

Percutaneous transhepatic obliteration (PTO) and Balloon-occluded retrograde transvenous obliteration (BRTO)

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Introduction

Percutaneous transhepatic obliteration (PTO) had been used for the treatment of bleeding varices since early 1970's and predated the TIPS era.⁽¹⁾ Although classical PTO could obtain initial hemostasis, high rates of recurrence or rebleeding could occur.⁽²⁾ Therefore, less invasive treatment option of endoscopic sclerotherapy or band ligation became the first-line treatment. In classical PTO, several embolic materials including coils, gelatin sponge, and cyanoacrylate have been introduced into the afferent gastric vein. It is difficult to obtain sufficient filling with embolic agents introduced from the afferent gastric vein in the entire varices. This will result in the regrowth of the residual varices with development of a collateral supply. Recently, modified PTO (m-PTO) techniques have developed to obtain sufficient variceal filling with embolic/sclerosing agents.⁽³⁾ These techniques showed high technical success rates with complete obliteration of varices with lower recurrence rates in gastroesophageal varices.^(3,4) The m-PTO technique is now a good treatment option for the treatment of gastric varices (GV) which is difficultly treated by balloon-occluded retrograde transvenous obliteration (BRTO). The classical and m-PTO techniques have been applied for the treatment of the ectopic varices (ECV) including duodenal, rectal, and stomal varices.⁽⁵⁾

In many countries when endoscopy fails to control gastric variceal bleeding, a transjugular intrahepatic portosystemic shunt (TIPS) traditionally is performed as portal decompression since 1989.⁽⁶⁾ However, TIPS has not shown the same effectiveness in controlling gastric variceal bleeding that it has with esophageal variceal bleeding.^(7,8) For the past 2 decades, BRTO has become common in Japan for the management of GV.⁽⁹⁻¹⁹⁾ BRTO has been effective in controlling gastric variceal bleeding with low rebleed rates.⁽⁸⁾ BRTO has many advantages over TIPS in that it is less invasive and can be performed on patients with poor liver function and those with encephalopathy (and may even improve both).^(7,8) However, its secondary product is occlusion of a spontaneous hepatofugal shunt, BRTO causes an increase in portal hypertension, with potential aggravation of esophageal varices and ascites. This lecture includes the concept, technique, and outcomes of PTO and BRTO for the management of GV, hepatic encephalopathy (HE) and ECV owing to portal hypertension.

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How to manage GV

Alternative routes for transvenous obliteration can be classified into (A), portal venous access routes and (B), systemic venous access routes. The portal venous approach to transvenous obliteration is called balloon-occluded antegrade transvenous obliteration (BATO) and is a collective definition, including (1)-PTO, (2)-through an existing TIPS(Trans-TIPS), and (3)-trans-iliocolic vein obliteration (TIO). PTO is usually from necessity; however, trans-TIPS approach is usually used because of the low-risk access route. TIO is rarely resorted to and almost always is utilized as an access for mesenteric varices/ECV.⁽²⁰⁾

Transvenous obliteration of GV (with duodenal and mesenteric varices being similar) can be performed from the systemic venous side (draining veins/shunts) or from the portal venous side (portal afferent feeders). Balloon-occluded transvenous obliteration from the systemic veins is referred to as BRTO, and balloon-occluded transvenous obliteration from the portal veins is referred to as BATO.⁽²⁰⁾

With the advent of BRTO in the early 1990s, it has been used as a second choice approach or an adjunct to the traditional transrenal BRTO approach.

From a technical application standpoint, the first choice of access/approach for balloon-occluded transvenous obliteration of GV is the traditional transrenal route (BRTO).^(10-12,21)

In general, BATO (m-PTO) is considered an adjunct or an alternative to BRTO when BRTO fails completely or partially in obliterating the GV.^(20,22)

These technically challenging cases include failed gastrosplenic shunt catheterization, failed occlusion of gastrosplenic shunt due to large gastrosplenic shunt (larger than balloon-occlusion catheter), and duplicated gastrosplenic shunts/numerous venous collaterals with inability to occlude the gastric variceal system in its entirety.^(20,23)

