Anatomy and Classification of Gastrorenal and Gastrocaval Shunts

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ABSTRACT

The gastric varices communicate with gastrorenal and gastrocaval shunts and are classified according to the pattern of venous inflow into three types, which differ in the number and location of the inflow veins. The gastric varices are also classified according to their venous drainage into four different types, reflecting the size and number of collateral veins communicating with the gastric varices and the gastrorenal/gastrocaval shunt. Lastly, the gastric varices are classified according to their appearance on balloon-occluded retrograde venography into five grades representing the degree of opacification of the gastric varices and the collateral veins. Understanding these anatomic classifications is crucial in planning endovascular obliteration of gastric varices.

KEYWORDS: Gastric varices, portal hypertension, liver cirrhosis, BROTO, portosystemic shunt

Objectives: Upon completion of this article, the reader should be able to explain the anatomic classification of the portosystemic shunts that contribute to the formation of gastric varices.

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Gastric fundal varices with hemorrhage are associated with a higher mortality rate than esophageal variceal bleeding,¹⁻³ and optimal management of gastric varices therefore requires a multidisciplinary approach. Generally, various treatment modalities such as pharmacotherapy, balloon tamponade, endoscopic procedures, endovascular treatment, and surgery have been performed.⁴⁻⁹ Transjugular intrahepatic portosystemic shunt (TIPS) has been widely used to treat bleeding esophageal and gastric varices.⁴⁻⁹

The complexity of gastric varices cannot be overstated and optimal endovascular management relies on an integral knowledge of gastric variceal anatomy. In the majority of cases, the anatomy of the varices dictates the approach used for treatment. An understanding of the afferent and efferent veins is of paramount importance, as the degree of difficulty in performing endovascular obliteration of gastric varices is directly correlated with the anatomic complexity of the varix. In 2003, Kiyosue et al outlined an

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Management of Gastric Varices: Endoscopic, BROTO, and TIPS;

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anatomic classification of gastric varices that reflects these features.^{10,11}

Balloon-occluded retrograde transvenous obliteration of varices (BRTO) is an endovascular technique developed to manage gastric varices.^{12–21} The technique is based on using occlusion balloons to modulate the flow in the portosystemic shunts that contributes to the gastric varices. The goal of this technique is to allow administration of a sclerosing agent into the gastric varices to cause obliteration of the varices without reflux of the agent into the systemic or portal circulations.

ANATOMIC CLASSIFICATION SYSTEM FOR VARICES

The gastric varices are supplied by a single or multiple afferent gastric veins, commonly the left and posterior gastric veins, but also seen with the short gastric veins, and rarely the gastroepiploic vein, which typically supplies the

varices after endovascular or surgical exclusion of other main afferent veins (Fig. 1). The varices drain through several pathways, most commonly a gastrorenal shunt (80–85%) which is thought to be a hypertrophied inferior phrenic vein that is connected to the left renal vein at the same draining point of the left adrenal vein. The second most common pathway is through a direct gastrocaval shunt where the gastric varices drain through the inferior phrenic vein or pericardiophrenic vein directly into the inferior vena cava (IVC). Other smaller venous pathways include ascending lumbar vein, perivertebral venous plexus, intercostal veins, and rarely the azygous vein.

Chikimora et al¹³ studied the correlation between angiographic vascular patterns and endoscopic findings of esophageal and gastric varices by performing percutaneous transhepatic portography and concluded that the portal collateral system was divided into two systems: the portoazygos venous system and the portophrenic venous system.¹³ The former contributed to the formation of

Figure 1 Most common variceal anatomic variants. IVC, inferior vena cava; PV, portal vein; SV, splenic vein; SMV, superior mesenteric vein; LGV, left gastric vein; PGV: posterior gastric vein; SGV, short gastric vein; LRV, left renal vein. * indicates direct communication between gastric vein and gastrorenal or gastrocaval shunt.

esophageal and cardiac varices and the latter to the formation of isolated gastric varices located at the fundus or at both the cardia and fundus. The left gastric vein participated as blood supply in 70% of the isolated gastric varices and in 100% of the esophageal varices ($p < .01$).¹³ The posterior gastric vein participated as blood supply in 70% of the isolated gastric varices and in 24% of the esophageal varices. The main blood drainage routes of isolated gastric varices were gastroduodenal shunt (85%), gastrophrenic shunt (10%), and gastropericardiac shunt (5%).¹³

CLASSIFICATION BASED ON VENOUS INFLOW

Gastric varices are classified into three types according to the pattern of their afferent veins (Fig. 2). Type 1 gastric varices are supplied by a single afferent gastric vein. This is the most common and simplest type to treat. In type 2, the gastric varices are supplied by multiple afferent gastric veins; and type 3, by single or multiple gastric veins with coexistent gastric veins that are directly contiguous with the shunt but do not contribute to the varices.

