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Original Article

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Efficacy and safety of EUS-guided coil embolization in combination with cyanoacrylate injection versus conventional endoscopic cyanoacrylate injection in the treatment of gastric varices with spontaneous portosystemic shunts

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Abstract

Background: Gastric varices (GV) with spontaneous portosystemic shunts (SPSS) pose considerable risks and challenges for administering endoscopic cyanoacrylate (CYA) injection. This study aimed to evaluate the efficacy and safety of EUS-guided coil embolization in combination with CYA injection compared to conventional endoscopic CYA injection for managing GV with SPSS.

Methods: This retrospective analysis included patients with SPSS treated with either EUS-guided coil embolization in combination with CYA injection or conventional CYA injection for gastric variceal bleeding at Ningbo Medical Center Lihuili Hospital (Zhejiang, China) between January 2018 and March 2023. Patient demographics, procedural details, and follow-up results were reviewed.

Results: The study evaluated 57 patients: 21 in the combined treatment group undergoing EUS-guided coil embolization in combination with CYA injection and 36 in the conventional group receiving conventional endoscopic CYA injection. Both cohorts achieved a 100% technical success rate. The mean volume of CYA used was significantly lower in the combined group (1.64 ± 0.67 mL) than in the conventional group (2.38 ± 0.72 mL; $P < 0.001$). Early GV rebleeding rates did not differ significantly between the groups; in contrast, the combined treatment group exhibited a considerably lower incidence of late GV rebleeding than the conventional group (4.8% *vs* 27.8%, $P = 0.041$).

Conclusions: EUS-guided coil embolization in combination with CYA injection demonstrated superiority over conventional endoscopic CYA injection in reducing late GV rebleeding in treating GV with SPSS.

Keywords: EUS; coil embolization; gastric varices; cyanoacrylate; spontaneous portosystemic shunts

Introduction

Gastric varices (GV) occur in approximately 20% of patients with portal hypertension, making up a much smaller proportion compared to those with esophageal varices, of which only 5% are implicated in gastrointestinal bleeding [1, 2]. Bleeding caused by GV is typically more severe and more difficult to manage, carrying a higher mortality rate [3]. Current guidelines advocate using endoscopic cyanoacrylate (CYA) injection as the treatment modality for GV [4, 5].

As portal hypertension progresses, spontaneous portosystemic shunts (SPSS) develop in approximately 60% of patients with cirrhosis, and 28% of these shunts are large shunt tracts [6]. Gastrorenal shunt (GRS) and splenorenal shunt (SRS) are common types of SPSS known to exacerbate the risks associated with endoscopic CYA injection. Currently, a defined treatment strategy for GV associated with SPSS is yet to be established, with endoscopic CYA injection being one of the mainstays of treatment [1, 4]. One of the severe complications arising from endoscopic CYA injection is ectopic embolism [7, 8], and the presence of SPSS may increase the risk of this complication.

Since the initial successful implementation of coil embolization by Levy in 2008 for managing refractory bleeding from ectopic varices [9], this technique has been increasingly applied in clinical settings. Endoscopic ultrasound (EUS) allows enhanced visualization of GV and helps identify the feeder vessels. Deploying coils under EUS guidance into these target vessels can substantially mitigate the risk of ectopic embolism associated with direct CYA injection. Recent evidence suggests that EUS-guided coil-based therapies may be superior to endoscopic or EUS-guided CYA injection alone in treating GV [10–13]. However,

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current studies are limited to patients with GV alone, and there are no studies involving patients with GV combined with SPSS, who may face an increased risk of ectopic embolism.

Therefore, the objective of this retrospective cohort study is to evaluate the efficacy and safety of EUS-guided coil embolization in combination with CYA injection in comparison to conventional endoscopic CYA injection in the treatment of GV with SPSS.

Materials and methods

Study design and patients

This single-center retrospective cohort study was conducted by reviewing cases of patients with cirrhosis and SPSS who were treated for GV bleeding through EUS-guided coil embolization in combination with CYA injection or conventional CYA injection at Ningbo Medical Center Lihuili Hospital (Zhejiang, China) between January 2018 and March 2023. The inclusion criteria for eligible patients were: (i) age ≥ 18 years; (ii) endoscopic evidence of active or recent bleeding from GV; (iii) confirmation of SPSS by computed tomography angiography (CTA) of the portal vein; and (iv) treatment with either EUS-guided coil embolization in combination with CYA injection or conventional CYA injection.

Exclusion criteria included: (i) insufficient baseline or follow-up data; (ii) concomitant hepatocellular carcinoma or other malignancies; z(iii) concurrent hepatorenal syndrome or hepatic encephalopathy; and (iv) history of gastric or esophageal surgery.

Patients were categorized into two groups according to their treatment modality: the combined treatment group received EUS-guided coil embolization in combination with CYA injection. In contrast, the conventional group was treated with conventional endoscopic CYA injection. Demographic information, clinical characteristics, cirrhosis etiology, SPSS specifics, procedural details, and follow-up data were meticulously compiled.

This study was conducted in line with the ethical standards of the Helsinki Declaration and received approval from the Research Ethics Committee of Ningbo Medical Center Lihuili Hospital (Approval number: KY2019PJ025).

