Diagn Interv Radiol 2021; 27: 238–243

INTERVENTIONAL RADIOLOGY

ORIGINAL ARTICLE

Combined Y-configured stents for revising occluded transjugular intrahepatic portosystemic shunt

Xiaoze Wang
Yongjun Zhu
Ming Zhao
Xuefeng Luo*
Li Yang*

PURPOSE
We aimed to determine the technical feasibility, safety and prognosis of the transjugular intrahepatic portosystemic shunt (TIPS) revision by combined Y-configured stents placement.

METHODS
We retrospectively evaluated 12 patients who received TIPS revision using Y-stenting technique between June 2015 and January 2019. The rates of technical success, complication, shunt patency, hepatic encephalopathy and mortality were described and analyzed.

RESULTS
The combined Y-configured stents were successfully placed in 11 of 12 patients (92%) without major complications. The median portosystemic pressure gradient (PPG) decreased from 23 mmHg (interquartile range, IQR, 18.5–27.5 mmHg) to 10 mmHg (IQR, 9–14 mmHg). The left internal jugular vein approach was used in 5 patients. Four patients required a shunt extension with an extra stent to resolve the stenosis at the portal venous terminus. Two patients developed hepatic encephalopathy, which was medically controlled within 3 months after the procedure. The TIPS patency and survival rates were both 100% during a median follow-up period of 10 months (IQR, 5.5–14 months).

CONCLUSION
TIPS revision by combined Y-configured stents placement was technically feasible and safe with favorable clinical outcomes.

Transjugular intrahepatic portosystemic shunt (TIPS) has been widely used for the treatment of portal hypertension complications by decompressing the portal venous system (1). Shunt patency has been greatly improved since the introduction of dedicated polytetrafluoroethylene-covered stents. However, dysfunction still occurs in 8%–20% of patients within the first year after TIPS creation (2).

TIPS dysfunction can arise from acute thrombosis and pseudointimal hyperplasia within the stent or at the hepatic vein outflow (3–5). Angioplasty, with or without stent placement, is frequently attempted to restore adequate TIPS function. In some cases where TIPS dysfunction is associated with altered shunt configuration or stent displacement, especially in a "T-bone" configuration, entry to the previous shunt seems to be challenging (6). This troublesome situation is more likely to occur when TIPS is created with a non-Viatorr stent, such as Fluency stent-grafts (Bard & BD). This type of stent is still widely used due to its relatively low cost, though its rigid structure may change the shunt orientation gradually. Moreover, a combined transjugular and transhepatic approach has been described (7, 8). After a percutaneous transhepatic puncture of the stent strut, a wire is passed through the lumen to inferior vena cava (IVC) and snared from the transjugular access to establish the channel. Of note, this approach brings a relatively high risk for bleeding and prolonged operative time when compared with only transjugular access (9). Parallel TIPS is generally used as the last resort (10, 11). Despite its proven efficacy, parallel stent placement through the portal vein may increase the risk of intraabdominal hemorrhage and aggravate liver function.

Herein, inspired by the stent-in-stent technique used in the placement of bilateral biliary metallic stents and coronary stents (12–14), we tried to recanalize the occluded TIPS via en-

From the Department of Gastroenterology and Hepatology (X.W., M.Z., X.L. ✉ *luo_xuefeng@yeah.net*, L.Y. ✉ *yangli_hx@scu.edu.cn*), Sichuan University-University of Oxford Huaxi Joint Centre for Gastrointestinal Cancer, West China Hospital, Sichuan University, Chengdu, China; Department of Gastroenterology and Hepatology (Y.Z), Second Affiliated Hospital of Chongqing Medical Univeristy, Chongqing, China.

* Xuefeng Luo and Li Yang contributed equally to this work.

Received 1 October 2019; revision requested 24 October 2020; last revision received 25 March 2020; accepted 28 April 2020.

Published online 19 January 2021.

