# Detection of fundic varices obturation by endoscopic ultrasound versus multidetector computed tomography

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**Background**
Gastroesophageal varices (GVs) present in 50% of patients with liver cirrhosis. GVs bleed at a rate of 5–15%, and the 6-week mortality after hemorrhage is 20%. GVs are treated with a tissue adhesive, cyanoacrylate, where repeated sessions are performed 2–4 weeks until obliteration, and eradication is achieved with 2–4 injections using 1–2 ml/ session. Endoscopic ultrasonography (EUS) was found superior to endoscopy in detecting gastric varices. Gastric varices obturation can be detected using CD-EUS to assess blood flow in variceal lumen after cyanoacrylate injection. Multidetector computed tomography (MDCT) is an acceptable imaging modality for abdominal vascular system and assessment of endoscopic therapy of fundal varices. To our knowledge, there is no study for detecting GV obturation yet. The aim of this study to compare between EUS and MDCT in detecting obturation of GV and comparing EUS and upper endoscopy in detection of GV obturation.

**Patients and methods**
A total of 22 patients with liver cirrhosis presented with acute GV bleeding for the first time, which was confirmed and managed by upper endoscopy, being carried out in the first 12 h after admission. Then the patients were subjected to monthly gastric varices injection of cyanoacrylate until they appeared to be obturated by upper endoscopy using blunt end of injection catheter sheath to palpate varices. After that EUS and CT were done for evaluation of GV, in addition to perigastric and paragastric collaterals.

**Results**
EUS is superior to CT in detecting GV obliteration, with a high significant difference ($P$=0.04), whereas EUS and upper endoscopy have similar results in detecting the obliteration of GV ($P$=0.68). There was a statistically significant association between splenic size and GV obliteration ($P$=0.002) and a significant negative correlation between size of paragastric collaterals and GV obturation.

**Conclusion**
EUS is superior to CT in detecting the obliteration of GV.

**Keywords:**
computed tomography, endoscopic ultrasonography, fundal varices, paragastric collaterals, perigastric collaterals

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## Background and aim

Gastroesophageal varices (GV) are found in ∼50% of patients with liver cirrhosis, and the severity of liver disease predicts their presence [1]. Varices are present in 85% of Child C cirrhotic patients, whereas they are present in 40% of Child A patients. The rate of developing varices in cirrhotic patients without varices is 8% per year. HVPG more than 10 is considered a major predictor of developing varices [2]. There are different types of classifications commonly used for gastric varices, for example, Sarin's classification, Hashizome classification, and Arakawa's classification. The most commonly used one is Sarin's classification [3], and it classifies gastric varices into the following:

(1) GV type 1: the esophageal varices extend along lesser curvature.
(2) GV type 2: the esophageal varices extend along greater curvature.
(3) Isolated gastric varix type 1: varices in the fundus.
(4) Isolated gastric varix type 2: varices in stomach or duodenum.

Size of the varices, presence of red signs, and the degree of liver dysfunction were directly related to risk of bleeding [4].

Cyanoacrylate (tissue adhesive) is the best treatment for acute gastric variceal bleeding [5]. If tissue adhesive



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is not available, band ligation seems to have some benefit in small GV2 varices [6]. Trans-jugular intrahepatic porto-systemic shunt (TIPS) is the best treatment for persistent bleeding or severe rebleeding in spite of combined pharmacological and endoscopic treatment therapy [7]. Direct obliteration of GVs can be done using balloon-occluded retrograde transvenous obliteration (BRTO) [4].

