Balloon-occluded Retrograde Transvenous Obliteration (BRTO): Preprocedural Evaluation and Imaging

Abdullah M. S. Al-Osaimi, M.D., F.A.C.P., F.A.C.G., A.G.A.F.,[1] Saher S. Sabri, M.D.,[2] and Stephen H. Caldwell, M.D.[1]

ABSTRACT

Patients undergoing balloon retrograde transvenous obliteration (BRTO) are mostly decompensated cirrhotic with either bleeding gastric varices (GV) or hepatic encephalopathy. It is crucial that clinicians are up-to-date with the assessments needed prior to BRTO to anticipate and prevent complications, and to deliver critical quality care. These patients will require preprocedural assessments and management, including endoscopic, clinical, laboratory, and imaging evaluation. Endoscopic evaluation is mandatory prior to BRTO, and it is highly recommended that it be performed at the same institution where BRTO will be performed. It is essential that clinicians are aware of the potential benefits and complications that may result from BRTO. These complications should be anticipated and prevented when possible. For GV bleeders, there should be consideration of a transvenous intrahepatic portosystemic shunt (TIPS) during or before BRTO in patients with refractory ascites or pleural effusion, as well as endoscopic banding or a TIPS in patients with high-risk esophageal varices. Patients undergoing BRTO are usually complicated and require a team approach. In this article, the authors address these assessment and preparatory management and planning procedures prior to the BRTO procedure as well as expected outcomes and potential complications.

KEYWORDS: Gastric varices, portal hypertension, liver cirrhosis, BRTO, TIPS, splenorenal shunt

Objectives: Upon completion of this article, the reader should be able to (1) identify the essential preprocedural work-up needed for patients undergoing balloon retrograde transvenous obliteration (BRTO); (2) name the possible adverse events and/or complications following a BRTO procedure; and (3) list the clinical, laboratory, endoscopic, and radiologic assessment tools in managing these patients prior to BRTO.

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[1]Division of Gastroenterology and Hepatology, Department of Medicine; [2]Division of Interventional Radiology, Department of Radiology, University of Virginia Health System, Charlottesville, Virginia.

Address for correspondence and reprint requests: Abdullah M. S. Al-Osaimi, M.D., F.A.C.P., F.A.C.G., A.G.A.F., Associate Professor of Medicine and Surgery, Medical Director of Liver Transplantation, Division of Gastroenterology and Hepatology, Department of Medicine, University of Virginia Health System, P.O. BOX 800708, Charlottesville, VA 22908-0708 (e-mail: aa6h@virginia.edu).

Management of Gastric Varices: Endoscopic, BRTO, and TIPS; Guest Editors, Wael E. A. Saad, M.D., F.S.I.R., and Saher S. Sabri, M.D.

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Patients who undergo balloon retrograde transvenous obliteration (BRTO) for bleeding gastric varices (GV) will require preprocedural assessments and management including endoscopic, clinical, laboratory, and imaging evaluations (see Figs. 1 and 2). It is crucial that clinicians are appraised of these needed assessments pre-BRTO to prevent complications and deliver critical quality care. The majority of patients undergoing BRTO are cirrhotics and require a team approach with involvement of gastroenterologists/hepatologists, endoscopists, and interventional radiologists. Open dialogue and collaboration is essential in the management of pre-BRTO patients. In this article, we will address these assessment and preparatory management and planning issues prior to the BRTO procedure and what expected outcomes and potential complications to anticipate. To our knowledge none of the management strategies discussed carry U.S. Food and Drug Administration (FDA) approval. Clearly, this is an area in need of carefully planned research to optimize management of GV bleeds.

CLINICAL ASSESSMENTS

Patients who are considered for BRTO are usually cirrhotics with bleeding varices and/or hepatic encephalopathy (HE).[1–5] Thus, assessment of these patients' liver function, including coagulation parameters, bilirubin, nutrition, in addition to blood counts, and renal function is crucial to assess synthetic reserve. In addition, assessment for presence of ascites, pleural effusion (hepatic hydrothorax), anasarca, and hypotension is of paramount importance as these variables influence outcomes in our experience. In patients with GV bleed, we emphasize the need for upper endoscopy in the same institution performing BRTO, to confirm the diagnosis and ensure careful team consideration of management options. In patients with GV bleed and uncontrolled ascites and/or hepatic hydrothorax, or high-risk esophageal varices, consideration of TIPS with BRTO is advisable to simultaneously effect portal decompression.

