A Novel Endovascular Adjustable Polytetrafluoroethylene-covered Stent for the Management of Hepatic Encephalopathy after Transjugular Intrahepatic Portosystemic Shunt

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Transjugular intrahepatic portosystemic shunt (TIPS) is frequently complicated by hepatic encephalopathy. When medical therapy fails, TIPS narrowing and resultant increase in the portosystemic pressure gradient and blood flow to the liver is performed in order to reverse the encephalopathy. We present a method for reducing the TIPS using a polytetrafluoroethylene-covered balloon expandable stent placed over a self-expanding stent. This results in a narrowed TIPS that not only rapidly increases the portosystemic gradient but also can be adjusted by dilating the balloon expandable stent. This method was successful in narrowing the patient's TIPS, acutely increasing the portosystemic gradient and reversing the hepatic encephalopathy.

J Vasc Interv Radiol 2007; 18:563–566

Abbreviations: PET = polyethylene terephthalate (PET), PTFE = polytetrafluoroethylene, TIPS = transjugular intrahepatic portosystemic shunt

TRANSJUGULAR intrahepatic portosystemic shunt (TIPS) has historically been a successful option for the treatment of complications secondary to portal hypertension. Indications for TIPS include variceal bleeding, refractory ascites, as well as Budd-Chiari syndrome. The principal advantage of TIPS is the decreased rates of procedural mortality and early complications compared with surgery (1,2). One major complication of TIPS is hepatic encephalopathy (3). Decreased pressure within the portal system also results in reduced hepatic perfusion and may rarely lead to fulminant liver failure. If uncontrollable with medical therapy, hepatic encephalopathy may need to be resolved with narrowing of the TIPS and subsequent increase in portosystemic pressure gradient. We present a method for reducing the diameter of a TIPS using a polytetrafluoroethylene (PTFE)-covered balloon expandable stent (iCAST; Atrium Medical Corp., Hudson, NH) placed over a self-expanding stent (Wallstent Endoprosthesis; Boston Scientific, Natick, MA). This approach results in an acute increase in the portosystemic pressure gradient, which can be adjusted by dilating the balloon expandable stent to the desired diameter.

CASE REPORT

The institution does not require institutional review board approval for retrospective reports.

A 68-year-old woman with hypertension, diabetes mellitus, and prior right hepatectomy for adenocarcinoma presented with intractable ascites and partial portal vein thrombosis. An initial TIPS was created from the residual right hepatic vein to the left portal vein with a 10 mm × 68 mm Wallstent. Because of recurrent thrombosis, this was subsequently revised several months later to a 10 mm × 7 cm self-expanding PTFE-covered stent (Viatorr TIPS Endoprosthesis; W. L. Gore & Associates, Inc., Flagstaff, AZ). The portosystemic gradient was decreased from 33 mm Hg after TIPS failure to 15 mm Hg. Two days after revision, the patient developed fulminant hepatic failure and hepatic encephalopathy unresponsive to medical management including lactulose and dietary protein restriction. Given her deteriorating condition, a TIPS reduction was performed 5 days after initial revision.

An adjustable PTFE reducing stent was constructed using a 10 mm × 94 mm Wallstent constrained by a 39-mm Atrium PTFE balloon expandable stent. The Wallstent delivery system was initially placed through a 10-F TIPS sheath (Cook Medical Inc., Bloo-

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None of the authors have identified a conflict of interest.

DOI: 10.1016/j.jvir.2007.02.004

mington, IN). While maintaining the Wallstent in the closed position, the PTFE stent was slid over the delivery catheter (Cook Medical Inc.) and positioned over the midportion of the Wallstent. The Wallstent was partially deployed to the limit marker band, and the PTFE stent was then hand crimped. The distal tip of the Wallstent delivery system was severed to allow for easier removal through the constraining PTFE stent after deployment. The entire system was then pulled back into the 10-F sheath (**Fig 1**).

After preparing the delivery system, the patient's right internal jugular vein was accessed, and a 12-F, 25-cm sheath (Cook Medical Inc.) was placed with its tip in the right atrium. The TIPS was catheterized using a 5-F Multi-Purpose A catheter (Cook Medical Inc.). The initial portosystemic gradient was then measured at 13 mm Hg. The entire reducing system was then introduced over an Amplatz wire (Cook Medical Inc.) through the 12-F sheath and appropriately positioned within the existing TIPS. The 10-F sheath was withdrawn, deploying the distal expanded Wallstent. After pulling the entire system back into the correct position within the TIPS, the remainder of the Wallstent was deployed (**Fig 2a**).