Endoscopic ultrasonography (EUS) was first used in portal hypertensive patients in 1980s for the diagnosis of GV and portal hypertension [8]. EUS was found to be inferior to conventional endoscopy in detecting and grading of esophageal varices but superior to conventional endoscopy in detecting gastric varices [9]. The greatest advantage of EUS is that it allows endoscopists to observe the variceal lumen directly under or outside the wall of the esophagus and stomach [10]. EUS detected GVs as serpiginous, anechoic channels in the submucosa and the mucosa of the stomach below the gastroesophageal junction. They are connected by perforator veins to the perigastric and paragastric collaterals. By noting the inflow and outflow perforator channels in the upper gastric wall, it is possible to recognize the inflow and outflow tracts of GV. Perigastric collaterals are opposed directly to the wall of the stomach, whereas the paragastric collaterals are separated from the wall of the stomach by a clear hyperechoic layer [10]. The size and shape of the varices may not show any changes immediately after therapy by examination using the upper endoscope, but the varices become echogenic by EUS evaluation, and the blood flow is absent by Doppler. So, EUS can provide an objective end point for fundic varices treatment [10]. Although the persistence of large paraesophageal collaterals after eradication of esophageal varices is associated with recurrence of the varices and rebleeding, there is no evidence that the size or number of the paragastric collaterals which usually persist after gastric varices obturation is associated with the recurrence or rebleeding. There are only limited data that monitoring of gastric variceal obturation by EUS leads to lower rebleeding rates when compared with the standard practice of evaluating variceal patency by palpation using the blunt end of the injection catheter sheath [10].

Willmann *et al.* [11] stated that multidetector computed tomography (MDCT) angiography can differentiate between submucosal and perigastric fundal varices with sensitivity of 87% in detecting GVs, and also, it may be used for the assessment of the endoscopic therapy of GVs.

## Aim of this study

The aim is to compare EUS versus multidetector triphasic CT and upper endoscopy in the detection of obturation of gastric varices.

## Patients and methods

This is a prospective cohort study conducted on 22 patients between July 2017 and June 2018 at Specialized Medical Hospital Endoscopy Unit in collaboration with Radiology Department, Mansoura University. The study included patients with liver cirrhosis who presented with acute gastric variceal bleeding for the first time, confirmed and managed by upper endoscopy after resuscitation. They were subjected to full medical history, physical examination, and laboratory investigations, including CBC, kidney function tests, liver function tests, and viral markers (HBsAg, HCV Ab, and HIV Ab). Abdominal US for detecting signs of portal hypertension and focal lesions and Child–Pugh score were assessed for all our patients [12].

Upper GI endoscopy (EGD) was done using a video endoscope (Pentax EG 290 KP and Pentax EG 3490 k). Gastric varices were identified based on Sarin's classification. Repeated sessions of cyanoacrylate injection were performed. Palpation of the varix was done by the injection catheter sheath, and when the varix appears to be obturated, EUS and CT were done.

Patients were scheduled for EUS with anesthesia using propofol by echoendoscope (Pentax EG 3870 UTK). The varix was identified as an anechoic tubular structure in the submucosal layer that is connected to deep veins by perforators. Dilated veins outside the gastric wall were classified as perigastric collaterals if they were in direct contact with muscularis propria (fourth layer) or paragastric collaterals if they were located away from muscularis propria layer. EUS is a good modality to assess obturation by applying color Doppler study, and the varix is said to be obturated when there is no flow in the submucosal veins.

MDCT was done after confirmation of normal kidney functions. Intravenous administration of 1.2–1.5 ml/kg contrast was done, and imaging was performed. Varix is considered to be obturated when there is absence of contrast intake.

Once EGD palpation identifies hard GV, EUS, and CT were done to determine obliteration of GV along with perigastric and paragastric collaterals with perforator evaluation.

### Inclusion criteria

The following were the inclusion criteria:

(1) Age more than 18 years old.
(2) Patients with liver cirrhosis (Child A or B).
(3) Patients presenting with acute gastric variceal hemorrhage.
(4) Successful control of variceal bleeding via injection of cyanoacrylate.

### Exclusion criteria

The following were the exclusion criteria:

(1) Child C patients.
(2) Patients with hepatic encephalopathy.
(3) Patients with HIV.
(4) Uncorrected coagulopathy (INR >1.5 and thrombocytopenia <50 000).
(5) Conditions altering gastrointestinal tract (GIT) anatomy as gastric bypass surgery.
(6) Refusal to participate.
(7) Uncooperative patients.
(8) Patients with HCC.