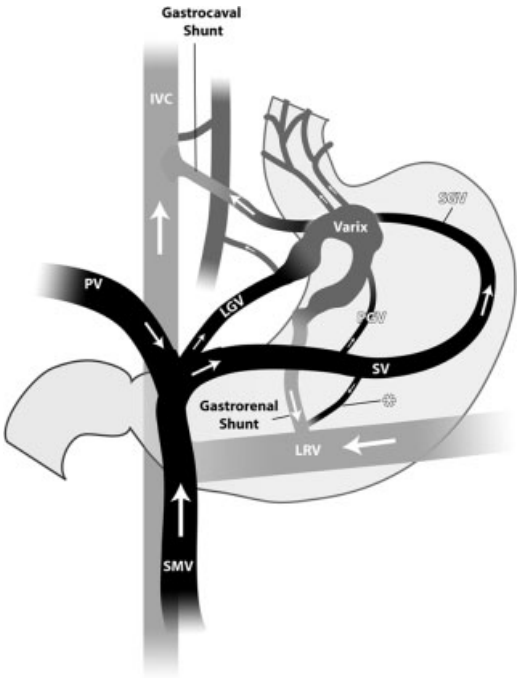

Figure 1 Anatomy of the portal circulation: Gastric varices due to splenic vein thrombosis tend to arise from the short gastric veins running from the hilum of the spleen to the greater curvature aspect of the stomach rather than through splenorenal (asterisk) or gastrorenal shunts common with portal hypertensive fundal varices. IVC, inferior vena cava; PV, portal vein; LGV,left gastric vein; SMV, superior mesenteric vein; SV, splenic vein; SGV, short gastric vein; LRV, left renal vein. (Courtesy of Dr. Saher Sabri.)

Endoscopic Management of Bleeding Gastric Varices

Initial management of GV bleeding involves diagnostic and therapeutic considerations. Basic measures common to GI bleeding in general (such as establishment of intravenous access and airway control if the patient is unstable) are beyond the focus of this article, but it should be mentioned that overaggressive volume resuscitation can exacerbate portal hypertension and should be avoided as discussed below. Cirrhosis may be suspected by prior evaluation or through historical, physical, and laboratory findings although this is not always apparent at the outset. In patients with known or suspected portal hypertension, medical therapy also usually includes antiportal hypertension medications and antibiotic prophylaxis.

Once the patient is stabilized, upper endoscopic examination is usually undertaken as a routine early measure to evaluate upper GI bleeding. Detailed endoscopic management has been discussed in "Medical and Endoscopic Management of Gastric Varices" in this issue of *Seminars ofInterventional Radiology*.

Volume, Plasma, and ProCoagulants

Animal and human studies established that volume expansion increases portal vein pressure.[6–8] Variceal bleeding is predominantly portal pressure driven, thus it is apparent that minimizing portal pressure is an important goal in managing these patients and similarly avoidance of overaggressive volume resuscitation is warranted. Blood pressures lower than normal are therefore acceptable and relatively lower target hematocrit with red blood cell transfusions are key goals. This relationship has led to the target hematocrit level of 21% from the Baveno IV Conference on Variceal and Portal Hypertensive Bleeding,[9] whereas optimization of platelet function suggests a target of 25% for hematocrit (due to flow rheology and effective platelet margination).[10]