DOI 10.5152/dir.2021.20036

You may cite this article as: Wang X, Zhu Y, Zhao M, Luo X, Yang L. Combined Y-configured stents for revising occluded transjugular intrahepatic portosystemic shunt. Diagn Interv Radiol 2021; 27: 238–243

dovascular puncture of the strut of the existent stent and followed with deployment of a new covered stent with a "Y" configuration (Fig. 1). The purpose of the present study is to evaluate the technical feasibility, safety and clinical outcomes of this new TIPS revision technique.

Methods

Patients

This study was approved by the ethics committee of our institute (No. 2018391). Between June 2015 and January 2019, a total of 131 patients underwent TIPS revisions in our hospital. Among them 12 patients received Y-configured stents implantation. The demographic, laboratory, radiologic and follow-up data were prospectively recorded and retrospectively analyzed. Informed consent for the procedure and data collection was acquired from each patient.

Procedure

All recanalization procedures were performed under sedation and local anesthesia. The left internal jugular vein approach was used for a more favorable course to canalize the previous shunt when the angle between the initial stent and the right hepatic vein was approximately 90°. TIPS revision through the mesh of the initial stent were only considered when failing to canalize the shunt via hepatic vein terminus. Puncture of the stent strut was made via the right hepatic vein or IVC using Rosch–Uchida TIPS set (RUPS-100, Cook Medical). The optimal planned needle pass was evaluated under fluoroscopic posteroanterior and lateral images. The proximal end of the stent was generally avoided to prevent extrahepatic puncture. Once entry to the stent was achieved, a 0.038-inch hydrophilic wire was advanced through the occluded shunt and positioned within the portal vein. Over the wire, the metal cannula was inserted through the mesh into shunt lumen, to predilate the mesh region. The new tract was serially dilated using a various-sized balloon ranging from 4 mm to 10 mm (PTA, Cordis/Johnson and Johnson), followed by placement of an 8 mm or 10 mm covered stent (Fluency, Bard & BD) extending to the confluence of the hepatic vein and IVC. The diameter of the balloon and the new stent was chosen based on the initial stent. An additional bare stent (SMART, Cordis/Johnson and Johnson) was placed extending the portal venous terminus, if necessary. Then, the shunt was repeatedly dilated with the same balloon. The portography was performed and the portosystemic pressure gradient (PPG) was measured before and after stent placement. Persistently visualized varices after shunt revision were embolized with metal coils (Nester, Cook Medical) (Fig. 2).

Main points

- Combined Y-configured stents placement was technically feasible and safe for occluded transjugular intrahepatic portosystemic shunt (TIPS).
- The shunt patency after combined Y-configured stents placement is favorable.
- The left internal jugular vein approach can be used for a more favorable course to recanalize the dysfunctional TIPS when the previous stent comes to an acute angle with the hepatic vein.

