparing patients with and without SI are shown in (▶ **Table 5**) for reference.

▶ **Table 2** Baseline characteristics of patients undergoing colonoscopy that had associated splenic injury compared to those who did not.

	No splenic injury (n = 2,257,800)	Splenic injury (n = 240)	*P* value
Mean age	64.13	63.67	0.15
Female gender	52.71 %	60.87 %	0.27
Race			0.17
▪ Caucasian	68.09 %	81.82 %	
▪ African American	15.55 %	6.82 %	
▪ Hispanic	10.40 %	6.82 %	
▪ Asian	2.86 %	2.27 %	
▪ Other	3.10 %	2.27 %	
Median income in zip code			0.73
▪ $ 1 – $ 37,999	28.85 %	24.44 %	
▪ $ 38 K – 47,999	26.11 %	33.33 %	
▪ $ 48 K – 63,999	24.25 %	22.22 %	
▪ > $ 64,000	20.78 %	20.00 %	
Charlson Comorbidity Index			0.75
▪ 0	30.54 %	23.91 %	
▪ 1	22.02 %	21.74 %	
▪ 2	16.33 %	17.39 %	
▪ 3 or more	31.11 %	36.96 %	
Hospital region			0.17
▪ Northeast	17.55 %	17.39 %	
▪ Midwest	23.89 %	19.57 %	
▪ South	37.90 %	52.17 %	
▪ West	20.66 %	10.87 %	
Urban location	91.80 %	80.43 %	< 0.01
Teaching hospital	63.22 %	60.87 %	0.84
Bed size			0.73
▪ Small	17.59 %	21.74 %	
▪ Medium	29.51 %	26.09 %	
▪ Large	52.89 %	52.17 %	

Discussion

Between 2012 to 2018, we found the overall incidence of SI in the United States following an inpatient colonoscopy was 0.011%. This represents approximately 1 in 9,400 inpatient procedures, which is higher than previously described for outpatient colonoscopies [3, 4]. We found the incidence of SI has remained relatively stable between 2012 and 2018. Our study showed that SI was associated with significantly higher inpati-

▶ **Table 3** Adjusted odds of outcomes in patients with splenic injury compared to those without splenic injury after inpatient colonoscopy.

Outcome	Adjusted odds	95% confidence interval	*P* value
Inpatient mortality	14.45	5.15–40.60	<0.01
Shock	6.13	2.48–15.10	<0.01
ICU stay	10.11	4.55–22.44	<0.01
AKI	1.26	0.51–3.16	0.62

ICU, intensive care unit; AKI, acute kidney injury.

▶ **Table 4** Additional USD$ and length of stay in patients with splenic injury compared to those without splenic injury after colonoscopy.

Outcome	Adjusted mean	95% confidence interval	*P* value
Additional costs	$ 20,927[1]	$ 13,477, $ 28,377	<0.01
Additional charges	$ 86,813	$ 45,997, $ 127,629	<0.01
Additional LOS (days)	4.7	2.5,6.9	<0.01

LOS, length of stay.
[1] The USD$ are adjusted for inflation using the Consumer Price Index.

▶ **Table 5** Crude means comparing patients with splenic injury and without splenic injury.

Outcome	No splenic injury	Splenic injury	*P* value
Costs	$13,030	$34,872	<0.01
Charges	$53,032	$138,285	<0.01
LOS (days)	4.5	9.4	<0.01

ent resource utilization, need for splenectomy, and higher odds of inpatient morbidity and mortality compared with patients who underwent inpatient colonoscopy and did not have an associated SI.

Several reasons could explain the apparent increase in the incidence of SI following an inpatient colonoscopy compared to outpatient procedures. First, the 0.0045% to 0.00725% rate of SI for outpatient colonoscopies was measured for cases occurring before 2012 [3,4]. There could have been an increase in awareness of SI by gastroenterologists and non-gastroenterologists leading to an increased detection in patients presenting with abdominal symptoms following colonoscopy. The alternative may be possible as well, that the incidence of SI may be truly increasing. Additional studies are needed to determine the effects of increased awareness on SI as a possible confounder for its increased incidence. Second, the previously reported incidence for SI was reported from elective colonoscopies. This study evaluated the incidence of SI in patients undergoing inpatient colonoscopies, which are typically not elective procedures, as they are usually performed for gastrointestinal bleeding in elderly patients [14], These procedures may carry a higher associated risk given the patient demographics and higher number of comorbidities. Thirdly, given the large sample size examined by this study, a more accurate estimate of the actual inpatient occurrence may have been reached. Similarly, Singla et al. found a higher overall incidence than previously reported for outpatient procedures. They found an incidence of SI of 1 in 6,000 for inpatient colonoscopies between 2000 to 2007 given their large sample size of 2,654,456 colonoscopies [6].

