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ORIGINAL ARTICLE

Safety of Endoscopy in Cirrhosis

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Abstract

Background Endoscopic procedures are among the most commonly performed medical procedures and the serious adverse event rate is reported to be 1–3 adverse events per 1000 procedures.

Aims Here, we have examined the safety of endoscopy specifically in cirrhotic populations.

Methods We conducted a retrospective case (cirrhosis)–control (non-cirrhosis) study of the outcomes of patients undergoing endoscopy in a large academic medical center. The primary outcome was a procedural or post-procedural complication. Complete clinical data were collected for all patients undergoing endoscopic procedures—including esophagogastroduodenoscopy, colonoscopy, EUS, ERCP, flexible sigmoidoscopy, and others. Cirrhosis was carefully defined based on clinicopathological grounds.

Results We identified 16,779 patients who underwent endoscopy, including 2618 with cirrhosis and 14,161 without cirrhosis. There were 167 complications (0.99%), which included 15/2618 cirrhotics (0.6%) and 152/14,161 (1.1%) non-cirrhotics. The most common complications were cardiopulmonary (including hypotension and hypoxemia) found in 67% of patients; procedurally related complications occurred in 19% of patients. The complication rate was the same or lower in cirrhotics than controls undergoing esophagogastroduodenoscopy (0.6% vs 0.9%, $p=0.03$), colonoscopy (0.6% vs. 0.6%, $p=$NS), or ERCP (0.7% vs. 1.4%, $p=$NS) Logistic regression analysis identified the following features to be associated with an increased risk of having a complication: inpatient status, history of myocardial infarction, and an EUS procedure.

Conclusions Endoscopy in cirrhotic patients was as safe or safer than non-cirrhotic patients undergoing similar procedures.

Keywords Safety · Endoscopy · Cirrhoses

Introduction

Endoscopic procedures are commonly performed and carry a low risk of adverse events with large case series reporting overall adverse event rates of 0.5% to 0.01% and mortality rates ranging from 0 to 1 in 0.05% [1]. Minor adverse events are common and are often under-reported for a variety of reasons. Major adverse events related to endoscopy are less common and include cardiopulmonary adverse events, infectious events, perforation, and bleeding. Cardiopulmonary adverse events can range from minor events such as transient hypoxia or hypotension to cardiopulmonary arrest. Infectious events can be directly related to the procedure itself or as a result of failure to follow guidelines for reprocessing and use of endoscopic devices [2]. Perforation, although rare, is associated with a mortality rate between 2 and 36% [3, 4]. Clinically significant bleeding is also rare and is more likely to occur in patients with underlying coagulopathy or thrombocytopenia [1].

Chronic liver disease and portal hypertension create unique physiological states that are thought to predispose cirrhotic patients to an increased risk of complications related to endoscopic procedures. Decreased hepatic synthetic dysfunction, the presence of portal hypertension,

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decreased capacity for drug metabolism, and changes in coagulation are all thought to contribute to a hypothetical increased complication risk [5].

Despite the potential risks, cirrhotic patients often undergo endoscopy for a variety of reasons to include evaluation of gastrointestinal hemorrhage, screening for colon cancer, evaluation of abnormal imaging findings, and to assess for and treat the complications of portal hypertension such as esophageal varices. Despite low rates of complication in non-cirrhotic patients, clinicians are often reluctant to perform procedures on cirrhotic patients.

Multiple studies have examined complication risk in patients with cirrhosis in the perioperative period and have identified the severity of liver dysfunction (typically assessed with an extrapolation of the MELD or CTP score), as an independent predictor of perioperative morbidity and mortality [6]. Despite a substantial body of literature addressing surgical risk in cirrhotic patients, data regarding safety of endoscopy in cirrhosis are extremely limited. Here, we hypothesized that endoscopy in cirrhotic patients, as with surgery, would carry a higher complication rate than endoscopy performed in non-cirrhotic patients.

