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Review Article

Articulated percutaneous plastic biliary stents: How to do it

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ABSTRACT

The use of articulated plastic biliary stents is not well known. This technique allows drainage of two or more biliary segments using a single percutaneous access in hilar lesions. In patients that need dilatation of benign biliary stenoses, articulated plastic biliary stent allows placing two or more plastic in the area of stenosis achieving a large internal temporal dilatation while using smaller external biliary drains.

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Introduction

Percutaneous transhepatic biliary drainage (PTBD) is an established method to provide drainage of benign and malignant biliary strictures. Endoscopic methods are preferred in patients with distal obstruction of the biliary system, while in patients with obstruction at the hilum, PTBD has a higher technical success than the endoscopic methods, with lesser incidence of cholangitis.¹ Effective drainage is often challenging in patients with obstruction at the hilum due to the anatomical complexity of the bile ducts, and frequently two or more PTBD are required in order to achieve effective drainage.

Many patients with benign strictures after laparoscopic cholecystectomy injuries or after liver transplant are treated with biliary-enteric (BE) anastomosis. Stenosis of the surgical anastomosis is a frequent postoperative problem. Due to the altered anatomy, PTBD is required to treat most of these patients. The long-term success of PTBD ranges from 56% to 81%.^{2–5} The main factors associated with long-term success of the radiologic treatment of benign strictures are the ability to place a large (> 16 Fr) PTBD drain, and the possibility of leaving the drain in place for at least 6 months. In some patients even larger drains are needed, with some patients requiring placement of bilateral large caliber PTBD drains.⁵

The technical success of PTBD is between 90% and 95%. Unfortunately, drainage-related complications are very common. Some complications related to the procedure include: bleeding

(3%–7%), acute sepsis (3%–5%), and pleural transgression (1%–5%).^{6–8} Delayed complications are even more common and mostly related to the presence of the PTBD catheter and include: pericatheter bile leak (15%–20%), catheter dislodgement (10%–20%) and catheter obstruction with or without cholangitis (47%). Multiple drains increase the incidence of these complications which frequently require repeated interventions.⁸ The presence of the drain is not only uncomfortable and painful, but a constant reminder of the disease to the patients, with negative psychological effects.

Articulated biliary plastic stents (ABPS) allow drainage of two or more biliary ducts in hilar strictures using a single percutaneous access, decreasing the incidence of catheter related complications secondary to multiple biliary drains. This technique can also be used in the long-term treatment of benign biliary anastomotic strictures and allows achieving a very large internal diameter at the area of stenosis, while using a smaller biliary drain externally. ABPS not only decreases the discomfort and pain, but may also result in less cholangitis, liver abscess formation and bile leakage, which can be associated with large bore catheters, due to the blockage of smaller bile ducts.⁹ The technique uses readily available materials that are inexpensive. This technique is relatively unknown and seldom used.

ABPS were originally described for the replacement of biliary T tubes as early as 1990.^{10,11} In 1997, Shlansky-Goldberg et al¹² described the use of the ABPS in anastomotic and hilar lesions in 16 patients with benign or malignant biliary strictures for an average duration of 7 months. A variation of the technique de-

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scribed originally by Tsai et al¹³ uses a dual catheter technique where a smaller 10 Fr. drain was placed inside a 18 Fr. catheter to drain multiple bile ducts with a single access. More recently Gwon et al⁹ used the dual catheter technique for the treatment of anastomotic strictures in 79 patients by placing an 8.5 Fr catheter inside a 14 Fr PTBD catheter, with the smaller tube exiting through a distal side hole, providing further dilatation of the anastomosis thanks to the presence of the two catheters.

The purpose of this essay is to review the technique, applications and complications of ABPS for the percutaneous treatment of benign and malignant biliary strictures.

Indications

The potential clinical indications for ABPS are multiple and include complex benign or malignant hilar strictures that require bilateral PTBD, benign distal biliary strictures, and benign BE anastomotic strictures that involve the hepatic ducts. Ideal candidates are patients with an existing PTBD catheter with a mature percutaneous tract that require contralateral drainage due to persistent elevation of the liver enzymes or recurrent cholangitis, or patients that require long-term drainage of benign biliary strictures which usually involves placement of large bore catheters.

Possible configurations of APBS are multiple. In hilar strictures a Y- or T-configuration can be created, while in distal strictures, a double barrel is fabricated.