A recent study by Olaiya et al. in elderly patients (mean age 83.9 years ± 2.73) analyzed the outcomes of inpatient colonoscopies using the NIS database between 1998 to 2013 [14]. It included 296,385 colonoscopies and showed the incidence of SI was 0.22 per 1,000 colonoscopies, or about 1 in 4,550 procedures, which is similar to our reported incidence for 2014 and 2016. The study showed that SI was significantly associated with the odds of inpatient mortality (OR 25.93; 95% CI, 14.61–46.01). Interestingly, our current study found a statistically lower odds of mortality with SI (aOR 14.45; 95% CI 5.15–40.60), which is most likely due to the differences in the average age and level of comorbidities. Similar to our study, the study by Olaiya et al. found no patient-dependent or procedure-dependent variables associated with an increased risk of SI. Possible procedure-dependent variables for an increased risk of SI may include an increase in deep sedation, changes in colonoscope design, and more use of the stiffener. Additional studies are needed to further determine whether risk factors for SI differ between patients undergoing inpatient or elective colonoscopies.

Several of this study's limitations need to be considered, which are primarily related to the nature of the NIS. Firstly, any administrative database is inherently associated with the risk of miscoding. Despite that, the HCUP employs specialized coders to extract the data from the insurance claim form, the information within the form may be miscoded. This dataset only examines the outcomes of patients who were admitted to the hospital, for which the conclusions apply only to the inpatient population. The bulk of total colonoscopies are performed in the outpatient setting, which cannot be analyzed in this study. The relatively higher-than-reported occurrence of this AE may be related to the fact that admitted patients have an acute disease process, making them comparatively "sicker" than their outpatient counterparts. Other than calculating the general comorbidity indices, the NIS does not contain specific data on grading the severity of acute illness, which is a very important factor associated with inpatient AEs. In addition, this study excluded patients who underwent inpatient colonoscopies not occurring on the day of admission given only procedural codes have time-defining variables. This, naturally, excludes from the analysis patients who underwent colonoscopy during any other day of hospitalization and had a splenic injury.

Nonetheless, our study has shown SI will continue to be seen in the inpatient setting as an AE of colonoscopies. Given its seriousness, it should be included in the informed consent, even if it is uncommon. Our study raises awareness on this condition for patients presenting with abdominal pain in the post-proce-

dural setting. Additionally, it serves as an update to the literature on the occurrence of this event in the inpatient setting. Indeed, further studies are required to determine if the incidence of SI is truly increasing, or if it is better explained by the increased awareness.

Conclusions

Although colonoscopy-associated SI is an underappreciated AE and uncommon, this study found the incidence to higher than previously reported for outpatient procedures. Additionally, it was associated with higher odds of inpatient mortality, morbidity, and resource utilization. Increased awareness of this condition likely explains its increased incidence in recent years. We found that only non-urban hospitals carried a higher risk of SI. These observations are relevant not only for gastroenterologists, but for all providers caring for inpatients in the post-colonoscopy setting. Larger and prospective studies are needed to better understand the risk factors associated with SI in patients undergoing inpatient colonoscopies.

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Competing interests

The authors declare that they have no conflict of interest.

References

[1] Wherry DC, Zehner H. Colonoscopy-fiberoptic endoscopic approach to the colon and polypectomy. Med Ann Dist Columbia 1974; 43: 189–192

[2] Piccolo G, Di Vita M, Cavallaro A et al. Presentation and management of splenic injury after colonoscopy: a systematic review. Surg Laparosc Endosc Percutan Tech 2014; 24: 95–102

[3] Bielawska B, Hookey LC, Sutradhar R et al. Anesthesia assistance in outpatient colonoscopy and risk of aspiration pneumonia, bowel perforation, and splenic injury. Gastroenterology 2018; 154: 77–85.e73

[4] Cooper GS, Kou TD, Rex DK. Complications following colonoscopy with anesthesia assistance: a population-based analysis. JAMA Intern Med 2013; 173: 551–556

[5] Rex DK. Colonoscopic splenic injury warrants more attention. Gastrointest Endosc 2013; 77: 941–943

[6] Singla S, Keller D, Thirunavukarasu P et al. Splenic injury during colonoscopy–a complication that warrants urgent attention. J Gastrointest Surg 2012; 16: 1225–1234

[7] Ha JF, Minchin D. Splenic injury in colonoscopy: a review. Int J Surg 2009; 7: 424–427

[8] Kothari ST, Huang RJ, Shaukat A et al. ASGE review of adverse events in colonoscopy. Gastrointest Endosc 2019; 90: 863–876.e833

[9] Pavlidis E, Gkizas I, Mavromati O et al. Splenic injury following elective colonoscopy: a rare complication. J Surg Case Rep 2016; 12: rjw214

[10] Brennan IM, Faintuch S, Sacks B. Superselective splenic artery embolization for the management of splenic laceration following colonoscopy. Acta Radiol Short Rep 2014; 3: doi:10.1177/2047981614524199

[11] Health Care Cost and Utilization Project. HCUP National Inpatient Sample (NIS). Rockville, MD: Agency for Healthcare Research and Quality; 2012

[12] Project HCaU. NIS Description of data elements. available at (date accessed 05/25/2020): www.hcup-us.ahrq.gov/db/vars/hosp_bedsize/nisnote.jsp

[13] Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992; 45: 613–619

[14] Olaiya B, Adler DG. Adverse events after inpatient colonoscopy in octogenarians: results from the national inpatient sample (1998-2013). J Clin Gastroenterol 2020; 54: 813–818