Methods

After obtaining Institutional Review Board approval through the Medical University of South Carolina, we conducted a retrospective cohort study with the primary outcome being safety, defined as the absence of adverse events as detailed. We included patients over the age of 18 who underwent an endoscopic procedure at the Medical University of South Carolina in both outpatient and inpatient settings between January 1, 2010 and December 31, 2014. All endoscopies recorded in the institution's endoscopy reporting system (EndoWorks, Olympus Corp.) were included. We recorded basic demographic including age, gender, ethnicity, and ASA score, along with comorbid medical conditions including pulmonary, cardiac, and renal disease as detailed in the results section as well as other comorbidities required to calculate the Charlson Comorbidity Index [7]. ASA score was assessed by the physician prior to the procedure and was recorded in the procedure note. In accordance with the American Society of Anesthesiologists Physical Status Classification System, developed by the ASA executive committee, standard definitions were used and are provided in online appendix [8]. We also obtained laboratory data from patients around the time of their procedure as well as periprocedural vital signs such as systolic and diastolic blood pressure as well as heart rate, respiratory rate, and oxygen saturation. In order to calculate the Child–Pugh score, we also obtained clinical information such as the presence of ascites and hepatic encephalopathy. For each procedure, we recorded the duration of the procedure in minutes, and the type of sedation utilized. Once all endoscopies with complete data were identified, this dataset was screened to identify patients with cirrhosis as described [9].

Sedation/anesthesia was provided at the discretion of the endoscopist performing the procedure, and included moderate sedation (typically with a benzodiazepine and narcotic) administered by the endoscopist or monitored anesthesia care (MAC; also, propofol-based deep sedation) administered by an anesthesiologist. Patients receiving general anesthesia were excluded.

Complications occurring during or immediately after endoscopy are recorded per institutional standards under the adverse events tab located on the endoscopy report. Complications were identified using proprietary EndoIntelligence software. In order to verify the validity of the search, we used the EndoAnalysis tool to perform a free text search of all text in endoscopy reports to ensure that no reports were missed using the initial EndoIntelligence search. We specifically searched for the following complications (listed). We then reviewed the records of all patients reported to have a complication to verify that there was a true complication.

We generated a list of keywords associated with adverse events. Text processing was then used to identify patients with complications. A complete listing of the keywords is located in online appendix. Procedure notes containing these terms were then reviewed to ensure that they were used in the intended context. Since there is no current standard for expected intra-procedural hemodynamic changes, we utilized the following clinical definitions (a priori) [10]:

(a) Hypoxia: Oxygen saturation $< 90\%$
(b) Hypotension: Systolic blood pressure < 80 or diastolic blood pressure < 40, or MAP < 60, or $> 20\%$ drop in baseline MAP.
(c) Bradycardia: Heart rate < 55
(d) Tachycardia: Heart rate ≥ 110
(e) Bradypnea: Respiratory rate < 15
(f) Tachypnea: Respiratory rate > 35

Other complications such as procedure-related complications, and deaths were also recorded.

Statistical Analysis

The study was designed as a case–control study including patients with cirrhosis (case) and those without cirrhosis (control). Univariate analysis (means, proportions, and p value) of demographic, clinical, and laboratory variables was performed to identify variables associated with the outcome. A multivariable FIRTH logistic regression model was employed for the outcome to account for the low number of events. Multicollinearity was also assessed. Backward

selection was used to determine variables selected for the models (based on $p \leq 0.05$). Receiver operating characteristic (ROC) curves were created by plotting sensitivity against (1- specificity) for assessing the accuracy of predictions. To assess and adjust for potential model overfitting, we used the Harrell Optimism Correction [11]. The Harrell optimism correction is an estimate of internal validity that penalizes for overfitting. SAS 9.3 (SAS Institute Inc., Cary, NC) and IBM SPSS Modeler (Version 17)—Essentials for R (IBM Corporation, Armonk, NY) were used for the statistical analyses.