Techniques of PTO

The techniques of percutaneous transhepatic puncture of the portal venous branch are similar to those of percutaneous transhepatic biliary drainage. Under ultrasonographic (US) guidance, a 20-18G needle is advanced into the right branch or umbilical portion of portal vein. After confirming to puncture a portal branch, a 0.035-inch guide wire is advanced further to the main portal vein. Then, the outer plastic tube is exchanged to the 5F angiographic sheath. After superior mesenteric or splenic venous portography and selective angiography of the target branches are performed for evaluate the anatomical and hemodynamic feature of the lesions, a 5F occlusion balloon is often used to control the blood flow during embolization procedure, which allows the stagnation of the embolic/ sclerosing agents in the target vessels and/or varices. Various sclerosing agents and embolic materials including EO, polidocanol, glue (cyanoacrylate-lipiodol mixture), and coils has been used. Any embolic materials are generally effective for occlusion of the shunt, however, successful and

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stable obliteration of varices requires sclerosing agents or glue filling entirely the varices. For this purpose, liquid sclerosing/embolic agents should be injected in the varices or close to the varices under flow control by occlusion balloon and/or after coils embolization of the afferent and drainage vein. When the varices are supplied from multiple afferent veins, some of which should be occluded with coils before the injection of the sclerosing/embolic agent into the varices. After embolization procedure, portography is performed to evaluate the obliteration of the varices or shunt and portal venous hemodynamics including portal venous flow and collaterals. Then, the catheter and sheath are withdrawn with embolizing the puncture tract in the hepatic parenchyma with coils, gelform and/or glue.

Techniques of BRTO

The BRTO procedure is an endovascular technique that causes occlusion of outflow portosystemic shunt, such as a gastroduodenal shunt, using an occlusion balloon followed by the endovascular injection of a sclerosing agent directly into the gastro-variceal system.⁽¹⁰⁻¹²⁾ The *gastro-variceal system* is a collective term for the gastroduodenal shunt and the gastric or gastroesophageal varices. Balloon occlusion is used for two technical reasons: (1) occlusion of the gastroduodenal shunt so that retrograde venography can be performed to visualize the gastric-variceal system and (2) to adjust flow and cause stagnation of the sclerosant within the gastric-variceal system without reflux of the sclerosant into either the portal or systemic vasculature.^(7,9) Stagnation in the flow is helpful to maximize sclerosant dwelling time to achieve maximal effect of the sclerosant on the gastro-variceal system endothelial lining, leading to thrombosis and subsequent scarring of the system. As can be concluded, stagnation of flow is essential to the BRTO procedure.^(8,24)

Unconventional routes have also been described; transhepatic, trans-phrenic, trans-pericardiac, trans-iliocolic, trans-gonadal, and trans-azygos approaches.⁽²⁵⁾

Vascular Access

Percutaneous venous access of the femoral or internal jugular vein using standard Seldinger technique is performed with placement of a 8-10F sheath. Most IRists prefer to use a right femoral vein approach; however, some operators have adopted the jugular vein approach exclusively.⁽²⁶⁾

Shunt Catheterization

In Japan, catheterization of the gastroduodenal shunt via the left renal vein is typically accomplished using catheters with mounted occlusion balloon that are specifically designed for the BRTO procedure. Reversed-shaped balloon catheters that provide effortless and stable access into the gastroduodenal shunt are available in Japan.⁽²⁷⁾

Shunt Occlusion

The occlusion balloon, with the compliant balloon mounted on the catheter, is sized to occlude the draining gastrosplenic shunt. The shunt can be occluded at any point where there is a narrowing within the gastrosplenic shunt; occlusion does not need to occur at the confluence of the shunt and the left renal vein.

Balloon-occluded Retrograde Venography

Balloon-occlusion venography is performed to define the type of gastric variceal system and determine the anatomy of venous drainage. The cases are classified according to the venous drainage pattern.^(11,12) In general, the operator attempts to opacify the whole gastric-variceal system with its afferent (portal venous supply) and any efferent (systemic draining veins) veins that decompress the system. Identification of the afferent vessels (portal venous supply) is to familiarize the operator with the "the point of no return" where sclerosant injection is stopped just before overspill occurs into the portal venous system.⁽²⁷⁾

Sclerosant Injection

The aim during sclerosant injection is to fill the entire gastric-variceal system so that no varices remain and no unnecessary portosystemic connections are left for the system to revascularize. The embolization end point is minimal filling of the afferent portal vasculature that was previously identified during balloon-occluded retrograde venography. Injection of a sclerosing agent can be performed with or without use of a microcatheter.⁽²⁸⁾ I do suggest advancing a microcatheter, if feasible, through or adjacent to the balloon-occlusion catheter as deeply as possible into the gastric-variceal system.⁽²⁸⁾ From this viewpoint, a new coaxial balloon catheter system for BRTO was developed.⁽²⁹⁾ This allows an even distribution of sclerosant in the system for optimal sclerosis effect.⁽²⁸⁾