Preoperative examination and preparation

Before surgery, all participants underwent a CTA of the portal vein to confirm SPSS presence and to classify the type of SPSS (Figure 1A and B). The anatomical classification of SPSS was used to define them, with an SRS identified as a shunt between the splenic hilum and the left renal vein, and a GRS characterized as a shunt between the gastric-related veins and the left renal vein. Gastric-related veins include GV, the short gastric vein, and the posterior gastric vein. The SPSS with the largest diameter was identified and measured. EUS assessed the GV to identify the target vessel and measure its maximal diameter. GV were classified endoscopically based on the Sarin classification [2]. Endoscopic treatments were performed under general anesthesia with tracheal intubation, depending on the patient's preference and the endoscopist's recommendation. All cases included in this study were managed by the same group and performed by the same expert endoscopist.

EUS-guided coil embolization in combination with CYA injection procedure

EUS was performed using a forward-viewing echoendoscope (TGF-UC260J; Olympus Corporation, Tokyo, Japan) or a curvilinear-array echoendoscope (GF-UCT260; Olympus Corporation, Tokyo, Japan) connected to an ultrasound scanning system (EU-ME2 Premier Plus; Olympus Corporation, Tokyo, Japan).

With the gastric fundus filled with water, the echoendoscope was positioned in the distal esophagus to assess the GV's anatomy and observe the blood flow. Color Doppler was used to precisely locate the feeding vessel or varix lumen, aiding in identifying the puncture target. The coil (Nester Embolization Coil, 0.018-inch, Cook Medical, Bloomington, Indiana, United States) was preloaded and then inserted into the target vessel in the lower esophagus using a 22-gauge needle (Endoscopic Ultrasound Needle, Cook Medical, National Technology Park, Limerick, Ireland) under EUS guidance. Once the coil was successfully positioned, N-butyl-2-cyanoacrylate (Medical Adhesive; Compont Medical Devices Corporation, Beijing) was injected into the GV employing the "modified sandwich method" [14, 15], with the volume adjusted according to Color Doppler feedback. 3 mL lauromacrogol (Tianyu Pharmaceutical Corporation, Shanxi, China) was administered before and after the CYA injection. The obliteration of varices was evaluated with Color Doppler, with additional endoscopic CYA injection performed until the blood flow signal vanished. Post-procedure, the effectiveness of varix obliteration was assessed via Color Doppler (Figure 2), and a follow-up CTA of the portal vein was repeated 1 week later to determine the displacement of the implanted coil (Figure 1C and D).

Conventional endoscopic CYA injection procedure

A therapeutic gastroscope (GIF-Q260J; Olympus Corporation, Tokyo, Japan) was utilized for the conventional procedure. The endoscopist determined the location and quantity of CYA injections during each session, focusing primarily on GV that showed signs of recent or active bleeding or those with the largest diameter. The "modified sandwich method" was employed for CYA injection into GV. 3 mL lauromacrogol was administered before and after the CYA, mirroring the approach used in the combined treatment group. Injections were performed using a 25-gauge sclerotherapy needle (Endo-Flex GmbH, Voerde, Germany) until the targeted GV complex exhibited firmness to catheter palpation and the bleeding had ceased.

Follow-up after endoscopic therapy

Post-treatment, patients were scheduled for a follow-up endoscopy or EUS after 1 month or sooner if there was a recurrence of bleeding. Successful obliteration of GV was indicated by the absence of visible varices during endoscopy or the detection of induration with catheter palpation. As confirmed by Color Doppler, a lack of blood flow in GV was also a marker of successful obliteration. Should any residual variceal blood flow be detected, further endoscopic CYA injections were performed. Subsequent endoscopies were then scheduled monthly until obliteration was confirmed. Once obliteration was achieved without rebleeding, annual surveillance with endoscopy or EUS was conducted. Data collection involved clinical, endoscopic, and telephone follow-ups, alongside medical history and records. Follow-up duration was determined by the timing of the last endoscopy or EUS.

Outcome measures and definitions

The outcome measures included the frequency of late GV rebleeding, adverse events, technical success, and the number of sessions required to achieve GV obliteration. Early GV rebleeding was classified as rebleeding within 5 days of the procedure, while late rebleeding referred to episodes occurring beyond 5 days post-procedure [16]. An adverse event was defined as an occurrence that prevented the completion of a planned procedure and/or resulted in the prolongation of hospital stay, according to