Results

From January 1, 2010 to December 31, 2014, 16,779 procedures were performed that had complete data available (Fig. 1). The cirrhotic cohort consisted of 2618 cirrhotic patients and there were 14,161 non-cirrhotic controls. There were 167 adverse events with 15 in the cirrhotic group (0.6%) compared to 162 (1.1%) in the non-cirrhotic group.

Within the 2618 cirrhotic group, there were more male patients (64%) compared to non-cirrhotics (45%) and more Caucasian patients (75%) compared to non-cirrhotics (61%). Clinical features including age and inpatient status were relatively evenly matched. The average MELD Score was 14 and Child–Pugh Score 9. Usage of MAC anesthesia was similar among groups at 44% in the cirrhotic cohort and 43% in non-cirrhotic controls. The remainder of the patients received benzodiazepine/opioid-based moderate sedation administered by the endoscopist. One-third of patients had a complication of cirrhosis other than varices, with 24% having any ascites at the time of procedure and 9% having had a history of hepatic encephalopathy (Table 1).

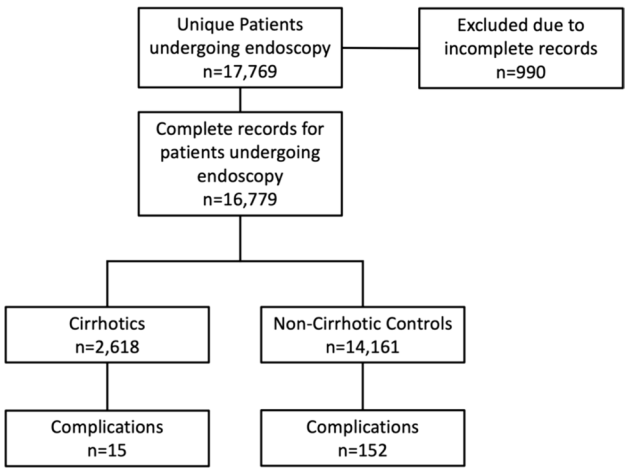

Fig. 1 Consort diagram of patients. Patients included in the study are depicted graphically

As expected, patients in the cirrhotic cohort had higher ranges of ASA scores suggesting greater comorbid diseases, although CCI severity scores were slightly higher in non-cirrhotic patients (Table 1). The majority of cirrhotic patients were ASA 3 (92%) and there were 37 patients (1%) labeled ASA 4. The most predominant ASA group in the non-cirrhotic group was ASA 3 (55%), followed by ASA 2 (25%), ASA 1 (18%), and ASA 4 (2%). Pre-procedural vital signs including systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, and oxygen saturation were similar among the groups. Also as expected, cirrhotic patients were found to have statistically significant differences in peri-procedural labs including higher serum creatinine values, higher INR, higher total bilirubin, and lower serum albumin, and platelet counts than non-cirrhotic patients (Table 1).

Chronic diseases including essential hypertension, diabetes mellitus, chronic kidney disease, and peripheral vascular disease were the most common in both groups. The cirrhotic group had a higher amount of chronic kidney disease and diabetes when compared to non-cirrhotic patients ($p = < 0.0001$, $p = 0.076$). The non-cirrhotic group had a greater frequency of cancer, congestive heart failure, cerebrovascular disease, myocardial infarction, and peripheral vascular disorders (Table 2).

The most commonly performed procedure in both groups was EGDs with 1667 (64%) in the cirrhotic group compared to 6456 (46%) in the control group. The next most commonly performed procedure in the cirrhotic group was ERCP (16%), which was higher than the control group (10%, $p = < 0.0001$). There were fewer EUS procedures performed on cirrhotic patients (3%) compared to 7% in controls ($p = < 0.0001$). Colonoscopy made up 13% of procedures in the cirrhotic group compared to 29% in the non-cirrhotic controls ($p = < 0.0001$). Procedural time (in minutes) was slightly shorter in the cirrhotic group and cirrhotic patients also had a shorter length of hospital stay ($p = < 0.0001$) (Table 3).