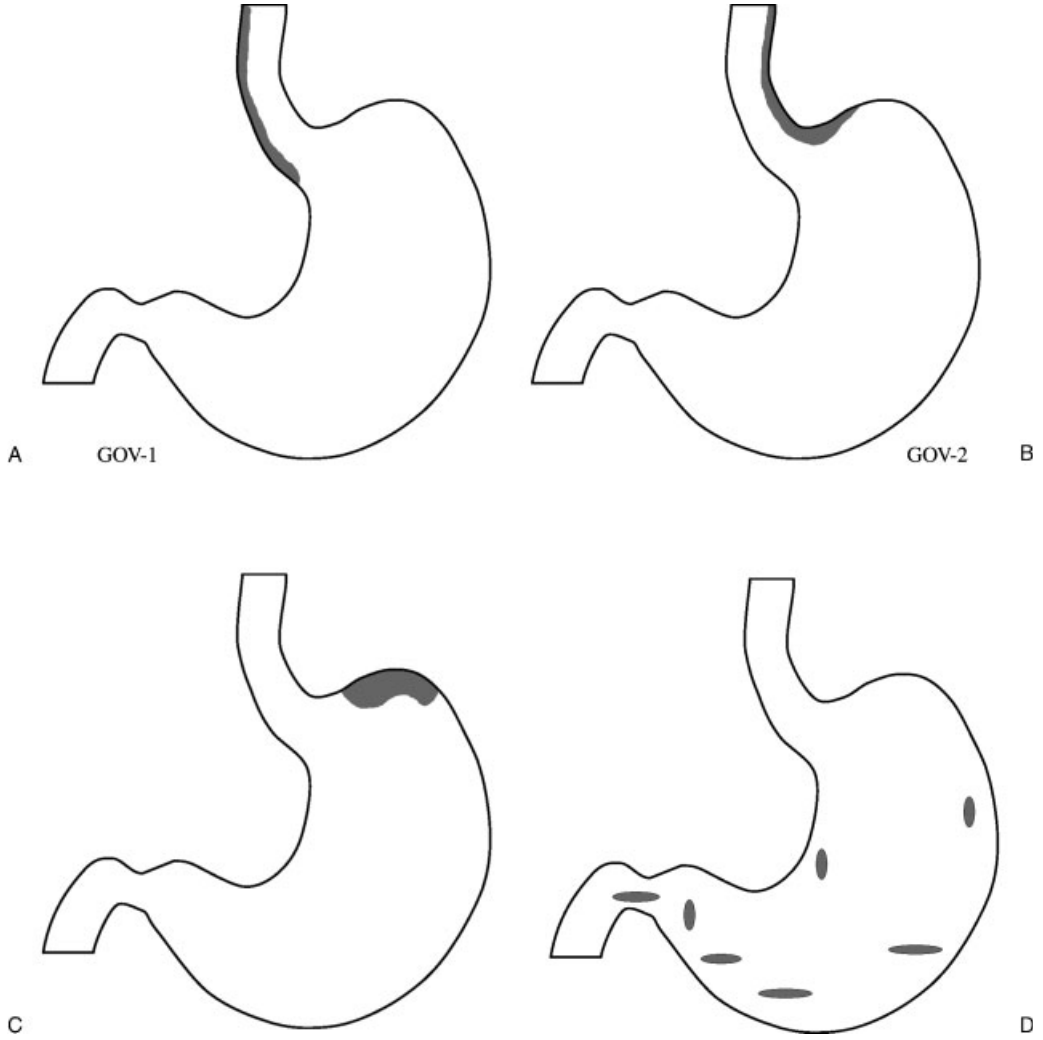

Figure 2 Schematic diagram of Sarin's Endoscopic Classification of Gastric Varices: Fundal varices are included in two of the groups: (A) Type 1 gastroesophageal varices (GOV 1) are typically continuation of esophageal varices into the lesser curvature varices. (B) Type 2 gastroesophageal varices (GOV 2) when the esophageal and fundal varices are present in continuity over the cardia, (C) Type 1 isolated gastric varices (IGV 1), that are usually fundal gastric varices. (D) Type 2 isolated gastric varices (IGV 2) are gastric varices at ectopic sites in the stomach outside the cardiofundal region or the first part of the duodenum. An alternative classification based on vascular anatomy (determined by dominant feeder veins) has been proposed and is especially useful in consideration of balloon retrograde transvenous obliteration.

Renal support may be necessary for volume control. In liver transplantation, maintaining low volumes and associated low portal pressures played a significant role in controlling bleeding during transplantation.[11] Detailed fluid and transfusion management has been discussed in an earlier article in this issue, Al-Osaimi AMS, Caldwell SH. Medical and endoscopic management of gastric varices. Semin Intervent Radiol 2011; 28:273–282.