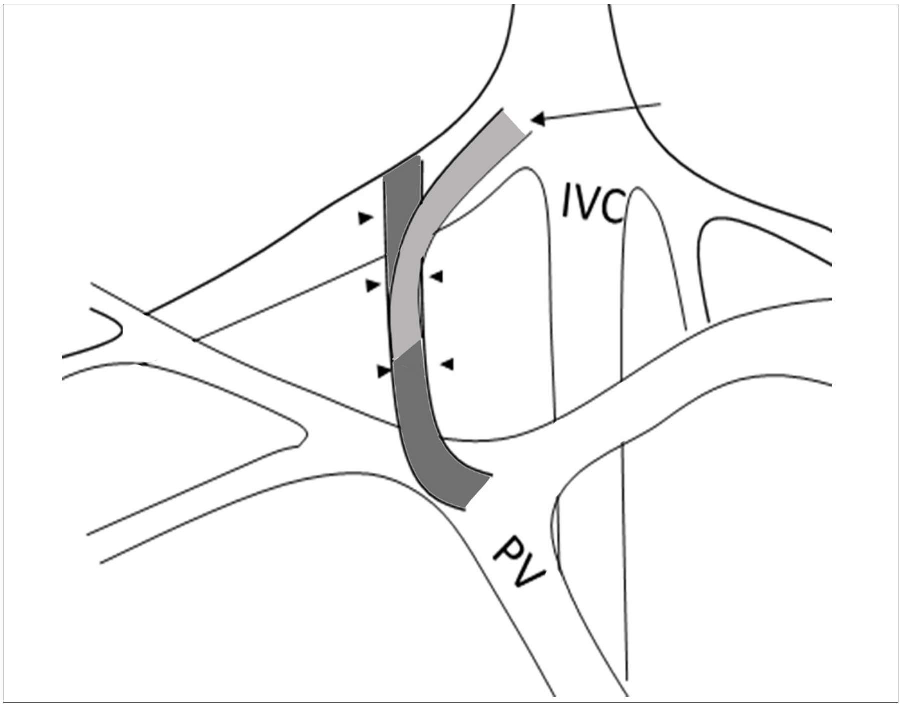

Figure 1. A schematic of Y-configured stents implantation. The angle between the initial stent *(arrowheads)* and the right hepatic vein was approximately 90°. A new stent *(long arrow)* was deployed through the mesh of the initial stent to restore the portosystemic shunt.

Follow-up and definitions

Technical success refers to the restoration of shunt flow with new covered stent implantation through the mesh of the initial stent (15). All patients were supervised at 1, 3 and 6 months after shunt revision and every 6 months thereafter. TIPS dysfunction was considered at flow velocity >180 cm/s or <60 cm/s within the stent lumen as measured by Doppler ultrasonography (US), or the recurrence of portal hypertension complications. Thereafter, the shunt venography and manometry were carried out to confirm it.

Statistical analysis

Continuous variables were presented as mean ± standard deviation or median (interquartile range, IQR), and categorical variables as frequency (percentage). All data were analyzed using SPSS software (version 19.0; IBM Corp.). Non-parametric Wilcoxon test was used to assess the difference between paired continuous variables. A p value less than 0.05 was considered statistically significant.

Results

The mean age of 12 patients was 49.1±11.9 years (range, 31–71 years); there were 5 male and 7 female patients. The cause of cirrhosis was hepatitis B virus infection (n=5), primary biliary cholangitis (n=3), hepatitis C virus (n=2), alcoholism (n=1), and autoimmune hepatitis (n=1). Child-Pugh A was classified in 8 patients and Child-Pugh B class was classified in the rest. The mean Model for End-Stage Liver Disease (MELD) score was 9.3±1.5. All patients had undergone *de novo* TIPS for prevention of variceal rebleeding. The median time between TIPS creation and dysfunction was 33 months (IQR, 13.5–39