Medications used for conscious sedation included fentanyl and midazolam. The mean dose of fentanyl was 100 µg ± 31 µg in cirrhotics compared to 92 µg ± 33 µg in non-cirrhotics ($p = 0.33$). The mean dose of midazolam was 4 mg ± 1.4 mg in cirrhotics compared to 4 mg ± 1.4 mg in non-cirrhotics ($p = 0.18$).

Overall, there were 167 complications (as defined in Methods), and 71% of complications occurred in inpatients (Table 1). Cardiovascular and pulmonary complications were the most common, including 67% of all complications, followed by procedural complications (19%), provider concerns for closer monitoring (9% which reflect complications that were not directly documented in procedural reports), and medication complications (4%). The most common cardiopulmonary complications were hypoxia (56 patients, 29%

Table 1 Demographics

Variable	Cirrhotics ($n=2618$)	Non-cirrhotics ($n=14161$)	p value
Age (mean, SD)	56 ± 11	58 ± 15	< 0.0001
Sex (%)			< 0.0001
Female	944 (36%)	7766 (55%)	
Male	1674 (64%)	6395 (45%)	
Race (%)			< 0.0001
Non-caucasian	656 (25%)	5455 (39%)	
Caucasian	1962 (75%)	8706(61%)	
Inpatient (%)	1281 (49%)	6683(47%)	
Adverse events (%)	15 (0.6%)	162 (1%)	0.017
ASA score			< 0.001
1	0	2598 (18%)	
2	211 (8%)	3370 (25%)	
3	2370 (91%)	7816 (55%)	
4	37 (1%)	377 (2%)	
Moderate (conscious) sedation	14,161 (56%)	7999 (57%)	0.01
MAC (%)	1157 (44%)	6162 (43%)	0.01
Systolic BP, (mean, SD)	122 (21)	127 (22)	0.52
Diastolic BP, (mean, SD)	67 (13)	70.7 (13)	0.67
Heart rate, (mean, SD)	79 (16)	80 (15)	0.042
SaO_2, (mean, SD)	97 (2)	97 (2)	0.0036
Respiratory rate, (mean, SD)	18 (3)	18 (2)	0.0763
Ascites (%)	627 (24%)	330 (2%)	< 0.0001
Hepatic encephalopathy (%)	238 (9%)	0 (0%)	< 0.0001
Albumin, (mean, SD)	2.7 (1)	3.1 (1)	0.009
Creatinine, (mean, SD)	1.5 (2)	1.3 (2)	< 0.0001
INR, (mean, SD)	1.4 (1)	1.2 (0.3)	< 0.0001
Total bilirubin, (mean, SD)	3.5 (6)	1.2 (3)	< 0.0001
White blood cell count, (mean, SD)	7.0 (5)	8.1 (4)	< 0.0001
Hemoglobin, (mean, SD)	10.1 (2)	11 (2)	0.89
Platelet count, (mean, SD)	139 (102)	248 (118)	< 0.0001
Charlson Comorbidity Index, (mean, SD)	3.2 ± 2.4	3.2 ± 2.6	< 0.0001
MELD, (mean, SD)	14 ± 10	–	
Child–Pugh score, (mean, SD)	9 ± 2	–	

ASA American Society of Anesthesiologists, *MAC* monitored anesthesia care, *MELD* model for end-stage liver disease

of all complications) and hypotension (43 patients, 26% of all complications). Rhythm disturbances including bradycardia, tachycardia, and dysrhythmia (ventricular tachycardia or fibrillation) occurred in 12 patients (7% of all complications). There was once instance of asystole, which led to a peri-procedural death (Table 4). Procedural complications included 14 perforations (8% of complications) as well as 3 incidences of stent malpositioning, 1 palatal tear, and 1 post-ERCP pancreatitis. Fourteen patients were transferred to the intensive care unit following their procedures for closer monitoring. Medication or sedation-related complications made up 4% of all complications and included aspiration in 3 patients (2%), refractory emesis in 2 patients (1.6% of all complications), 1 case of allergic reaction to medication, and 1 laryngospasm (Table 4).