1. T-configuration: After access into a contralateral bile duct is obtained, the plastic stent is deployed crossing from the right to the left ducts, forming a T. It is easier to construct and exchange. It is used in the treatment of hilar bilateral strictures (Fig. 1).

2. Y-configuration: The main biliary drain and the contralateral hepatic duct stent are placed in Y-configuration crossing into the small bowel using a single percutaneous access. The initial configuration is a T with the deployed stent crossing from the access site into the contralateral bile duct, with forward movement of articulating point, the stent is advanced into the distal common bile duct (CBD) or intestine forming a Y. It is used in the treatment of hepatic duct and associated BE anastomosis stenosis, as the presence of the two plastic catheters across the anastomosis may improve the long-term patency (Fig. 2).

3. Double barrel configuration: The plastic stent is deployed from the access site across the stenosis. The stent and drain are placed crossing in parallel through the stenosis at the BE or CBD into the small bowel in a double barrel configuration. This is the simplest and easiest construction technique (Fig. 3).

Contraindications

The contraindications to APBS are all relative and similar to the PTBD and include, uncorrectable coagulopathy, severe ascites and sepsis. In many cases, recurrent cholangitis is related to the presence of undrained biliary radicles and APBS is actually indicated to resolve the infection. However, due to the multiple manipulations needed, APBS is usually reserved for patients that have controlled and treated infections and it is not performed in patients with untreated active bacteremia or sepsis.

Fig. 2. Cholangiogram shows articulated biliary plastic stents in a Y-configuration.

Fig. 1. Cholangiogram shows articulated biliary plastic stents in a T-configuration.

Fig. 3. Cholangiogram shows articulated biliary plastic stents in a double barrel configuration.

Disadvantages

APBS requires multiple steps and is relatively complex in some cases. Catheter and stent exchanges are more time consuming and complex than a routine PTBD catheter exchange. Removing the stents is usually straightforward, but although the contralateral access is momentarily lost, recovering access is relatively simple.¹²

Steps to Articulate Plastic Stents

In most cases, the patient already has a PTBD catheter in place. Although placing APBS *de novo* is possible, the manipulation of the fresh liver parenchyma tract can be associated with bleeding, bile leak and is usually painful, and therefore, most frequently, the APBS is delayed for 2 to 3 weeks after initial PTBD placement.

Prophylactic broad spectrum antibiotics are given before the procedure. Conscious sedation and local anesthesia are administered in the standard fashion. The existing biliary catheter is removed over a stiff wire placed in the small bowel. An 8 Fr introducer sheath is placed over the wire and advanced near the hilum. Using the combination of a curved angiographic catheter and a guidewire, the obstruction of the contralateral duct is crossed. A cholangiogram, with limited amount of contrast, is performed to delineate the anatomy of the stenosis and identify the length of the obstruction. It is important not to over-distend the biliary system with contrast medium to prevent cholangitis. The angiographic catheter is then advanced as distally as possible, inside the contralateral bile duct. A good support wire with a short distal tip, such as the Rosen wire (Cook, Bloomington, IN, USA), is advanced, again as distally as possible, into the contralateral duct. Having two differently colored wires can be helpful. For example, a blue Amplatz superstiff guidewire (Boston Scientific, Natick, MA, USA) can be placed in the small bowel and the green Rosen wire can be used in the contralateral bile duct. For a double barrel configuration, both wires are placed across the stenosis into the small bowel. Balloon dilatation of the hilar stenosis can then be performed, if BE or CBD anastomosis stenosis are also present, those can also be dilated using the second wire.

Stent Fabrication

The distal tip of a standard biliary catheter can be used for stent fabrication, since it already has multiple side holes. For contralateral bile ducts with short segments, the distal tip of an Amplatz anchor catheter (Boston Scientific), or a double mushroom plastic biliary stent (Cook) can be used with less risk of migration. However, these stents are more rigid and should not be used for Y-configuration because they tend to kink during placement.

The length of catheter needed for the stent fabrication is determined based on the length of the bile ducts and the distance to the BE or CBD anastomosis for Y-configuration, or to the hilum in T-configuration. Use the radiopaque markers of the dilation balloon (usually 4 cm apart) to estimate the length of the stent. The stent will be placed from the contralateral bile duct into the ipsilateral access duct (T-configuration) or from the contralateral bile duct into the small bowel (Y-configuration). For the Y-configuration, longer stents will be created. Cut the distal end of a biliary catheter with scissors and remove the retention suture

Fig. 5. Photograph shows placement of the retrieval suture 2 to 3 mm from the end of the catheter.