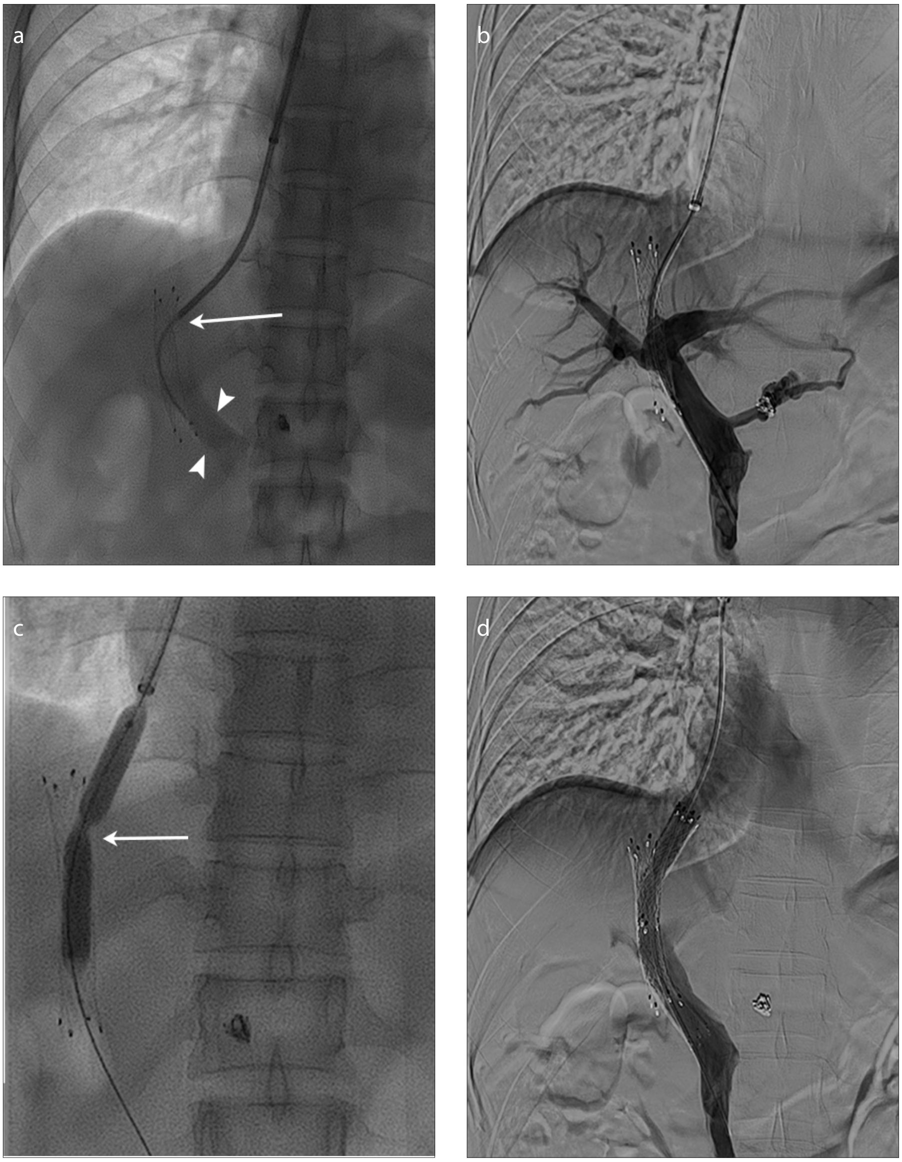

Figure 2. a–d. A 48-year-old man patient had no intrastent flow at Doppler ultrasonography 32 months after TIPS creation. Panel **(a)** shows metal cannula of RUPS-100 held in the right hepatic vein and the Rosch-Uchida needle catheter punctured through strut of the previous stent *(long arrow)*. The trunk of the portal vein *(arrowheads)* displayed after contrast injection. Portography **(b)** shows completely occluded initial shunt and opacified varices. The hemodynamic measurement showed a portosystemic pressure gradient of 20 mmHg. Fluoroscopic image **(c)** shows an inflated balloon in the strut of the previous stent *(long arrow)*, dilation was continued until the waist deformity of the balloon catheter was lost. Final portography **(d)** shows unhindered blood flow in the shunt after Y-configured stents assembled. The portosystemic pressure gradient was reduced to 9 mmHg.

months). At the latest US examination, blood flow within the shunt was absent in 6 patients; the intrastent flow velocity was less than the lower limit in 4 patients (33.7±12.1 cm/s), too rapid in 1 patient (191 cm/s), and a bit slow in 1 patient (65.5 cm/s). Recurrence of variceal bleeding occurred in 9 patients before the scheduled TIPS revisions were performed (Table 1).

The technical success was achieved in 11 patients (92%). In one patient, the initial Wallgraft stent (Boston Scientific/Meditech) was so rigid that fenestration could not be completed, even after multiple balloon dilatations. Ultimately, a parallel TIPS was deployed. The Y-configured stents were assembled successfully in the rest of patients whose original TIPS was created with Fluency stent-grafts. Among them, the left internal jugular vein approach was used in 5 patients. The median PPG decreased from 23 mmHg (IQR, 18.5–27.5 mmHg) to 10 mmHg (IQR, 9–14 mmHg) ($p = 0.001$). In 7 patients, a single stent-graft was sufficient. In the other 4 patients, shunt extensions with additional overlapped bare stents were required to resolve the stenosis at portal vein terminus (Table 2). Two patients with visualized coronary vein and varices after stent placement received variceal embolization with metal coils. Two patients had mild residual stenosis of the new shunt at the initial stent strut site. One patient who presented with multiple gastric varices and splenorenal shunt received balloon-occluded retrograde transvenous obliteration after shunt recanalization. No major complications occurred during any of the procedures.