Complications occurred in all types of endoscopic procedures. The rate of complications was highest in patients undergoing ERCP, with complication rates of 0.7% for ERCPs in cirrhotic patients compared to 1% in non-cirrhotic controls. Complication rates in colonoscopies and EGDs were 0.6% in cirrhotic patients, and in non-cirrhotic controls undergoing colonoscopy; the complication rate for EGD was 0.9% for upper endoscopy in non-cirrhotic controls (Table 5). Interestingly, there were no complications of EUS in the cirrhosis group, while the complication rate for EUS in the control group was 4%. This is likely due to the

Table 2 Comorbidities

Variable	Cirrhotics ($n=2618$)	Non-cirrhotics ($n=14,161$)	p value
Cancer (%)	420 (16%)	2933 (21%)	<0.0001
Cerebrovascular disease (%)	75 (3%)	562 (4%)	0.0063
Chronic kidney disease (%)	762 (29%)	2501 (18%)	<0.0001
Chronic pulmonary disease (%)	489 (19%)	2594 (18%)	0.66
Congestive heart failure (%)	245 (9%)	1761 (12%)	<0.0001
Diabetes (%)	1089 (42%)	4480 (32%)	0.076
Hypertension (%)	1611 (62%)	8590(61%)	0.4
Myocardial infarction (%)	191 (7%)	1184 (8%)	0.0058
Peripheral vascular disorders (%)	143 (5%)	999 (6%)	0.12

frequent performance of celiac axis blockade in the control group, which often leads to post-procedural hypotension. The average time for endoscopy in minutes was higher in patients who had a complication (24 ± 26 min compared to 18 ± 16 min, $p=0.003$). Inpatients in the complication group had a longer length of stay (hours) 197 ± 466 compared to 150 ± 391, although this difference was not statistically significantly different ($p=0.19$, Table 5).

Finally, we performed logistic regression analysis in hopes of identifying clinical variables associated with an endoscopic complication. Our final model identified male sex, procedural time, albumin, platelet count, Child–Pugh Score, Inpatient status, EUS, congestive heart failure, cerebrovascular disease, myocardial infarction, and ASA status as being significantly associated with a complication. EUS procedures, inpatient status, and history of myocardial infarction were identified as having the greatest correlation with adverse events as the odds of an adverse event increased by 44% with an EUS procedure, 63% with inpatient status, and 95% with history of myocardial infarction ($p=0.005$). Increasing platelet count, increasing serum albumin, Child–Pugh score, and ASA 1 and 2 status were found to be protective of complications (Table 6).

Discussion

The results of our study suggest that endoscopy is at least as safe in cirrhotic patients as in non-cirrhotic controls. We identified both sedation-related and procedure-related complications. The overall complication rates in cirrhotic patients and non-cirrhotic controls were low at 0.5% and 1%, respectively. Sedation-related complications made up the majority of complications in both groups, accounting for 60% of complications in the cirrhotic group and 67% of complications in the control group. Procedural complications, although rare, were the next most common type on complication, accounting for 33% of complications in the cirrhotic group, compared to 17% in the control group.