The study was conducted according to the Declaration of Helsinki and International Conference on Harmonization guidelines and was approved by the institution's review board before initiation. Informed written consent was taken from all patients before undertaking any study-related procedures.

### Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package, version 23.0. Qualitative data were described using number and percent. Quantitative data were described using mean and SD. Significance of the obtained results was judged at the 5% level. $\chi^2$ Phi-Cramer $V$ test was used for categorical variables, to compare between different groups. Mann–Whitney $U$ test was used for nonparametric and quantitative variables, to compare between two study groups. Spearman's correlation test was used for nonparametric correlation between quantitative and ordinal variables. Sensitivity, specificity, and accuracy were calculated for upper endoscopy and CT (Figs 1–4).

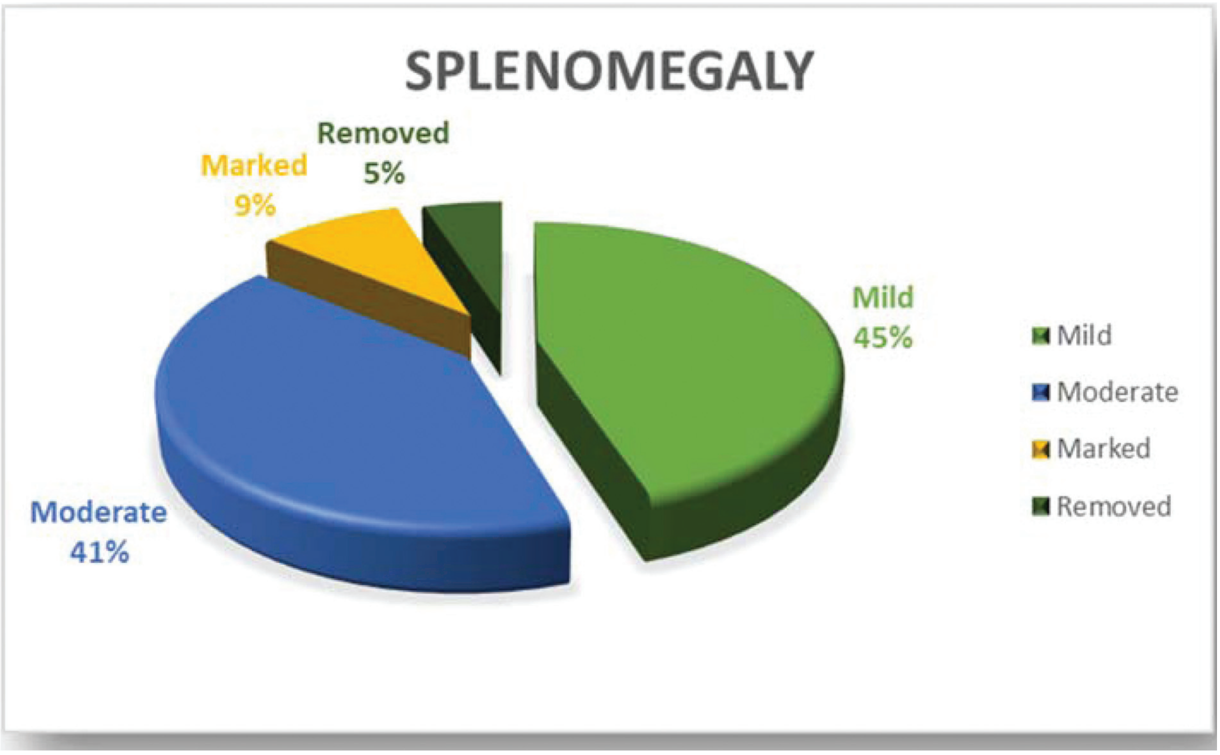
## Results

The mean age of the studied group was 55.6±6.3 years. The study comprised 15 (68%) males and seven (32%) females.