All patients survived during a median follow-up period of 10 months (IQR, 5.5–14 months), and none of the patients had variceal rebleeding or recurrence of ascites. The blood flow velocity within the shunt in each patient was in the normal range at the recent US examination (112.3±32.2 cm/s; range, 64.8–150 cm/s). Grade II hepatic encephalopathy was observed in two patients at 2 and 3 months, respectively, and was managed successfully with lactulose administration. Notably, both patients developed hepatic encephalopathy after *de novo* TIPS insertion (Table 2).

Discussion

In the present study, we retrospectively analyzed 11 patients who successfully underwent TIPS revisions with the Y-stenting technique. This revision technique was technically feasible and safe for occluded TIPS, especially for those with inaccessible hepatic venous terminus. The clinical outcomes were favorable as well.

The application of TIPS has been limited by the relatively high incidence of shunt dysfunction, even after widespread use of covered stents. Pseudointimal hyperplasia in the hepatic vein outflow was the pivotal reason for chronic TIPS occlusion, making the recanalization through original shunt challenging. Clark et al. (16) have shown that preliminary stent position within the hepatic vein outflow was predictive for TIPS patency, and stent not extending to hepatocaval confluence was more likely occluded. The shear stress from the fast intrastent blood flow may facilitate pseudointimal hyperplasia, leading to the outflow blockage of TIPS. On account of the previous clinical studies (16, 17), we placed TIPS with hepatic end adjacent to hepatocaval confluence in the present series. Notably, all shunt dysfunction in our study was re-

Table 1. Patient characteristics, technical data, and outcomes

Variables	Values
Age (years), mean±SD (range)	49.1±11.9 (31–71)
Male/female	5/7
Etiology, n (%)	
Hepatitis B	5 (42)
Hepatitis C	2 (17)
Primary biliary cholangitis	3 (25)
Autoimmune hepatitis	1 (8)
Alcoholism	1 (8)
Child-Pugh grade, n (%)	
A	8
B	4
MELD score, mean±SD (range)	9.3±1.5 (6–12)
Time after *de novo* TIPS (months), median (IQR)	33 (13.5–39)
Symptoms of *de novo* TIPS dysfunction, n (%)	
Variceal rebleeding	9 (75)
None	3 (25)
Technique success, n (%)	11 (92)
Left jugular access, n (%)	5 (42)
Stent type, n (%)	
Fluency alone	7 (64)
Fluency and SMART	4 (36)
Pre-revision PPG (mmHg), median (IQR)	23 (18.5–27.5)
Post-revision PPG (mmHg), median (IQR)	10 (9–14)
Follow-up (months), median (IQR)	10 (5.5–14)
Clinical outcomes, n (%)	
TIPS dysfunction after revision	0 (0)
Hepatic encephalopathy	2 (18)
Mortality	0 (0)

SD, standard deviation; MELD, model for end-stage liver disease; TIPS, transjugular intrahepatic portosystemic shunt; IQR, interquartile range; PPG, portosystemic pressure gradient.

lated to the alteration of stent configuration, which may be ascribed to the rigid structure and elastic retractive force of the Fluency stent. This kind of covered stent might be gradually straightened instead of maintaining the curved shape, and then the original position of the stent might be altered. Eventually, the end of stent may be covered up by hepatic vein wall and hyperplastic intima (6, 18). Despite its structural limitation, Fluency stent has not been completely replaced by Viatorr stent (W.L. Gore and Associates) in China and some other countries. This may be attributed to the validated efficacy and the relatively low cost of Fluency stent (6). Therefore, to optimize the strategy of deployment of this device, the cranial end of Fluency stent is expected to be placed extending over the hepatocaval confluence.