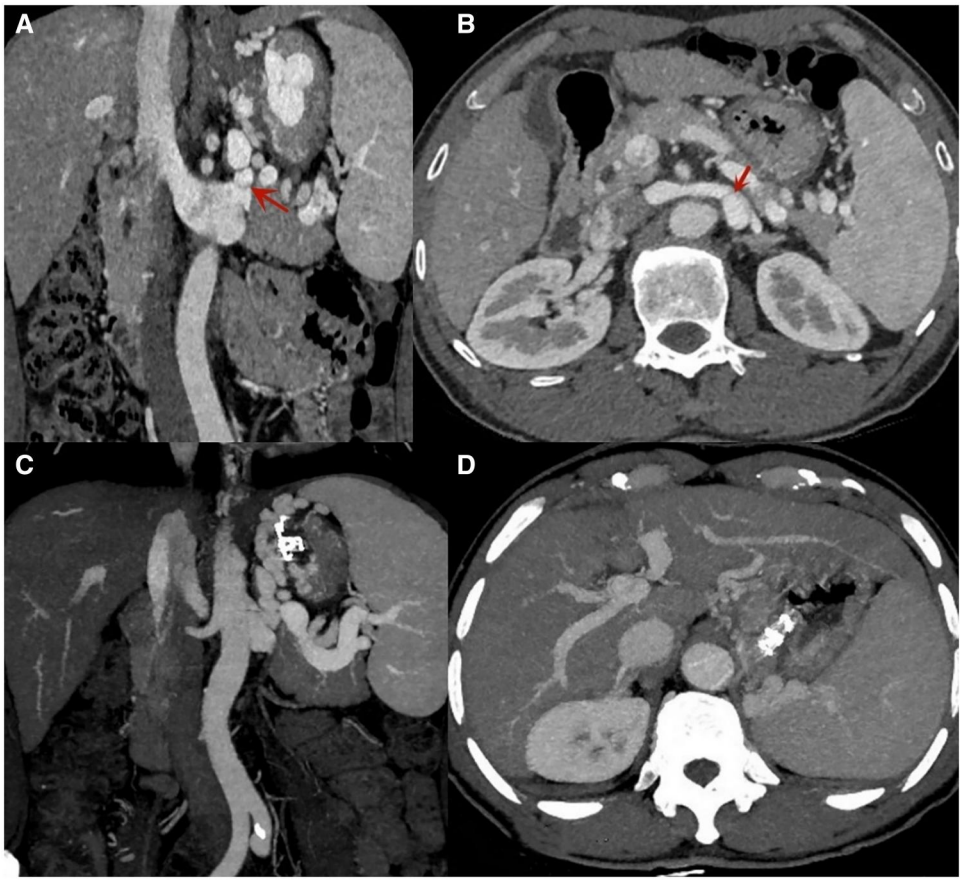

Figure 1. Preoperative and postoperative CTA of the portal vein. (A–B) CTA of the portal vein showed gastrorenal shunt in gastric varices (red arrow) preoperatively. (C–D) 1-week postoperative CTA of the portal vein showed that the coil did not migrate and was within the target vessel. CTA = computed tomography angiography.

consensus definitions established in previous ASGE workshops [17]. Adverse events, such as abdominal pain, fever, early GV rebleeding, and ectopic embolism, were classified as mild, moderate, or severe. The severity grades were primarily determined by the extension of hospital stay length [17]. Patients who developed postoperative symptoms, such as fever, abdominal pain, and chest discomfort, immediately underwent computed tomography scans to assess for potential ectopic embolism. Furthermore, a CTA of the portal vein was performed 1 week post-procedure to assist in the ectopic embolism evaluation. The diagnosis of ectopic embolism was based on a combination of clinical manifestations and imaging findings. Adverse events were documented by reviewing medical and nursing records in detail. Technical success was defined as the successful completion of the endoscopic procedure and no rebleeding of GV within 24 h. GV obliteration was confirmed endoscopically by the lack of visible varices, firmness upon catheter palpation of the treated GV complex, and/or the disappearance of the blood flow signal in Color Doppler during follow-up examinations.

Statistical analysis

IBM SPSS Statistics version 22.0 was utilized for conducting statistical analysis in this study. Continuous data that followed a normal distribution are presented as the mean ± standard deviation, and Student's *t*-test was used to compare between two groups. Continuous data exhibited significant skewness are presented as the median (interquartile range), and the Mann–Whitney U test was employed to compare between groups. Categorical data are presented as frequencies, and the Chi-square test or Fisher's exact test was used to compare between groups. $P < 0.05$ was considered statistically significant.

Results

Demographics and patient characteristics

The study comprised 57 patients, with 21 patients undergoing EUS-guided coil embolization in combination with CYA injection and 36 patients receiving conventional endoscopic CYA injection. There were no significant differences in baseline characteristics between the two groups, including gender, age, comorbidities, model for end-stage liver disease (MELD) score, Child-pugh classification, etiology of cirrhosis, incidence of concurrent portal vein thrombosis, therapeutic intent, and the diameter and type of SPSS (Table 1).

Variceal and procedural characteristics

In this study, every patient in both groups completed the endoscopic procedure, resulting in a 100% technical success rate. There were no significant differences between the groups regarding variceal and procedural characteristics, including the technical success, type of GV, size of GV, and the rate of GV obliteration. In the combined treatment group, successful GV obliteration was achieved by placing of a single coil in each patient. Conversely, in the conventional group, two patients did not attain GV obliteration and subsequently underwent transjugular intrahepatic portosystemic shunt (TIPS). The mean volume of CYA injected in the combined treatment group (1.64 ± 0.67 mL) used during the initial endoscopic procedure was significantly lower than in the conventional group (2.38 ± 0.72 mL; $P < 0.001$)