A total of 10 (45%) patients had mild splenomegaly, nine (41%) had moderate splenomegaly, and two (9%) had marked splenomegaly. Moreover, 18 (82%) patients were HCV positive. In addition, 17 (77%) patients were Child A and five (23%) patients were Child B..

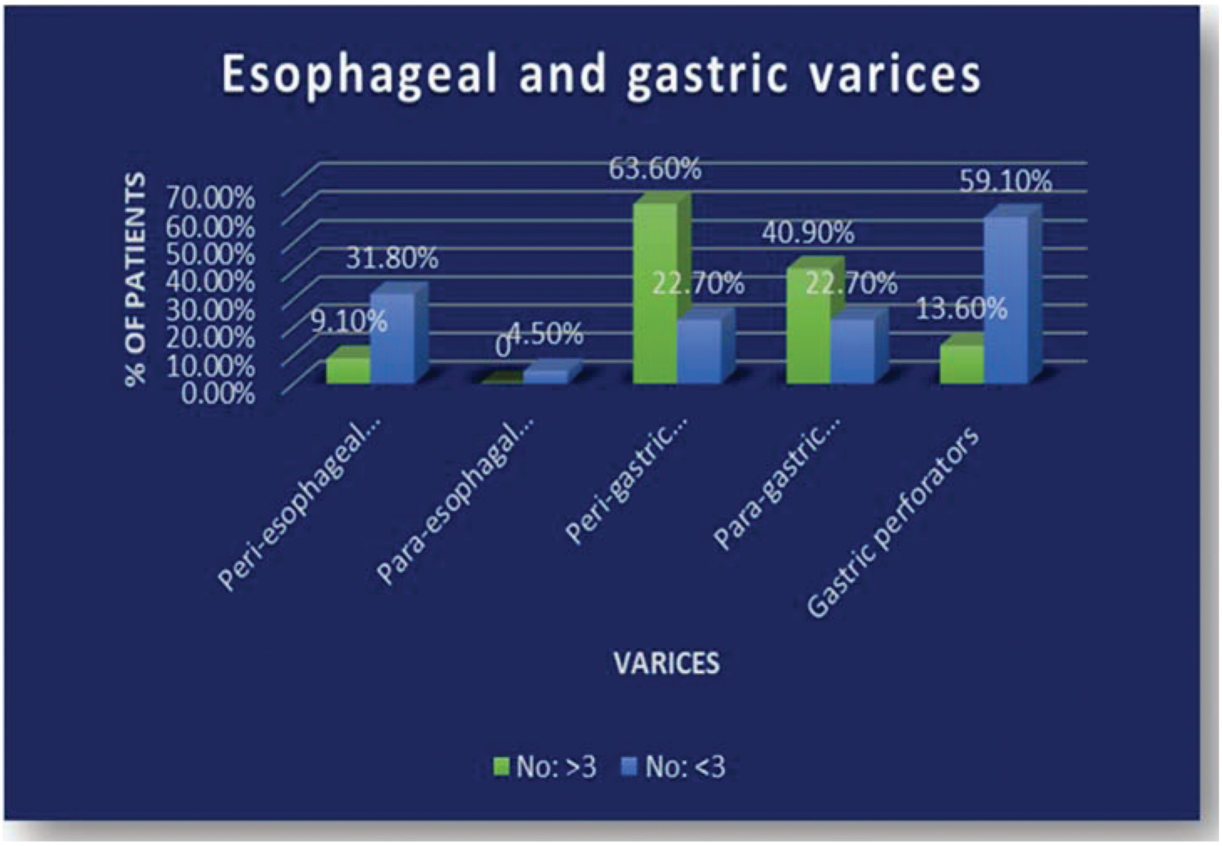
It was noticed in our study that the average number of sessions to achieve obturation was 3±1, whereas the average amount of CA was 4±1 ml.