Figure 2 Classification based on venous inflow. (A) Type 1 gastric varices are supplied by a single afferent gastric vein. This is the most common and simplest type to treat. (B) In type 2, the gastric varices are supplied by multiple afferent gastric veins; and (C) type 3, by single or multiple gastric veins with coexistent gastric veins that are directly contiguous with the shunt, but do not contribute to the varices.

Type 1

A single inflow (afferent) vein is most commonly the left or posterior gastric vein. During a BRTO procedure, this type would be the easiest to treat provided the outflow veins are appropriately occluded; the sclerosant administered through occlusion balloons usually refluxes into the gastric variceal complex and stagnates due to the high pressure from the portal system, which allows slow minimal reflux into the afferent vein.

Type 2

In this type, there are two separate afferent veins (the left and posterior gastric veins). These two afferent veins

may have different pressures that would affect the blood flow once the outflow vein is occluded during a BRTO procedure. One of these veins (the lower pressure vein) will function as a draining “efferent” vein once the outflow is occluded and that may result into efflux of sclerosant into the portal circulation during a BRTO procedure. The difficulty in this type is realizing that there are two separate afferent veins, which is hard to identify on preprocedural imaging and unless both have similar pressures, both afferent veins cannot be simultaneously visualized during balloon occluded retrograde venography. In rare instances, preprocedural imaging may demonstrate the presence of two separate afferent veins.

Figure 3 Classification based on venous drainage. (A) Type A has a shunt with a single draining vein. (B) Type B has a shunt with multiple collateral draining veins. (C) Type C has both a gastrocaval and gastrorenal shunt. (D) Type D has multiple small draining veins and no shunt.

Type 3

In this type, a separate afferent vein drains directly into the shunt and goes without communication to the gastric varices. This separate vein does not supply the gastric varices and its importance comes during the BRTO procedure when sclerosant administered into the shunt may escape through this vein and reflux into the portal circulation rather than the gastric varices. Embolization of this vein through a percutaneous transhepatic or transjugular route may be needed.

CLASSIFICATION BASED ON VENOUS DRAINAGE

Varices are more importantly categorized based on their draining venous pattern (Fig. 3).

Type A

Type A varices are contiguous with a single draining shunt commonly a gastroduodenal shunt and less commonly a gastrocaval shunt, which drains through an enlarged inferior phrenic vein directly into the IVC.

Figure 4 Classification based on degree of visualization of the gastric varices during balloon-occluded retrograde venography. (A) Grade 1. Gastric varices (arrow) are well opacified without evidence of collateral veins. (B) Grade 2. Collateral veins are small and few in number (white arrow). The gastric varices (black arrow) are well opacified (C). Grade 3. Collateral veins were medium to large (white arrows) and the contrast medium filled the gastric varices (black arrow) only partially. (D) Grade 4. Many large collateral veins (arrows), and the gastric varices are not opacified.

Type B

Type B varices are contiguous with a single shunt, usually a gastroduodenal shunt, and one or multiple collateral veins. These veins drain through a plexus of vessels back to the right atrium or IVC but do not form a discrete shunt. These draining veins include pericardiophrenic, ascending lumbar, intercostal, perivertebral veins, and rarely the azygous vein. Three additional subtypes of type B reflect the flow and size of these collaterals, where B1 represents small collateral veins, B2 represent medium-sized collateral veins and B3 represents large collateral veins with high flow but no discrete shunt that can be catheterized.

Type C

Type C varices are contiguous with both a gastroduodenal and gastroduodenal shunt. Two additional subtypes of C reflect the relative sizes of these two shunts. C1 represents a small second-sized shunt, which may be difficult to catheterize. Type C2 represents a sizeable second shunt, which can be catheterized and occluded with a balloon.

Type D

In type D varices a shunt is absent and the varices drain via small collaterals and are not directly contiguous with either the IVC or renal vein.

CLASSIFICATION BASED ON APPEARANCE ON BALLOON-OCCLUDED RETROGRADE VENOGRAPHY

Hirota et al¹⁴ suggested a grading based on degree of visualization of the gastric varices according to the results of balloon-occluded retrograde venography and classified the degree of progression of the gastric varices and collateral veins into five grades (Fig. 4): grade 1, gastric varices were well opacified without evidence of collateral veins; grade 2, collateral veins were small and few in number, and the contrast medium remained in the gastric varices for 3 minutes or more; grade 3, collateral veins were medium to large, there were few veins, and the contrast medium filled the gastric varices only partially and disappeared within 3 minutes; grade 4, there were many large collateral veins, and the gastric varices were not opacified; and grade 5, the shunt could not be occluded with the balloon catheter because of the large size of the shunt and the rapid blood flow.

Understanding the anatomic classification of the varices and defining the inflow and draining venous pathways is critical to performing the procedure successfully. The procedure can be modified to address each of the above-mentioned subtypes and this will be discussed in detail in the following article, "Balloon-occluded

Retrograde Transvenous Obliteration (BRTO): Technique and Intraprocedural Imaging."

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