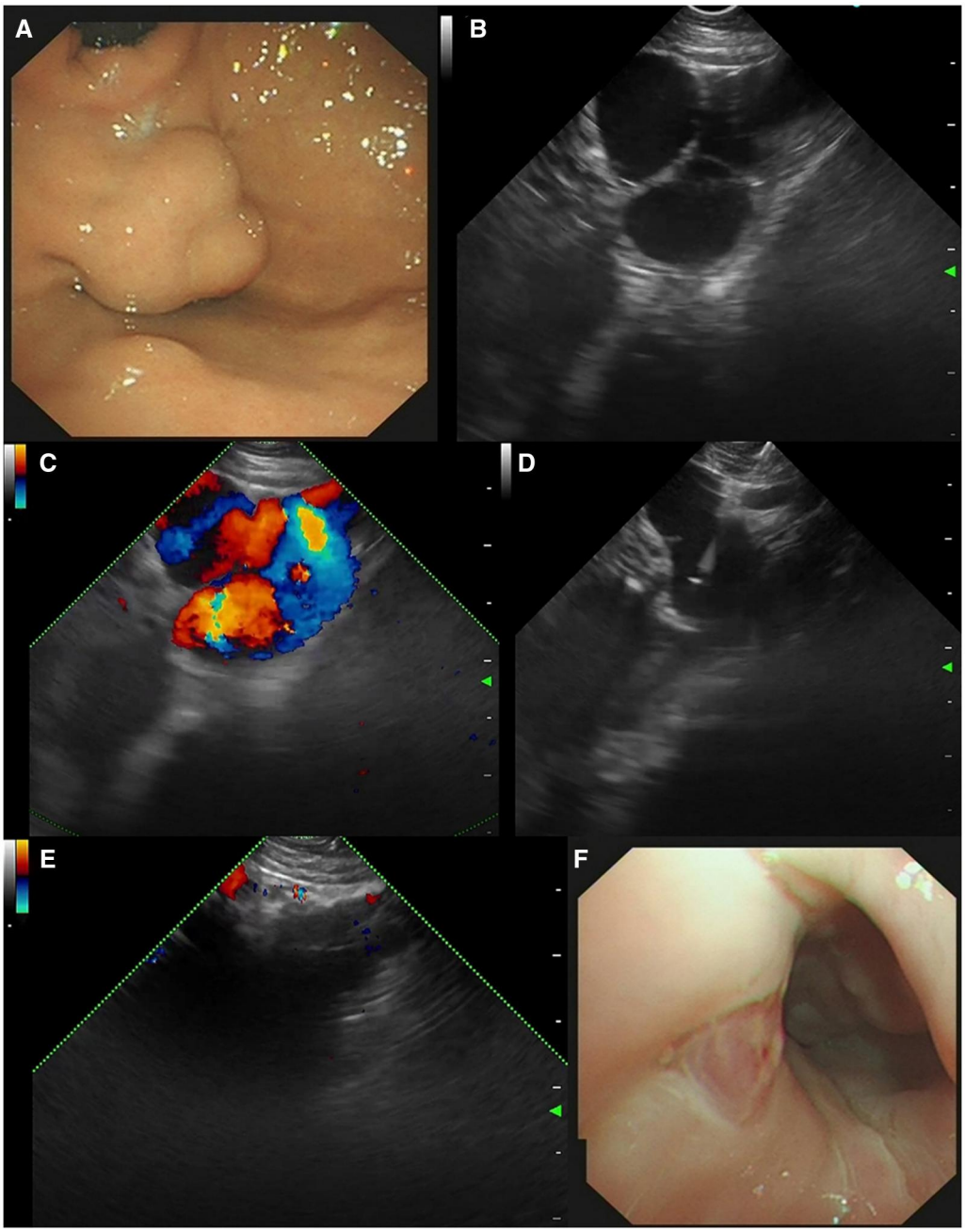

Figure 2. The procedure of EUS-guided coil embolization combined with CYA injection. (A) Gastroscopy revealed varices in the fundus. (B) EUS examination of the fundic region showed multiple anechoic lesions. (C) Color Doppler visualized abundant blood flow signals and identified the feeding vessel. (D) Punctured in the lower esophagus and placed coil under EUS guidance, followed by CYA injection. (E) Post-procedure Color Doppler re-examination, blood flow signal almost disappeared. (F) No significant abnormalities were observed at the lower esophageal puncture site. CYA = cyanoacrylate.

(Table 2). A follow-up CTA of the portal vein conducted 1-week post-procedure confirmed the stability of the implanted coil within the targeted vessel without displacement.

GV rebleeding and adverse events

The median follow-up for the patients was 13 months, with no significant difference in the follow-up duration between the two treatment cohorts. Both groups demonstrated effective control of GV rebleeding, particularly in the initial phase post-procedure. The early GV rebleeding rate was 0% in the combined treatment group and 2.8% in the conventional group, with no statistically significant difference observed between the two groups. However, the combined treatment group showed a significantly reduced incidence of late GV rebleeding compared to the conventional group (4.8% *vs* 27.8%, $P = 0.041$).

Adverse events reported in both groups included fever and epigastric pain, which were effectively managed in all cases. No severe adverse events, such as ectopic embolism, occurred in either group. The overall incidence of adverse events did not differ significantly between the groups, and the incidence of mild to moderate adverse events was also similar in both groups (Table 3).