**Figure 1**



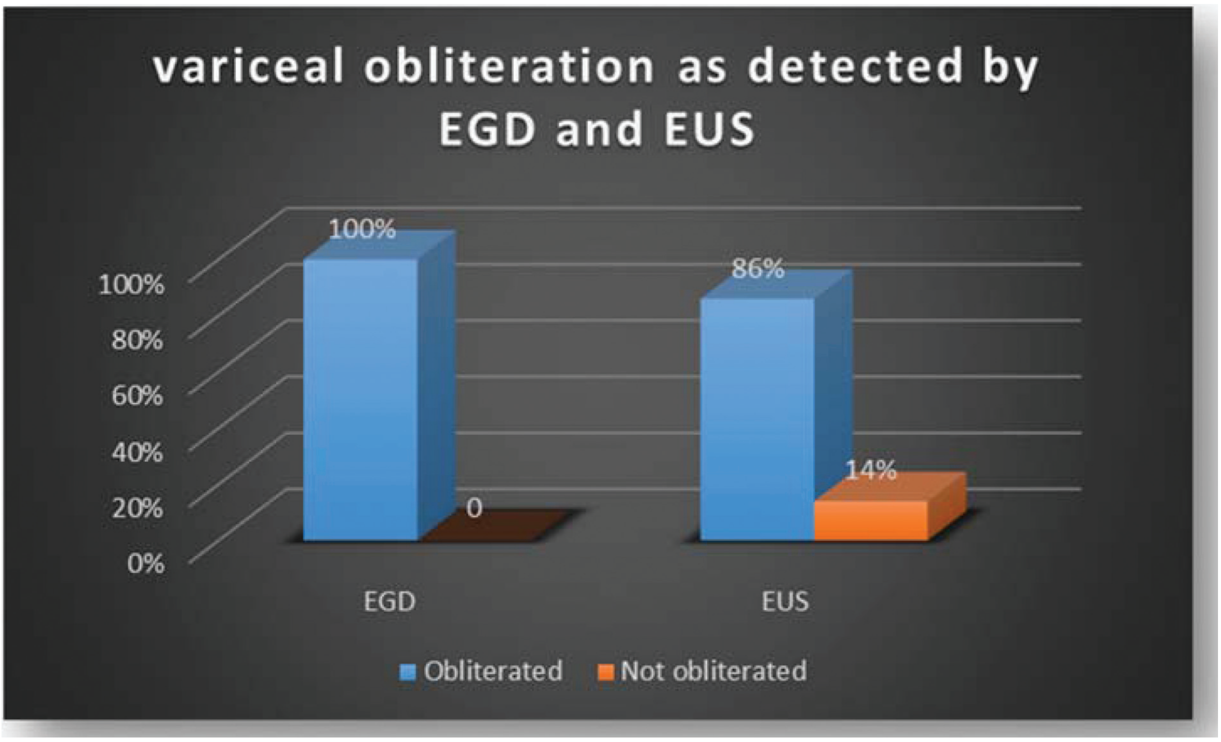

Marked splenomegaly in 9%, moderate in 41%, and mild in 45%.