A 4 mm × 4 cm angioplasty balloon catheter (Cook Medical Inc.) was centered in the PTFE stent and inflated. The distal and proximal ends (but not the middle) of the PTFE stent were then flared to 8 mm to obtain apposition of the PTFE-covered stent with the Viattor TIPS. The portosystemic gradient after dilation was elevated to 28 mm Hg, and portogram demonstrated antegrade flow into the portal veins and reduction of the TIPS diameter (**Fig 2b**).

The patient subsequently became more responsive over the next few days. An ultrasound was performed demonstrating the TIPS to be patent. However, several weeks later, the patient experienced an episode of bloody emesis. The patient's poor prognosis was discussed with her family and a do-not-resuscitate order was written. Three weeks after TIPS reduction, she suffered a fatal asystolic cardiac arrest.

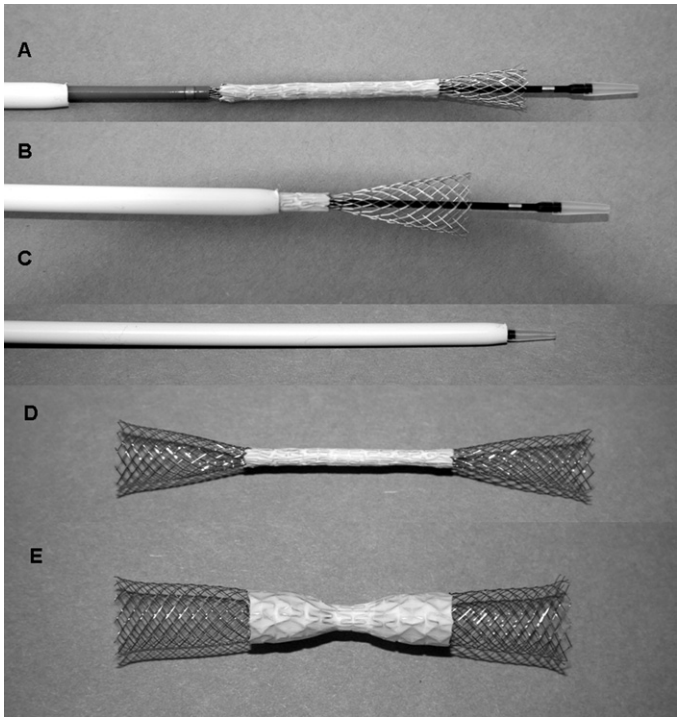

Figure 1. **a,** PTFE-covered balloon expandable stent mounted on a partially deployed Wallstent; **b,** the covered stent is then pulled back into a 10-F long sheath; **c,** the entire system is loaded into a 10-F sheath for delivery through a 12-F TIPS sheath; **d,** after deployment, the ends of the Wallstent flare to affix the system within the existing TIPS; **e,** the ends of the covered stent are flared to obtain the desired portosystemic gradient.

DISCUSSION

Hepatic encephalopathy occurs in as many as 35% of patients after TIPS (4). Although complex and poorly understood, the pathophysiology of hepatic encephalopathy involves derangement of the central nervous system. Elevated levels of intestinally derived compounds in the systemic circulation are the result of two processes. Gastrointestinal derived constituents that are normally processed by liver detoxification are allowed to directly enter the systemic circulation through the TIPS (5). Ammonia has been the most widely accepted culprit involved in this process. When ammonia or other nitrogenous compounds find their way into the central nervous system, it is thought that neurotransmission is disturbed resulting in the alteration in consciousness and mental status changes witnessed in hepatic encephalopathy (6). In addition, there is reduced hepatic metabolism of these compounds as the shunt results in reduced portal flow through the liver (7).

Several methods have been utilized to improve encephalopathy after TIPS. Reducing dietary protein while increasing dietary fiber to promote bowel transit has provided relief for many patients with hepatic encephalopathy and is one of the mainstays of medical therapy (8). Lactulose, which is a nonabsorbable compound, has also been used to reduce nitrogenous material in the bowel by promoting bowel transit as well as acidification of the colon (9). Neomycin, a nonabsorbable antibiotic, has also been used in patients unable to tolerate lactulose by reducing the intestinal production of ammonia from glutamine (10).

In nearly 10% of patients, hepatic encephalopathy after TIPS is refractory to medical therapy (11). Patients who do not respond to medical therapy for hepatic encephalopathy comprise a small but important group as more aggressive intervention is necessary. Several methods of TIPS occlusion or reduction aimed at reducing the amount of portal flow that bypasses the liver have been described.