Fig. 4. Photographs show cutting the anchor catheter with scissors and removing retention suture.

(Fig. 4). In the majority of the cases, an 8 or 8.5 Fr stent is placed in the contralateral site, but larger stents (10 or 12 Fr) can be used if there is enough room to accommodate the stent and the biliary drain.

Place the retrieval suture 2 to 3 mm from the end of the stent tying the suture with at least 4 knots. Use a strong, non-absorb-

able suture, such as 2-0 polypropylene, at least 75 cm long (Fig. 5). Using long sutures facilitates greatly the next steps and prevents accidentally pulling the stent during the manipulation. Place a clamp in the back of the suture. Ideally, a second operator should hold the suture stationary near the skin of the patient, to prevent accidental migration of the stent.

Assemble the proximal portion of the drain which was previ-

Fig. 6. Photograph shows placement of the plastic stent over the plastic stiffener. Proximal portion of drain to be used as a pusher.

Fig. 8. Photograph shows the percutaneous transhepatic biliary drainage catheter with the plastic stiffener in place.

Fig. 7. Photographs of the steps for stent articulation. (A) Pass the plastic stiffener through one of the side holes of the percutaneous transhepatic biliary drainage (PTBD) catheter; this will be the articulating point. (B) Advance the suture through the plastic stiffener and then through the back of the PTBD catheter. (C) Place clamp to hold suture in position.

Fig. 9. (A) Cholangiogram in a patient with liver transplantation and bilio-enteric anastomosis for primary sclerosing cholangitis (PSC) shows right percutaneous transhepatic biliary drainage (PTBD) catheter with stenosis at the proximal bile duct (arrow). Left side is not seen. (B) Cholangiogram after the PTBD catheter was removed and an angled catheter used to cannulate the left biliary system, shows severe stenosis at proximal left hepatic duct (arrow) due to recurrent PSC. (C) Radiograph shows balloon dilatation of the left biliary stricture. (D) Radiograph shows the 10 Fr anchor and a 10 Fr PTBD catheter in a T-configuration.

ously cut with the piece of drain, which is acting as the stent, by placing both pieces over the plastic stiffener of the drain. The proximal portion of drain will be used as a pusher (Fig. 6). Remove the sheath, keeping both wires in place. Advance the plastic stent assembly into the desired position. Deploy the plastic stent by removing the wire and the plastic stiffener, simultaneously holding the back of the cut catheter in position. The stent will be extending from the contralateral duct into the access duct or the hilum. For a double barrel configuration the stent is deployed from the access site across the stenosis into the small bowel.

For the stent articulation the operator then needs to decide where in the biliary catheter the articulation is going to be placed in order to achieve stent articulation. If the stent is going to have a Y-configuration, the articulation point has to be created near

the distal end of the biliary catheter, at one of the side holes of the pigtail portion. For a T-configuration, the articulation is placed more proximally closer to the radiopaque marker of the proximal side holes. For a double barrel configuration, the articulation point tends to be in the middle or proximal portion of the biliary drain.

The next step is passing the plastic stiffener through one of the selected side holes of the biliary catheter, where the articulation point will be created. Then advance the suture through the plastic stiffener, all the way through the lumen of the biliary catheter (Fig. 7).

The biliary catheter is now advanced over the stiff Amplatz wire. Hold the suture near the skin to prevent migration of the plastic stent as the biliary catheter is advanced inside the patient. The biliary catheter can be advanced without the plastic stiffener

Fig. 10. Photographs show wrapping suture around the outer shaft of the percutaneous transhepatic biliary drainage catheter and securing it with a knot.

Fig. 11. (A) A spot radiograph shows articulated biliary plastic stents in a T-configuration. (B) After percutaneous transhepatic biliary drainage removal the plastic stent is seen. (C) Plastic stent is being removed by pulling on the suture. (D) Photograph of a removed plastic stent.

if a tube of the same size is placed in a mature tract. Alternatively, the plastic stiffener can be placed partially inside the biliary catheter, without locking it in the back, so that slight tension in the suture can be maintained while the catheter is advanced over the wire into the small bowel (Fig. 8). As soon as the biliary catheter reaches the articulation point, pull on the suture until tension is created, when the articulating point is reached, the plastic stent will start moving with the biliary drain.