GV obliteration

In the combined treatment group, 90.5% of patients achieved GV obliteration within a single treatment session, compared to 70.6% in the conventional group. However, there was no statistically

Table 1. Demographics and patient characteristics

Characteristic	Combined treatment group ($n = 21$)	Conventional group ($n = 36$)	*P*-value
Age, years, mean ± SD	57.5 ± 7.7	58.8 ± 8.0	0.556
Gender, *n* (%)			
Female	7 (33.3)	9 (25.0)	0.499
Male	14 (66.7)	27 (75.0)	
Diabetes, *n* (%)	7 (33.3)	10 (27.8)	0.658
Hypertension, *n* (%)	5 (23.8)	7 (19.4)	0.744
Etiology of cirrhosis, *n* (%)			
HBV	13 (61.9)	24 (66.7)	0.988
HCV	1 (4.8)	2 (5.6)	
Alcoholic	2 (9.5)	4 (11.1)	
Schistosomiasis	1 (4.8)	1 (2.8)	
Autoimmune liver diseases	1 (4.8)	2 (5.6)	
Cryptogenic	3 (14.3)	3 (8.3)	
Purpose of treatment, *n* (%)			
Secondary prophylaxis	20 (95.2)	32 (88.9)	0.642
Management of acute bleeding episode	1 (4.8)	4 (11.1)	
Child-pugh class, *n* (%)			
A	7 (33.3)	16 (44.4)	0.763
B	10 (47.6)	14 (38.9)	
C	4 (19.0)	6 (16.7)	
MELD score, mean ± SD	10.2 ± 3.5	9.5 ± 3.4	0.465
Portal vein thrombosis, *n* (%)	5 (23.8)	10 (27.8)	0.743
Diameter of SPSS, mm, mean ± SD	8.7 ± 2.1	8.2 ± 1.9	0.307
Type of SPSS, *n* (%)			
GRS	16 (76.2)	24 (66.7)	0.448
SRS	5 (23.8)	12 (33.3)	

CYA = cyanoacrylate, HBV = hepatitis B virus, HCV = hepatitis C virus, MELD = model for end-stage liver disease, SPSS = spontaneous portosystemic shunts, GRS = gastrorenal shunt, SRS = splenorenal shunt.

Table 2. Comparison of variceal and procedural characteristics

Variable	Combined treatment group ($n = 21$)	Conventional group ($n = 36$)	*P*-value
Type of GV, *n* (%)			0.808
GOV1	1 (4.8)	2 (5.6)	
GOV2	13 (61.9)	19 (52.8)	
IGV1	7 (33.3)	15 (41.7)	
Size of GV, mm, mean ± SD	18.4 ± 5.9	19.5 ± 7.9	0.586
Volume of CYA injected, mL, mean ± SD	1.64 ± 0.67	2.38 ± 0.72	<0.001
Technical success, *n* (%)	21 (100)	36 (100)	–
Obliteration of GV, *n* (%)	21 (100)	34 (94.4)	0.526

CYA = cyanoacrylate, GV = gastric varices, GOV1 = type 1 gastroesophageal varices, GOV2 = type 2 gastroesophageal varices, IGV1 = type 1 isolate gastric varices.

significant difference in the number of sessions required to achieve GV obliteration between the two groups (Table 4).

Discussion

Patients with portal hypertension can develop several complications, including GV and SPSS, as the condition progresses. SPSS typically emerges as a compensatory pathophysiological response to portal hypertension aimed at reducing portal vein blood flow and decreasing portal pressure. SRS and GRS are commonly observed types of SPSS. A retrospective analysis of 700 patients with cirrhosis showed that SRS occurred in 8.43% and GRS in 7.14% of cases [18]. The risk of ectopic embolism is

Table 3. Comparison of GV rebleeding and adverse events

Variable	Combined treatment group ($n = 21$)	Conventional group ($n = 36$)	*P*-value
Early GV rebleeding, *n* (%)	0	1 (2.8)	>0.999
Late GV rebleeding, *n* (%)	1 (4.8)	10 (27.8)	0.041
Adverse events, *n* (%)	4 (19.0)	5 (13.9)	0.712
Mild adverse events, *n* (%)	4 (19.0)	4(11.1)	0.449
Fever	3 (14.3)	2 (5.6)	
Abdominal pain	1 (4.8)	2 (5.6)	
Moderate adverse events, *n* (%)	0	1 (2.8)	>0.999
Ectopic embolism	0	0	
Early GV rebleeding	0	1 (2.8)	
Severe adverse events	0	0	
Follow-up time, median (IQR), months	13.0 (8–16)	12.5 (8–15.75)	0.489

GV = gastric varices, IQR = interquartile range.

Table 4. Comparison of the number of sessions required to achieve obliteration

Number of sessions, *n* (%)	Combined treatment group ($n = 21$)	Conventional group ($n = 34$)	*P*-value
1	19 (90.5)	24 (70.6)	0.209
2	2 (9.5)	7 (20.6)	
3	0	3 (8.8)	

CYA = cyanoacrylate.

heightened due to the potential migration of CYA into the systemic circulation through the inferior vena cava via SRS or GRS. Another retrospective study indicated that the presence of SPSS increases the risk of complications and mortality among patients with cirrhosis [6]. Therefore, conventional endoscopic CYA injection poses increased risks and challenges in patients with gastric variceal bleeding associated with SRS or GRS.