We found that the overall rate of complications was lower in cirrhotics than non-cirrhotics. A possible explanation for this could be that patients were extremely carefully monitored given their known underlying disease or that administration of sedative medications was reduced [12]. Additionally, cirrhotic patients were generally well compensated at time of endoscopy as evidenced by the relatively modest rate of hepatic encephalopathy and ascites. MELD score and the Child–Pugh score have both been shown to be independent predictors of decompensation in compensated patients, with higher scores correlating with the presence of a more severe degree of portal hypertension [13]. One could speculate that inherent bias would influence clinicians to perform less "dangerous" procedures such as ERCP on cirrhotic patients. However, our study did not demonstrate such a trend as the proportion of ERCPs to all procedures performed was higher in the cirrhotic group compared to the control group. The willingness of endoscopists to perform these procedures with a high probability of complication may be partially enabled by previous data suggesting ERCP is safe in cirrhotic patients [14, 15]. Additionally, the complication rates for

Table 3 Endoscopic procedures

Variable	Cirrhotics ($n=2618$)	Non-cirrhotics ($n=14,161$)	p value
Colon	335 (13%)	4104(29%)	<0.0001
EGD	1667 (64%)	6456 (46%)	<0.0001
ERCP	408 (16%)	1482 (10%)	<0.0001
EUS	78 (3%)	1044 (7%)	<.0001
Flexible sigmoidoscopy	72 (3%)	613 (5%)	<0.0001
Other*	58 (1%)	465 (5%)	0.0032
Scope time (Min)	17 ± 15	19 ± 16	<0.0001
Length of stay (Hours, mean ± SD)	144 ± 289	152 ± 408	<0.0001

*Other: includes PEG/PEJ placement and ileoscopy

Table 4 Complications

	Cirrhotics	Non-cirrhotics
Total complications	15	152
Cardiopulmonary complications	9	103
Hypoxia	7	49
Hypotension	1	42
Dysrhythmia	0	7
Bradycardia	1	3
Tachycardia	0	1
Asystole	0	1
Procedural complications	5	27
Perforation	1	13
Bleeding	4	9
Stent malpositioning	0	3
Palatal tear	0	1
Pancreatitis	0	1
Provider concern	0	15
Transfer to ICU	0	15
Medication complications	1	6
Aspiration	0	3
Refractory emesis	0	3
Allergic reaction	0	1
Laryngospasm	1	0

Table 5 Clinical complications by procedure

Variable	Cirrhotics ($n=15$)	Non-cirrhotics ($n=152$)	p value
Colon	2/335 (0.6%)	25/4104 (0.6%)	1
EGD	10/1667 (0.6%)	57/6456 (0.9%)	0.25
ERCP	3/408 (0.7%)	21/1482 (1.4%)	0.28
EUS	0/78 (0%)	39/1044 (3.7%)	–
Flexible sigmoidoscopy	0/72 (0%)	4/613 (0.7%)	–
Other*	0/52 (0%)	6/465 (1.3%)	–

*Other: includes PEG/PEJ placement and ileoscopy

colonoscopy were low in cirrhotic patients. This is similar to results found by an earlier retrospective study in examining 243 cirrhotic patients undergoing colonoscopy, which found no major complications and low rates of post-interventional hemorrhage [16]. EUS was found to be the procedure associated with the highest number of complications in the non-cirrhotic group. The majority of these complications were post-procedural hypotension, which is likely due to the technique used for celiac plexus blockade for the management of abdominal pain.

We found that sedation-related complications were more common than procedure-related complications. Our data are consistent with a previous study in which cardiopulmonary complications, specifically those related to sedation and analgesia, accounted for some 60% of adverse events in patients undergoing upper endoscopy and 67% in those having colonoscopy [2]. One might speculate that cirrhotic patients would have a higher rate of cardiopulmonary complications due to their altered hemodynamics and metabolism of sedative-hypnotic drugs used in endoscopy; however, this was not the case in our study. This is consistent with other studies which found a low rate of complications in cirrhotic patients undergoing endoscopy utilizing either MAC or general anesthesia [17]. Interestingly, MAC use did not appear to protect from cardiopulmonary complications, implying that the majority of MAC use is likely discretional and not based upon true patient need. [12] Interestingly, cirrhotics received slightly more total fentanyl compared to non-cirrhotics, while there was no statistically significant difference in midazolam dosing.