**Figure 2**



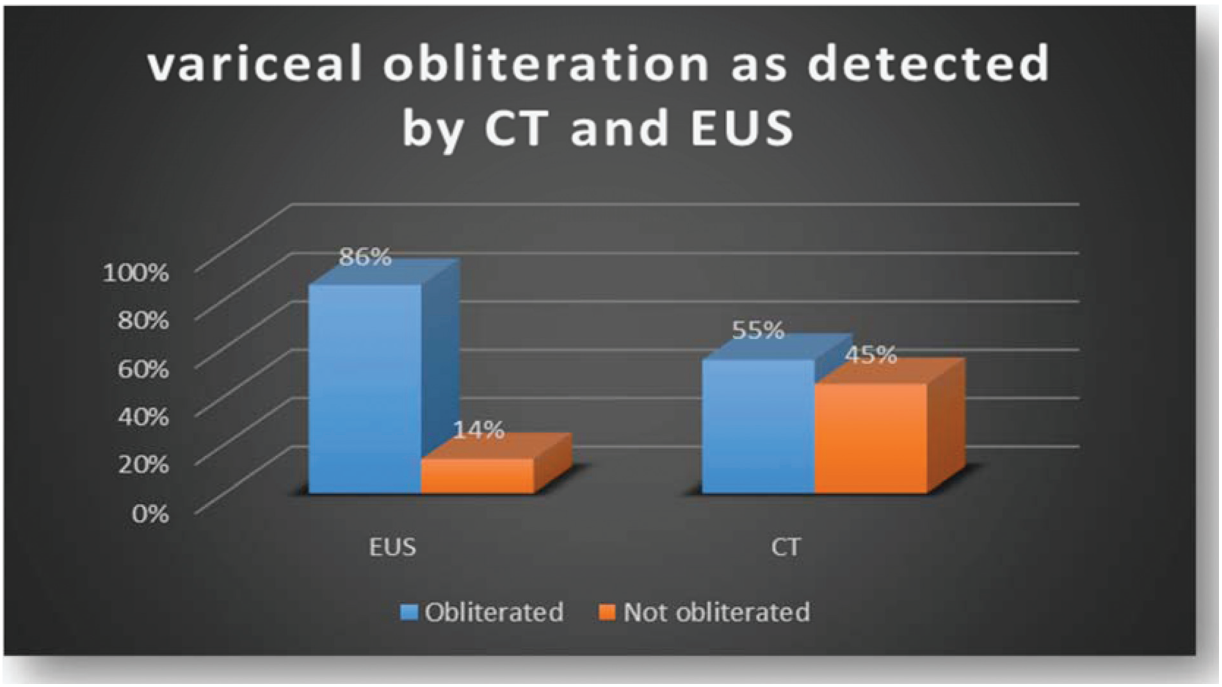

Distribution of the esophageal and gastric collateral circulation.

**Figure 3**




Comparison between EUS and EGD in detecting obturation. EUS, endoscopic ultrasonography.

**Figure 4**




Comparison between EUS and CT in detecting obturation. CT, computed tomography; EUS, endoscopic ultrasonography.

There was a highly significant difference between degree of splenic enlargement and gastric variceal obturation (*P*=0.002). All cases (10 patients) having mild splenomegaly achieved obturation, and eight patients with moderate splenomegaly achieved obturation, except for one patient. Meanwhile, the two patients with marked splenomegaly did not achieve obturation.

The Child–Pugh score was found to have statistically significant association with gastric varices obturation (*P*=0.05). Among 17 Child A cases, 16 of them achieved obturation, and of the five Child B cases, three patients were obturated.

The paragastric collaterals was 5.5±2.27 mm in obturated varices whereas it was 14.28±4.98 mm in nonobturated varices, with a high significance (Table 1).

In our study, we found no significant correlation between EUS and EGD regarding detection of GV obliteration (Table 2).

There was a statistically significant difference between CT and EUS (*P*=0.04). EUS detected obturation in 19 cases, whereas CT detected obturation in 12 cases. EUS demonstrated gastric variceal without obturation in three cases, whereas CT revealed nonobturation in 10 cases (Table 3).

We also found that the overall sensitivity was 100 and 63% and specificity was 86% and 30% for EGD and CT, respectively, in comparison with EUS, with an overall accuracy of 86 and 54%, respectively (Table 4).

## Discussion

EUS has become an important clinical diagnostic modality in the past few years in the management of GIT diseases, owing to established clinical indications, such as staging of GIT and pancreatic tumors, differentiation of submucosal lesions, evaluation of solid and cystic pancreatic masses, detection of lymph nodes, and fine-needle aspiration [13]. EUS is a very sensitive tool for GV detection. It is also very useful for the assessment of GV obliteration with tissue adhesive injection and predicting recurrence of varices [14]. Bhat *et al.* [14] stated that follow-up EUS is important to evaluate obliteration of all large gastric varices and to retreat if necessary. Willmann *et al.* [11] stated that MDCT angiography is equivalent to EUS in the detection and characterization of fundal varices, in particular with regard to the distinction between submucosal and perigastric fundal varices.