There is no consensus on the preferred treatment for GV combined with SPSS. Options include EUS-guided coil embolization in combination with CYA injection, balloon-occluded retrograde transvenous obliteration (BRTO), and TIPS [1, 4]. SPSS allows part of the blood to bypass liver metabolism and flow directly into the systemic circulation, increasing the risk of hepatic encephalopathy. By reducing liver perfusion, TIPS can heighten the risk of hepatic encephalopathy [19]. In contrast, BRTO is more complex and expensive compared to endoscopic treatments. Additionally, BRTO might exacerbate the severity of esophageal varices, leading to bleeding [20]. EUS-guided coil embolization in combination with CYA injection offers an advantageous alternative, mitigating the drawbacks of both techniques and reducing the risk of ectopic embolism.

N-butyl-2-cyanoacrylate is commonly used as a tissue adhesive in endoscopic injection therapy. The traditional 'sandwich' technique involves a tissue adhesive flanked by two "slices"—typically made of lipiodol, saline, or hypertonic glucose. These three types of "bread" constitute the traditional sandwich approach, with lipiodol historically being the most frequently used [14]. The "modified sandwich method", a newer variant, substitutes lipiodol with lauromacrogol. As a sclerosing agent, lauromacrogol directly impacts the vascular endothelium, encouraging thrombogenesis. This modification facilitates rapid localization and polymerization of the tissue adhesive, reducing the risk of ectopic embolism. Hu *et al.* [15] confirmed the efficacy and safety of the "modified sandwich method" in treating variceal bleeding.

A retrospective cohort study [21] underscored its advantage in lowering the required CYA volume for GV eradication. Moreover, a meta-analysis indicated the superiority of the "modified sandwich method" over the traditional sandwich method without lauromacrogol [14]. In China, the "modified sandwich method" is extensively utilized. In our research, this method was applied in both treatment modalities, yielding favorable outcomes.

EUS-guided coil embolization in combination with CYA injection for the treatment of GV was initially introduced in 2011, achieving a 100% technical success rate [22]. A subsequent 6-year clinical study further demonstrated its effectiveness in managing acute active bleeding, primary prophylaxis, and secondary prophylaxis of gastric variceal bleeding, significantly reducing the risk of ectopic embolism [23]. Furthermore, follow-up results from this study indicated that the rebleeding risk post successful GV obliteration was <3% [23]. In our study, both EUS-guided coil embolization in combination with CYA injection and conventional endoscopic CYA injection attained high technical success rates and exhibited a low incidence of early GV rebleeding in treating GV with SPSS. The technical success rate was 100% in both groups, with early GV rebleeding rates of 0% and 2.8%, respectively, showing no significant differences. However, the late GV rebleeding rate was considerably lower in the combined treatment group compared to the conventional group (4.8% *vs* 27.8%, $P = 0.041$). Several studies have reported late GV rebleeding rates between 6.4% and 9.2% when using EUS-guided coil embolization in combination with CYA injection, consistent with our results [23, 24]. Conversely, the incidence of late GV rebleeding with conventional endoscopic CYA injection ranges from 17% to 19.7% [8, 24, 25]. In our study, the incidence of late GV rebleeding with conventional endoscopic CYA injection was relatively high at 27.8%, potentially due to the concurrent presence of SPSS. A meta-analysis suggested that EUS-guided coil embolization in combination with CYA injection might offer a more effective treatment for late GV rebleeding than conventional endoscopic CYA injection, aligning with our study's findings [24].

EUS guidance facilitates accurate coil placement within the target vessel. Coils containing synthetic fibers slow blood flow, enhance tissue adhesion, and create a space-occupying effect, thereby reducing the required CYA volume. Unlike the conventional group's more random CYA injection, the combined treatment group benefitted from the precise real-time EUS assessment for variceal obliteration and targeted CYA injection. In the initial endoscopic session, the mean volume of CYA injected in the combined treatment group was significantly lower than in the conventional group (1.64 ± 0.67 mL *vs* 2.38 ± 0.72 mL; $P < 0.001$). This observation is supported by a randomized controlled trial which found that EUS-guided coil embolization in combination with CYA injection for variceal obliteration required significantly reduced CYA injection than conventional endoscopic CYA injection (1.40 ± 0.74 mL *vs* 3.07 ± 1.94 mL, $P = 0.002$), consistent with our findings [26].

Coils and CYA can effectively complement each other under EUS guidance. A randomized controlled trial indicated that EUS-guided coil embolization in combination with CYA injection leads to better clinical outcomes, with lower reintervention rates and rebleeding than coil embolization alone [11]. Samanta *et al.* [27] confirmed the safety and efficacy of EUS-guided coil-based therapy with CYA injection, highlighting lower rebleeding rates compared to endoscopic CYA injection. Moreover, a meta-analysis suggested that combination therapy is preferable to EUS-based monotherapy in managing GV [12]. In our research, EUS-guided coil embolization in combination with CYA injection was associated with a reduced incidence of late GV rebleeding. It required a lower mean volume of CYA for variceal obliteration compared to conventional endoscopic CYA injection. EUS-guided combination therapy proved more effective than CYA injection alone in treating GV.