The likelihood of bleeding complications differs in both upper and lower endoscopy given the differences in procedure types and the increased risks of polypectomy as compared to mucosal biopsies [18]. Polypectomy in cirrhotic patients has long been considered to be risky because of the possibility that these patients are often coagulopathic, even though objective laboratory data may not suggest coagulopathy. This assumption is further confounded by evidence suggesting that routine laboratory tests are a poor predictor of coagulopathy and/or bleeding [19]. Overall, bleeding occurred in 4 in cirrhotic patients and 9 in non-cirrhotic controls—a low rate of bleeding. Although these data must be interpreted with caution as delayed bleeding is less likely to be reported, a large number of patients were included. These data suggest that bleeding may not be as common as often feared. Finally, a study examined 344 colonoscopies with polypectomies in cirrhotic patients, and found that the complication rate was 6%, but resulted in no blood transfusion, perforation, or death [20].

We recognize the limitations of this study. The biggest limitation of this study is its retrospective nature, and the potential bias that this may introduce. For example, it is possible that only "healthy" cirrhotic patients were offered endoscopy (i.e., selection bias), and this could lead to a lower incidence of complications. While possible, this is less likely since many different types of patients with cirrhosis require endoscopy—and in our practice, this includes those who require EGD for bleeding, or banding of known varices, or those requiring colonoscopy for screening prior to liver transplantation (who by their very nature are typically decompensated). Also, MELD and Child–Pugh scores were elevated in the cirrhotic cohort (and in many patients to levels not compatible with compensated disease). Additionally, this study included consecutive patients, which would be likely to mitigate the risk of system selection bias. It should be pointed out that at our institution (like at

Table 6 Clinical variables associated with a complication

	Odds ratio (OR)	Lower OR	Upper OR	*p* value
Male	0.6663	0.0589	15.8696	0.0113
Scope time (Minutes)	1.0136	0.4844	0.9125	0.0010
Albumin	0.6842	1.0057	1.0207	0.0264
Platelet count	0.9975	0.4908	0.9562	0.0012
Child–Pugh score	0.6743	0.9959	0.9991	0.0002
CCI	1.0755	0.5343	0.8354	0.0197
Inpatient	2.6357	1.0119	1.1404	0.0000
EUS	5.4481	1.7248	4.1414	0.0000
Congestive heart failure	0.6235	3.6907	7.8889	0.0493
Cerebrovascular disease	0.3488	0.3748	0.9985	0.0237
Myocardial infarction	1.9521	0.0963	0.8849	0.0054
ASA 1	0.2103	1.2285	3.0143	0.0007
ASA 2	0.5076	0.0804	0.5132	0.0626
ASA 3	1.1245	0.2622	1.0384	0.8075

ASA American Society of Anesthesiologists, *CCI* Charlson Comorbidity Index, *EUS* endoscopic ultrasound

many other institutions), there is no standard for adverse event reporting and reporting is done at the discretion of the endoscopist, which may lead to an underestimation of the frequency of adverse events. Additionally, the endoscopist is often only aware of the immediate complications of procedures as patients may re-present to different hospitals for delayed procedure-related complications. We attempted to minimize this in our study by carefully reviewing the medical records of patients subsequent to the index endoscopy.

We conclude that endoscopy is safe in cirrhotic patients. Rates of complications including both sedation-related and procedure-related complications in cirrhotic patients are similar to those observed in non-cirrhotic patients. The presence of cirrhosis should not lead to an unnecessary avoidance of endoscopy in patients with cirrhosis.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10620-024-08539-x.

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Author's contribution Jerome Edelson—study concept and design; acquisition of data; analysis and interpretation of data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; and statistical analysis. Don Rockey—study concept and design; acquisition of data; analysis and interpretation of data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; and study oversight.

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Declarations

Conflict of interest The authors certify that we have no financial arrangements (e.g., consultancies, stock ownership, equity interests, patent-licensing arrangements, research support, honoraria, etc.) with a company whose product figures prominently in this manuscript or with a company making a competing product.

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