Confirmation of fundal variceal obturation is an important subject that has been rarely explored. Moreover, limited data are available about the average amount of cyanoacrylate and number of sessions needed to achieve obturation.

**Table 1 Comparison of size and number of collaterals in obturated and nonobturated groups by endoscopic ultrasonography**

| | Obturated (19) | Nonobturated (3) | *P* value |
|---|---|---|---|
| Perigastric collaterals | | | |
| Size (mm) | 4.56±1.56 | 8.6±4.35 | 0.17 |
| Number [*n* (%)] | 16 (84.2) | 3 (100) | 0.42 |
| >3 | 11 (57.9) | 3 (100) | |
| <3 | 5 (26.3) | 0 | |
| Paragastric collaterals [*n* (%)] | | | |
| Size (mm) | 5.5±2.27 | 14.28±4.98 | 0.02* |
| Number | 12 (63.2) | 2 (66.7) | |
| >3 | 7 (36.8) | 2 (66.7) | 0.44 |
| <3 | 5 (26.3) | 0 | |
| Gastric perforators [*n* (%)] | | | |
| Size (mm) | 3.59±1.44 | 5.27±2.0 | 0.19 |
| Number | 13 (68.4) | 3 (100) | |
| >3 | 2 (10.5) | 1 (33.3) | 0.80 |
| <3 | 11 (57.9) | 2 (66.7) | |

**P* value is significant <0.05.

**Table 2 Comparison of variceal obliteration detected by endoscopic ultrasonography and EGD**

| | EGD [*n* (%)] | EUS [*n* (%)] | *P* value |
|---|---|---|---|
| Obliterated | 22(100) | 19 (86) | 0.68 |
| Nonobliterated | – | 3(14) | |

EGD, upper GI endoscopy; EUS, endoscopic ultrasonography.

**Table 3 Comparison of variceal obliteration detected by endoscopic ultrasonography and computed tomography**

| | EUS [*n* (%)] | CT [*n* (%)] | *P* value |
|---|---|---|---|
| Obliterated | 19(86) | 12(55) | 0.04* |
| Nonobliterated | 3 (14) | 10 (45) | |

CT, computed tomography; EUS, endoscopic ultrasonography. **P* value is significant <0.05.

**Table 4 The sensitivity, specificity, and overall accuracy of upper endoscopy and computed tomography in comparison with endoscopic ultrasonography**

| | EGD (%) | CT (%) |
|---|---|---|
| Sensitivity | 100 | 63.1 |
| Specificity | 86.4 | 30 |
| Accuracy | 86 | 54.5 |

CT, computed tomography; EGD, upper GI endoscopy.

To our knowledge, this is the first study where evaluation of fundal varices obturation has been achieved.

This study was conducted to evaluate the efficacy of MDCT as noninvasive technique to confirm fundal variceal obturation in comparison with EUS, and to evaluate the efficiency of the standard upper GIT endoscopy in evaluating the obturation as it is the routine method for detection of obturation.

In our study, there were 19 patients with mild and moderate splenomegaly, representing 86% of the cases, who achieved obturation by EUS, and this may be owing to high-grade portal hypertension and large size of fundal varices and large size of perigastric and paragastric collaterals, which increase with increased portal pressure in marked splenomegaly. Although Merkel *et al.* [15] stated that there is no relation between splenic enlargement and rise in portal pressure or degree of GV, Berzigotti *et al.* [16] found that increasing size of spleen is an independent predictor of GV in compensated cirrhosis. Moreover, Procopet and Berzigotti [17] stated that splenomegaly is common in presence of portal hypertension, and it is a sensitive sign for detection of portal hypertension.

In addition, we found a significant association between Child–Turcotte–Pugh (CTP) and gastric varices obturation ($P$=0.05), where 16 Child A patients of 17 were obturated (94%), whereas three cases with Child B out of five were obturated (60%). This may be explained by that CTP score assesses severity of liver disease, as when the score of patients is more than or equal to 7 (i.e. Child B or C), there is severe liver disease and more increase in portal pressure, which is associated with increase in size of varices, and hence difficult obturation.