Anticipated Benefits, Outcomes, and Complications

Studies have demonstrated improvement of the hepatic functional reserve, increased portal blood flow, reduction of gastric variceal hemorrhage and improvement in impaired glucose tolerance testing after BRTO.[12–20] Recent studies have shown improvement or stability of hepatic function via Child-Pugh (CP) score and MELD (Model of End-Stage Liver Disease).[13,21] On the other hand, most of these patients are cirrhotics, thus detailed attention to the patient' liver and renal function pre- and post-BRTO is essential. Patients with fluid overload (including ascites, lower extremity edema, and/or hepatic hydrothorax[HH]), and esophageal varices will need close monitoring, as they may worsen post-BRTO in up to 40% of patients due to enhanced portal flow to the liver following BRTO.[13,22]

In the immediate and early post-BRTO period, complications have been noted including fever, chest or epigastric pain, hemoglobinuria, transient hypertension, nausea or vomiting, and pleural effusion (see Table 1 for comprehensive list).[13,22,23] Thus, a routine check of

Table 1 Adverse Events and Complications Post-BRTO[13,22,23]

Adverse Events/Complications	%
GI Complications	
Worsening esophageal varices	40
Nausea and/or vomiting	21
Rebleeding GV	10
Gastric ulcers	9
Worsening ascites	7
Hepatic encephalopathy	2
Hemorrhagic PHG	2
Non-GI Complications	
Epigastric, chest and/or back pain	56–76.5
Hemoglobinuria	49
Transient systemic hypertension	35
Transient fever	33
New or worsening pleural effusion	12
Pulmonary infarction	2

BRTO, balloon retrograde transvenous obliteration; GV, gastric varices; PGH, portal hypertensive gastropathy.

blood oxygenation and a chest roentgenogram is recommended in all patients following BRTO.[22] Lactate dehydrogenase, aspartate aminotransferase, and bilirubin may increase in the first couple of days, but usually return to baseline; it is thought to be due to intravascular hemolysis.[22,24] Renal function might be affected, which could be related to multiple factors including diuretic use (for ascites or fluid overload), acute tubular necrosis (most likely due to hemodynamic instability postvariceal bleed or ethanolamine oleate or other sclerosant agents), contrast-induced nephropathy or hepatorenal syndrome.[22,24] In 5–10% of patients undergoing BRTO, TIPS is performed either simultaneously or subsequently before or after BRTO; thus TIPS-specific complications should be anticipated, and prevented and corrected as clinically indicated.

PREPROCEDURAL IMAGING

Obtaining good quality imaging is required to decide if the patient is a candidate for the BRTO procedure and is critical for planning the procedure. The main anatomic features (Fig. 1) to be considered prior to performing the BRTO procedure include the patency of the main portal vein, the presence of a gastrorenal or gastrocaval shunt, and the presence or absence of gastric varices.

Patency of the Main Portal Vein

The main portal vein provides outflow pathway for the mesenteric and splenic venous circulation (Fig. 1). With elevation of portal venous pressure, usually secondary to chronic liver disease, collateral veins are formed and provide portosystemic pathways. Two of the common pathways include a gastorenal shunt, which is a communication between gastric veins, such as the left, posterior, or short gastric veins and the left renal vein. The other is a gastrocaval shunt, which is a communication between the aforementioned gastric veins and the inferior vena cava through phrenic vein pathways.[25–27] Commonly these collateral pathways course within the wall of the stomach and result in gastric varices (Fig. 2). These pathways provide essential outflow pathway for the mesenteric and splenic venous circulation secondary to portal hypertension. However, these pathways may be formed secondary to thrombosis of the main portal vein and provide the main and occasionally the only outflow for the mesenteric and splenic venous circulation. In such instances, when patients present with bleeding or high-risk gastric varices and complete thrombosis of the main portal vein, it would be contraindicated to perform the BRTO procedure as occluding the portosystemic shunts may result in mesenteric venous hypertension and mesenteric ischemia. Partial thromboses of the main portal vein or a small diminutive but patent main portal vein, however, are not contraindications for the procedure. Actually, occluding the competing portosystemic shunts may result in improved flow through the main portal vein.[1,23,26–29] Chronic occlusion of the main portal vein with cavernous transformation provides a challenging condition where there remains the risk that the collateral veins around the main portal vein forming the cavernous transformation may not be sufficient to provide outflow for the portal venous system after occluding the portosystemic shunts. However, if the cavernous transformation is robust, it may be acceptable to proceed with the BRTO procedure after weighing the risks and benefits of the procedure.