Previous studies have indicated that fever, abdominal pain, and ectopic embolism are common adverse events following endoscopic treatments for GV [26, 28, 29]. In our study, the most common complications following CYA injection were abdominal pain and fever, with no severe adverse events reported in either group. The incidence of adverse events was similar between the two groups. Our primary concern during the endoscopic procedure was the risk of ectopic embolism. A multicenter retrospective study found the incidence of asymptomatic ectopic embolism in GV to be only 2% (1/50) [30]. A meta-analysis reported a 4.3% rate of ectopic embolism with EUS-guided coil embolization in combination with CYA injection [24]. Our study recorded no cases of ectopic embolism. It maintained a 100% technical success rate, underscoring the safety and efficacy of EUS-guided coil embolization in combination with CYA injection in treating GV with SPSS.

A multicenter study showed that EUS-guided coil deployment achieved successful GV obliteration in 81.8% of patients after a single treatment, requiring fewer sessions than endoscopic CYA injection [31]. Combining coil and CYA injection could theoretically enhance the success rate of GV obliteration. In our study, the single-session success rates for GV obliteration were 90.5% in the combined treatment group and 70.6% in the conventional group. The use of coil in conjunction with CYA injection appeared to improve the success rate of GV obliteration, although the absence of a significant difference could be due to the limited patient sample size.

This study has several limitations. Being retrospective, it is subject to potential selection bias despite using consistent inclusion and exclusion criteria. The study may have a limited case number, conducted at a single center, mainly due to the specific inclusion of patients with GV combined with SPSS, which could influence the statistical results. Moreover, the relatively short and varied follow-up periods and other potential confounding factors might have influenced the outcomes.

In conclusion, EUS-guided coil embolization in combination with CYA injection is superior to conventional endoscopic CYA injection in preventing late GV rebleeding in the treatment of GV with SPSS. This integrated approach requires a lower mean volume of CYA injection for variceal obliteration than conventional endoscopic CYA injection. Future research, particularly a large-scale prospective randomized controlled trial, is needed to evaluate the efficacy and safety of EUS-guided coil embolization in combination with CYA injection in treating GV combined with SPSS further.

Authors' Contributions

D.C. collected the data, and drafted the manuscript. S.F. searched the literature, and design the study. R.S. analyzed the data and obtained the funding. All authors read and approved the final manuscript.

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Conflicts of Interest

None declared.