This is consistent with Kim *et al.* [18] who found that CTP has significant relation to initial homeostasis and rebleeding regardless of gastric varices size, and also agrees with Kovalak *et al.* [19] who found that GV are more common in patients with CTP class B or C. In addition, Bosch *et al.* [20] found that the 6-week mortality with each episode of variceal hemorrhage is related to the CTP where it is significantly higher in Child C patients.

In our study, the obturated group showed perigastric collaterals in 16 patients with average size 4.56±1.56 mm, paragastric collaterals in 12 patients with average size 5.5 ±2.27 mm and gastric perforators in 13 patients with average size 3.59±1.44 mm. On the contrary, when perigastric collaterals increase in size to average 8.6 ±4.35 mm ($P$=0.17), paragastric collaterals increase to 14.28±4.98 mm ($P$=0.02) and perforators increase to 5.27±2 mm ($P$=0.19), there is difficult obturation of gastric varices and this can be explained by high portal pressure and increased variceal size.

This goes hand in hand with a study done by Okasha and colleagues who studied the predictors of first variceal bleeding and found that perigastric and paragastric collateral sizes were significantly larger in patients who developed upper GIT bleeding. Moreover, they found that perigastric variceal collateral size more than or equal to 2 mm show a high risk value for bleeding, and in presence of collaterals size more than or equal to 4.45 mm the risk of bleeding increases three and half times. In addition, paragastric collateral size more than 6.2 mm was found significant with double-fold increased risk of bleeding [21].

In the present study, we found that patients needed three to four sessions (2.7±0.94) with about 4–5 ml (3.8 ±1.0) of cyanoacrylate to achieve obturation of gastric varices with average of 1–1.5 ml/session. This is in agreement with Mosli *et al.* [22] who found that a minimum of three endoscopic sessions is required to decrease the risk of rebleeding, and also Garcia-Pagán *et al.* [4] stated that gastric variceal eradication is achieved with two to four injections with a volume ranging from 1 to 2 ml per session.

In the current study, 22 patients appeared to achieve obturation by upper endoscopy using injection catheter palpation; however, on EUS assessment, 19 patients were truly obturated, whereas the other patients showed presence of blood flow in the varices by applying color Doppler study, with no statistical significance ($P$=0.68), and when comparing EGD with EUS, there was high sensitivity (100%), specificity (86.4%), and overall accuracy (86%).This agrees with Iwase *et al.* [23] who stated that linear Doppler EUS easily detects the persistence of blood flow in gastric varices after cyanoacrylate therapy. In addition, this agrees with Lee *et al.* [24] who accepted the use of EUS to identify the residual flow after confirmed obturation by upper endoscopy. Moreover, Sarin and Kumar [25] declared that GV obturation can be assessed by blunt palpation using the hub of the same injector with the needle kept in, and the residual blood flow can be assessed by EUS.

According to our study, CT portal venography was able to detect obturation of gastric varices in only 12 (55%) patients, with statistical significance ($P$=0.04), when compared with EUS, with sensitivity of 63.1%, specificity of 30% and overall accuracy of 54.5%. This result did not cope with Cui *et al.* [26] who stated that CTPV is acceptable to evaluate efficacy of endoscopic therapy in patients with GV. Moreover, our results go in contrast to Willmann and colleagues who found that MDCT may be useful for assessment of the therapeutic effect of endoscopic sclerotherapy of fundal varices [12].

## Conclusion

In conclusion, this study revealed that upper endoscopy can be used in detecting obturation of gastric varices with almost absolute sensitivity, high specificity, and overall accuracy in comparison with EUS, whereas MDCT has low sensitivity, specificity, and overall accuracy in the context of detecting degree of obturation.

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Nil.

**Conflicts of interest**
There are no conflicts of interest.

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