For a T-configuration, minimal manipulation is needed (Fig. 9). Simply pull slightly on the suture until the articulation point is reached. Make sure the position of the side holes of the PTBD catheter is adequate.

For a Y-configuration, once the biliary catheter reaches the articulation point in the ipsilateral bile duct or at the hilum, pull on the suture until tension is achieved. While holding tension on the suture, forward advancement of the PTBD will pull the articulated stent distally through the hilum into the BE anastomosis or the papilla. Avoid advancing the system too distally, because migration of the plastic stents out of the contralateral duct can occur.

For a double-barrel configuration, place the plastic stent into

the small bowel across the BE or distal CBD. The proximal portion can be placed in the proximal CBD; or in cases of BE anastomosis, in the ipsilateral access duct. Depending on the final diameter desired, different combinations of PTBD catheters and stents can be placed to achieve maximum dilatation.

Finally, wrap the back of the suture around the outer shaft of the PTBD catheter and secure it with a knot (Fig. 10). The drain is then capped. Leakage of bile can sometimes occur as there may be a poor seal between the hub of the catheter and the cap, because of the suture. Locking the suture with a three way stopcock will solve this issue. It is possible to trap the suture inside the catheter with the Boston Scientific biliary drains by closing the locking mechanism of the pigtail and cutting the suture short. In this manner, the retention suture won't be visible and there will be no leakage.¹¹

Stent Removal or Exchange

Start by cutting the suture from the back of the PTBD catheter. Then, remove the PTBD catheter over a guidewire. Harvest the suture near the access site and gently remove the stent under fluoroscopic guidance (Fig. 11). In most situations, the articulated stent will come out with no difficulties. In rare occasions, the plastic stent can be embedded in granulation tissue, making stent removal difficult. The suture might tear in those cases, the retrieval of the stent by using a snare is usually successful (Fig. 12).

Potential Complications

Most complications are similar to PTBD. Stent occlusion is possible but rare and easily resolved by changing the stent.¹² Hemobilia and cholangitis are also possible (Fig. 13). Routine tube and stent exchange every 3 months is important to prevent catheter occlusion and cholangitis.

Potential complications unique to this technique include; stent migration when the PTBD catheter moves forward, pulling the plastic stent into the small bowel (Fig. 14), difficulty to remove stent due to suture tear, stent kinking when the plastic catheter is cut too long. In the latter, the plastic stent can be retrieved using the suture and a shorter stent fabricated using the same catheter fragment (Fig. 15).

Conclusion

The use of articulated plastic stents is not well known, despite the fact that the technique was described almost 20 years ago. The

Fig. 12. Radiograph shows a stent retrieval using a snare (arrow) after the suture was torn.

Fig. 13. (A) Hepatic angiogram in a patient with history of cholangiocarcinoma with articulated biliary plastic stents in T-configuration, now with hemobilia, shows extravasation of contrast through the entry tract (arrow), only seen after the percutaneous transhepatic biliary drainage catheter was removed over a guidewire. (B) Angiogram after selective coil embolization shows no further evidence of hemobilia. It was not clear if bleeding was related to erosion due to the plastic stents or to tumoral vascular encasement.

Fig. 14. (A) Cholangiogram shows articulated biliary plastic stents in a double barrel configuration. (B) Cholangiogram two weeks later shows migration of the stent and percutaneous transhepatic biliary drainage catheter distally into the intestine.

Fig. 15. (A) Radiograph shows the left biliary stent in place made with a fragment of Amplatz anchor drain (Boston Scientific). (B) Radiograph shows that after advancing the percutaneous transhepatic biliary drainage and reaching the articulating point, the stent was kinked (arrow). (C) The plastic stent was retrieved using the suture and a shorter stent fabricated using the same catheter.

technique uses readily available materials of relatively low cost which can be custom made for each patient's specific needs. This technique allows drainage of two or more biliary segments using a single percutaneous access in hilar stenosis. APBS also allows achieving a large internal temporal dilatation of benign anastomotic biliary strictures, while using a smaller external biliary drain. ABPS is an alternative for the percutaneous management of complex benign and malignant biliary strictures.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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