References

1. Garcia-Tsao G, Abraldes JG, Berzigotti A *et al.* Portal hypertensive bleeding in cirrhosis: risk stratification, diagnosis, and management: 2016 practice guidance by the American Association for the study of liver diseases. *Hepatology* 2017;**65**:310–35.
2. Sarin SK, Kumar A. Gastric varices: profile, classification, and management. *Am J Gastroenterol* 1989;**84**:1244–9.
3. Sarin SK, Lahoti D, Saxena SP *et al.* Prevalence, classification and natural history of gastric varices: a long-term follow-up study in 568 portal hypertension patients. *Hepatology* 1992;**16**:1343–9.
4. de Franchis R; Baveno VI Faculty. Expanding consensus in portal hypertension: Report of the Baveno VI Consensus Workshop: Stratifying risk and individualizing care for portal hypertension. *J Hepatol* 2015;**63**:743–52.
5. EASL Clinical Practice Guidelines for the management of patients with decompensated cirrhosis. *J Hepatol* 2018;**69**:406–60.
6. Simón-Talero M, Roccarina D, Martínez J *et al.*; Baveno VI-SPSS group from the Baveno Cooperation. Association between portosystemic shunts and increased complications and mortality in patients with cirrhosis. *Gastroenterology* 2018;**154**:1694–705.e4.
7. Ríos Castellanos E, Seron P, Gisbert JP *et al.* Endoscopic injection of cyanoacrylate glue versus other endoscopic procedures for acute bleeding gastric varices in people with portal hypertension. *Cochrane Database Syst Rev* 2015;**2015**:CD010180.
8. Kang EJ, Jeong SW, Jang JY *et al.* Long-term result of endoscopic Histoacryl (N-butyl-2-cyanoacrylate) injection for treatment of gastric varices. *World J Gastroenterol* 2011;**17**:1494–500.
9. Levy MJ, Wong Kee Song LM, Kendrick ML *et al.* EUS-guided coil embolization for refractory ectopic variceal bleeding (with videos). *Gastrointest Endosc* 2008;**67**:572–4.
10. Bazarbashi AN, Wang TJ, Jirapinyo P *et al.* Endoscopic ultrasound-guided coil embolization with absorbable gelatin sponge appears superior to traditional cyanoacrylate injection for the treatment of gastric varices. *Clin Transl Gastroenterol* 2020;**11**:e00175.
11. Robles-Medranda C, Oleas R, Valero M *et al.* Endoscopic ultrasonography-guided deployment of embolization coils and cyanoacrylate injection in gastric varices versus coiling alone: a randomized trial. *Endoscopy* 2020;**52**:268–75.
12. McCarty TR, Bazarbashi AN, Hathorn KE *et al.* Combination therapy versus monotherapy for EUS-guided management of gastric varices: A systematic review and meta-analysis. *Endosc Ultrasound* 2020;**9**:6–15.
13. Sabri SS, Saad WE. Anatomy and classification of gastrorenal and gastrocaval shunts. *Semin Intervent Radiol* 2011;**28**:296–302.
14. Wu K, Song Q, Gou Y *et al.* Sandwich method with or without lauromacrogol in the treatment of gastric variceal bleeding with liver cirrhosis: a meta-analysis. *Medicine (Baltimore)* 2019;**98**:e16201.
15. Hu T, Stock S, Hong W *et al.* Modified 'sandwich' injection with or without ligation for variceal bleeding in patients with both esophageal and gastric varices: a retrospective cohort study. *Scand J Gastroenterol* 2020;**55**:1219–24.
16. de Franchis R; Baveno V Faculty. Revising consensus in portal hypertension: report of the Baveno V consensus workshop on methodology of diagnosis and therapy in portal hypertension. *J Hepatol* 2010;**53**:762–8.
17. Cotton PB, Eisen GM, Aabakken L *et al.* A lexicon for endoscopic adverse events: report of an ASGE workshop. *Gastrointest Endosc* 2010;**71**:446–54.
18. Wu Q, Shen L, Chu J *et al.* Characterization of uncommon portosystemic collateral circulations in patients with hepatic cirrhosis. *Oncol Lett* 2015;**9**:347–50.
19. Zheng M, Chen Y, Bai J *et al.* Transjugular intrahepatic portosystemic shunt versus endoscopic therapy in the secondary prophylaxis of variceal rebleeding in cirrhotic patients: meta-analysis update. *J Clin Gastroenterol* 2008;**42**:507–16.
20. Choi YS, Lee JH, Sinn DH *et al.* Effect of balloon-occluded retrograde transvenous obliteration on the natural history of coexisting esophageal varices. *J Clin Gastroenterol* 2008;**42**:974–9.
21. Xiaoqing Z, Na L, Lili M *et al.* Endoscopic cyanoacrylate injection with lauromacrogol for gastric varices: long-term outcomes and predictors in a retrospective cohort study. *J Laparoendosc Adv Surg Tech A* 2019;**29**:1135–43.
22. Binmoeller KF, Weilert F, Shah JN *et al.* EUS-guided transesophageal treatment of gastric fundal varices with combined coiling and cyanoacrylate glue injection (with videos). *Gastrointest Endosc* 2011;**74**:1019–25.
23. Bhat YM, Weilert F, Fredrick RT *et al.* EUS-guided treatment of gastric fundal varices with combined injection of coils and cyanoacrylate glue: a large U.S. experience over 6 years (with video). *Gastrointest Endosc* 2016;**83**:1164–72.
24. Mohan BP, Chandan S, Khan SR *et al.* Efficacy and safety of endoscopic ultrasound-guided therapy versus direct endoscopic glue injection therapy for gastric varices: systematic review and meta-analysis. *Endoscopy* 2020;**52**:259–67.
25. Chandra S, Holm A, El Abiad RG *et al.* Endoscopic cyanoacrylate glue injection in management of gastric variceal bleeding: US tertiary care center experience. *J Clin Exp Hepatol* 2018;**8**:181–7.
26. Lôbo M, Chaves DM, DE Moura D *et al.* Safety and efficacy of EUS-guided coil plus cyanoacrylate versus conventional cyanoacrylate technique in the treatment of gastric varices: a randomized controlled trial. *Arq Gastroenterol* 2019;**56**:99–105.
27. Samanta J, Nabi Z, Facciorusso A *et al.* EUS-guided coil and glue injection versus endoscopic glue injection for gastric varices: international multicentre propensity-matched analysis. *Liver Int* 2023;**43**:1783–92.
28. Bick BL, Al-Haddad M, Liangpunsakul S *et al.* EUS-guided fine needle injection is superior to direct endoscopic injection of 2-octyl cyanoacrylate for the treatment of gastric variceal bleeding. *Surg Endosc* 2019;**33**:1837–45.
29. Kozieł S, Pawlak K, Błaszczyk Ł *et al.* Endoscopic ultrasound-guided treatment of gastric varices using coils and cyanoacrylate glue injections: results after 1 year of experience. *J Clin Med* 2019;**8**:1786.
30. Huang Z, Zhang W, Lv F *et al.* Efficacy and safety of EUS-guided coil embolization combined with endoscopic cyanoacrylate injection versus balloon-occluded retrograde transvenous obliteration for gastric varices with high-risk ectopic embolism: a multicenter and retrospective cohort study. *Endosc Ultrasound* 2023;**12**:74–83.
31. Romero-Castro R, Ellrichmann M, Ortiz-Moyano C *et al.* EUS-guided coil versus cyanoacrylate therapy for the treatment of gastric varices: a multicenter study (with videos). *Gastrointest Endosc* 2013;**78**:711–21.

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