Presence of a Gastrorenal or Gastrocaval Shunt

With the BRTO procedure, an occlusion balloon is advanced into a portosystemic shunt through the systemic venous outflow pathway for the purpose of occluding the shunt. This allows stagnation of the sclerosing agent within the shunt and gastric varices resulting in obliteration of the varix. Preprocedural imaging is critical in documenting the presence of this portosystemic pathway (Fig. 3). The most common shunt to be occluded during a BRTO procedure is a gastrorenal shunt, which provides venous outflow in 90% of gastric varices cases with the remaining 10% draining through a gastrocaval shunt. Preprocedural imaging is important in measuring the size of the shunt. The diameter of the gastrorenal shunt is measured at the base of the shunt at the communication point with the left renal vein, which where the occlusion balloon will be placed. The balloon diameter is chosen to match the diameter of the shunt. In roughly 20% of patients with gastric varices and a

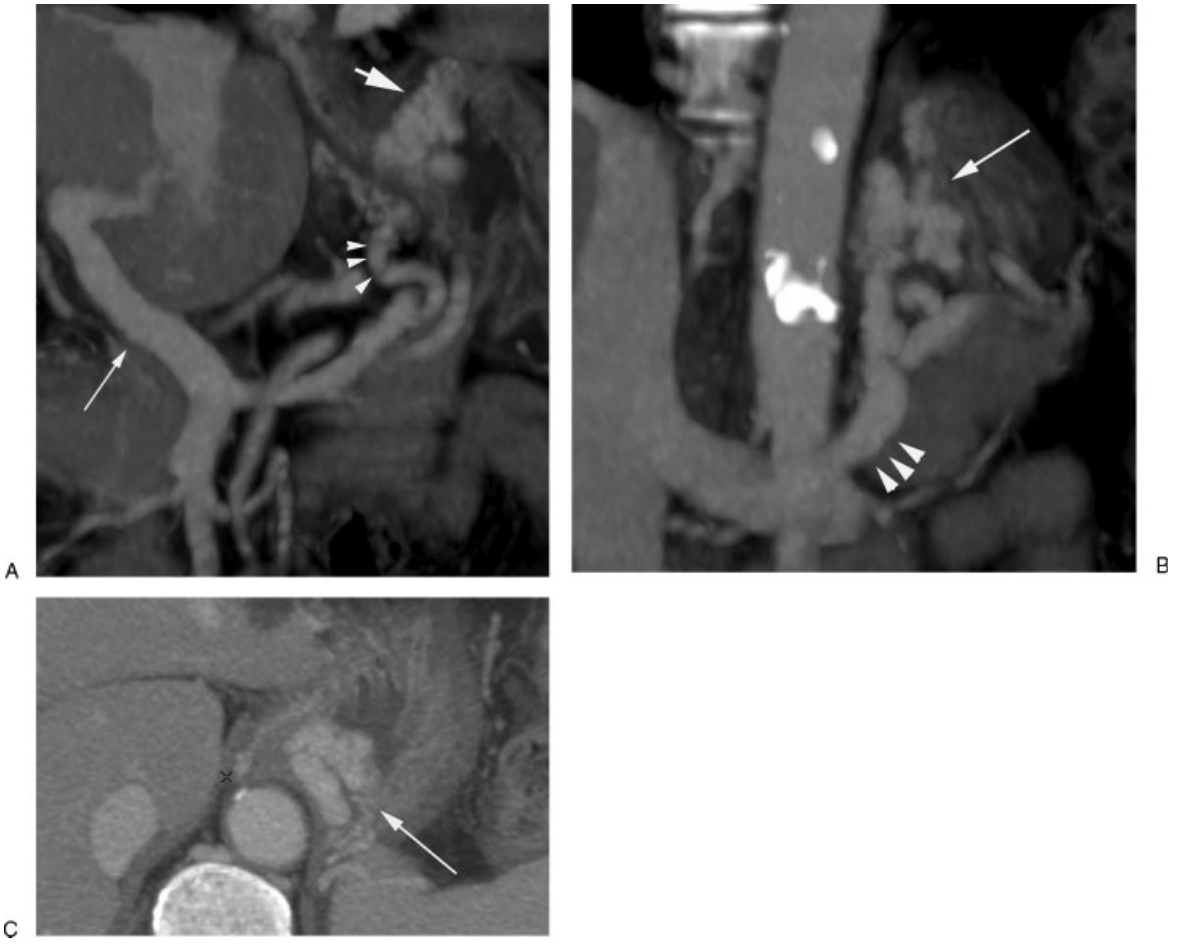

Figure 3 Preprocedural imaging with contrast-enhanced computed tomography (CECT).(A) Oblique coronal CECT shows patency of the main portal vein (small arrow). The posterior gastric vein (arrowhead) is the main feeding ''afferent'' vein for the gastric varices (large arrow). (B) Oblique coronal CECT shows gastric fundal varices (arrow) and gastrorenal shunt (arrowheads). (C) Axial CECT shows gastric fundal varices (arrow).

gastrorenal shunt, the anastomosis is too small to be safely accessed via the vena cava and alternative methods of managing the varices should be considered.

Presence or Absence of Gastric Varices

BRTO procedure can be performed to occlude portosystemic shunts to treat bleeding and high-risk gastric varices as well as treating hepatic encephalopathy. In the case of encephalopathy, gastrorenal or gastrocaval shunts may be present, but endoscopically evident gastric varices may be absent.

TRANSABDOMINAL DOPPLER ULTRASOUND