Numerous sclerosing agents can be used and have been described. These agents include 5% EOI which mixed 10% ethanolamine oleate (EO) and the same amount of Iopamidol as sclerosant.^(9,10,24) 3% STS, and Polidocanol. All agents can be used in liquid (sometimes in foam). In addition, liquid sclerosants such as N-butyl-cyanoacrylate and absolute ethanol have also been used.⁽³⁰⁾ EO is the traditional agent used for BRTO and is still the agent of choice in Asia.^(10,31) EO causes hemolysis in the blood vessels; as a result, free hemoglobin is released, which may cause renal tubular disturbances and acute renal failure. To prevent renal insufficiency, 2000 to 4000 U of haptoglobin is routinely administered intravenously during the BRTO to chelate the circulating free hemoglobin to minimize its nephrotoxic effects.^(11,12)

Once the entire gastric-variceal system is filled with sclerosant, I recommend performing an angio-CT or cone-beam CT to ensure that the entire system is filled with sclerosant, especially all the GV proper.

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Sclerosant Dwell Time (Balloon Dwell Time)

The occlusion balloon is left inflated for 4 to 24 hours. This protocol has been adopted for logistical reasons, such as cost concerns (patients stay overnight in monitored beds), patient comfort, and reducing the infection risk of indwelling catheters tethered at skin sites.⁽³⁰⁾ Therefore plug-assisted retrograde transvenous obliteration (PARTO) or coil-assisted retrograde transvenous obliteration (CARTO) are recently reported for solving these problems.^(32,33)

The most common cause of technical failure is likely a complex multicollateral gastrosplenic system with the consequent inability to fully opacify and sclerose the GV.^(14-18,25)

The aggravation of nongastric (esophageal or duodenal) varices appears to be a major problem following BRTO and reflects postprocedural increased portal hypertension.^(24,34,35) This effect varies widely, probably depending on the degree of vigilance, documentation, and thoroughness of follow-up endoscopy.

The greatest advantages of BRTO are its preservation of liver function and its reduction in the risk of HE.^(7,8) In fact, one of the indications for BRTO is HE with the presence of a gastrosplenic or gastro-splenoportal shunt.^(14,28)

BRTO has a protective long-term role in preserving liver function and protecting the liver from "portosystemic shunt syndrome."⁽¹⁷⁾

Endovascular management for ectopic varices

Although uncommon, ECV can involve any other part of GI tract and challenging for IRists to manage. The term ECV has been used to describe variceal veins other than those found in the esophagus and stomach. ECV are sometimes observed in the duodenum, small intestine, colon, rectum, peristomal, peritoneum, umbilicus.

Duodenal varices: The afferent vessel originates either from the SMV or from the portal vein trunk via either superior or inferior pancreaticoduodenal vein. The efferent vein drains into IVC via gonadal vein. These can be treated by BATO including PTO (m-PTO), BRTO, DBOE (dual balloon-occluded embolotherapy) according to the vasculature.

Rectal varices: These result from communication between the superior rectal vein (draining into portal vein via IMV) and the middle or inferior rectal vein that drains into IVC via internal iliac veins. These can be mostly treated by BATO including PTO (m-PTO), or balloon-occluded antegrade transvenous sclerotherapy (BATS)⁽³⁶⁾ according to the vasculature. BRTO is effective in selected case such as their draining vein is simple and accessible..

Stomal varices: Develop in the mucocutaneous junction of a stoma in patients with coexisting portal hypertension. These can be treated by BATO (BATS) including PTO (m-PTO) according to the vasculature.

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Conclusion

BRTO has shown considerable effectiveness for obliteration of gastric fundal varices and portosystemic shunt which may cause hepatic encephalopathy.

BATO including m-PTO is also reliable for obliteration of some of portosystemic shunt and the varices especially for the cases difficult to treat by BRTO or other RTOs. Selection of these techniques should be chosen by each individual based on anatomic and vasculature.

With the increasing experience of endovascular treatment, the management will be tailored to patient anatomy, clinical features of portal hypertension, and hepatic reserve.

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