Doppler ultrasound usually provides useful information on patency of the main portal vein and the direction of flow in the intrahepatic portal vein branches. However, it is limited in evaluating the presence and size of gastric varices and gastrorenal or gastrocaval shunts. For that reason, it is necessary to obtain good quality contrast-enhanced computed tomography (CECT) or magnetic resonance imaging (CEMRI).

CONTRAST-ENHANCED COMPUTED TOMOGRAPHY

CECT provides optimal visualization of the main portal vein and documents patency, and the presence of thrombus or cavernous transformation. The gastrorenal shunt can usually be visualized well with CECT (Fig. 3). The gastrocaval shunts are usually smaller in diameter and may be harder to visualize. The gastric varices can be visualized as enhancing vascular structures in the fundus or cardia of the stomach (Fig. 3). It is important not to use oral contrast agents these may obscure the visualization of the varices. The afferent gastric veins contributing to the gastric varices can be identified on CECT, especially if it is a type 1 gastric varix (defined by vascular anatomy) with afferent flow from one dominant afferent vein, most commonly the posterior or left gastric veins (Fig. 3). However, it may be difficult to know how many afferent veins contribute to the varices.

CONTRAST-ENHANCED MAGNETIC RESONANCE IMAGING

CEMRI similar to CECT provides optimal visualization of the portal veins and its branches as well as

the gastrorenal and gastrocaval shunts, the gastric varices, and the afferent gastric veins. The dynamic postcontrast sequences provide the needed information to plan the BRTO procedure. T2 weighted sequences can provide adequate visualization of the components of the gastric varices, inflow and outflow veins, and may compliment the contrast-enhanced sequences (Fig. 4).

SUMMARY

It is crucial that clinicians are up-to-date with the assessments needed prior to BRTO to anticipate and prevent complications, and to deliver critical quality care. These patients will require preprocedural assessments and management, including endoscopic, clinical, laboratory, and imaging to consider and optimize management options. It is essential that clinicians are aware of

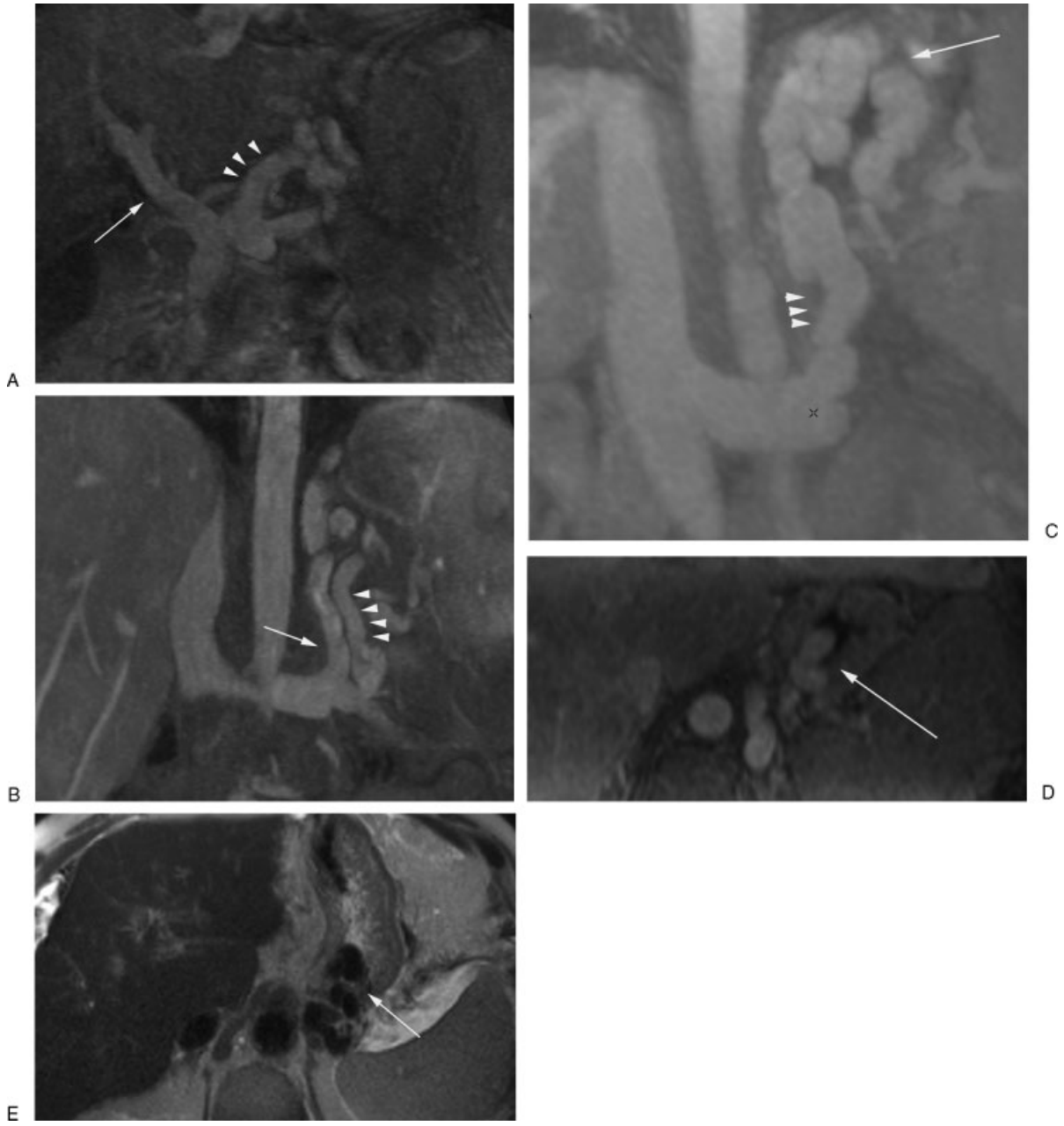

Figure 4 Preprocedural magnetic resonance imaging (MRI). (A) Contrast-enhanced MRI (CEMRI) in the coronal plane showing patency of the portal vein and the left gastric vein (arrowheads) as the main feeding ''afferent'' vein. (B) CEMRI in the coronal plane showing the posterior gastric vein (arrowheads) as the main feeding ''afferent'' vein. The gastrorenal shunt is also noted (arrow). CEMRI in the coronal (C) and axial (D) planes showing the gastrorenal shunt (arrowheads) and the opacified gastric fundal varices (arrow). (E) Axial T2-weighted MR image showing the gastric fundal varices as flow voids (arrow).

the potential benefits and complications that may result from BRTO. These complications should be anticipated and prevented when possible. The treatment of patients undergoing BRTO is usually complicated and requires a team approach.

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