In case of occluded TIPS, when the access to shunt from the original path cannot be achieved with guidewire, catheter, or stiff cannula, several advanced techniques can be considered. The combined transhepatic and transjugular approach is a commonly used technique (7, 8, 19). After percutaneous transhepatic puncture into the stent, a wire is threaded upward through the shunt outflow and snared from jugular vein access. Then a sheath is advanced over the guidewire into the shunt, followed by standard balloon dilation and stent implantation. This technique brings a relatively high risk of intraabdominal hemorrhage since it involves creating a tract through the liver (9). When multiple attempts to cross the occluded stent fail, or patients have coagulation disorders or massive ascites, parallel TIPS was regarded as a last resort. In 1998, Dabos et al. (20) first introduced the parallel TIPS insertion in 29 patients, suggesting better patency than the initial shunts. In a series of 18 patients who received parallel TIPS in our institution, the technical success rate was 100%, and the primary shunt patency rate at 1 year was 87.5% (10). Despite its efficacy at reducing portal venous pressure, the parallel TIPS may worsen hepatic function, because the extra parallel stent may occupy the limited space of portal vein and block intrahepatic blood flow. In contrast, the combined Y-configured stents deployment not only avoids high-risk transhepatic puncture but also recanalize the initial shunt instead of re-establishing a new one to reduce liver injury and maintain intrahepatic perfusion.

The Y-stenting revision is valuable in the reconstruction of dysfunctional TIPS. Similar techniques have been reported previously (21, 22). Ahmed et al. (21) described patients with Budd-Chiari syndrome who underwent TIPS insertions through the strut of previously placed stents in the hepatic vein or the IVC. Unlike their series, our stent insertions were through the covered portion of the previous stent strut, in which endovascular puncture of the polytetrafluorethylene cover was always required. The following balloon angioplasty of stent-graft mesh was slightly strenuous due to the ruggedness of the polytetrafluorethylene. The fenestration in Wallgraft stent is much more challenging. In our cohort, Y-stenting revision has failed in one patient who received *de novo* TIPS using a Wallgraft stent. After the Rosch-Uchida needle catheter was punctured into the stent lumen, the metal cannula and sheath could not pass through the mesh, even after the small-diameter balloon dilations were tried. But in all other patients implanted with Fluency stents, the mesh dilation of exiting stent was easier, and Y-configured stents were all successfully assembled. The waist deformity of the shunt at the stents junction site was obvious in two patients, but the PPG have reduced to 11 mmHg and 9 mmHg, respectively. The shunts have remained patent during the follow-up periods. Therefore, the operational details and application scenarios are innovative in the present study.

Table 2. Patient characteristics, technical data and outcomes

No.	Age / Sex	Etiology	Time after de novo TIPS (months)	Stent type and size for TIPS (mm)	Internal jugular approach	Size of balloon catheter (mm)	Stent type and size for TIPS revision (mm)	Pre/post -revision PPG (mmHg)	Adverse events	Follow-up (months)	Outcomes
1	63/F	PBC	60	Fluency 8 × 60	Left	4 × 60 6 × 60 8 × 60	Fluency 8 × 60	16/11	No	21	Alive and asymptomatic
2	71/F	AIH	46	Fluency 8 × 80	Right	6 × 60 8 × 60	Fluency 8 × 80	33/18	No	18	Alive and HE 3 months later
3	40/M	Alcoholism	14	Fluency 8 × 60	Right	8 × 60	Fluency 8 × 60, SMART 8 × 80	26/13	No	15	Alive and asymptomatic
4	43/M	HBV	23	Fluency 8 × 60	Left	8 × 60	Fluency 8 × 40	18/7	No	13	Alive and asymptomatic
5	61/F	HCV	57	Fluency 10 × 60	Left	8 × 60 10 × 60	Fluency 10 × 40	19/9	No	12	Alive and asymptomatic
6	48/F	PBC	21	Fluency 8 × 80	Left	8 × 60	Fluency 8 × 60, SMART 8 × 80	29/17	No	10	Alive and asymptomatic
7	47/F	PBC	12	Fluency 8 × 60, SMART 8 × 60	Right	8 × 60	Fluency 8 × 40	23/15	No	9	Alive and HE 2 months later
8	44/F	HBV	32	Fluency 8 × 60mm	Left	6 × 60 8 × 60	Fluency 8 × 40, SMART 8 × 80	20/9	No	8	Alive and asymptomatic
9	37/M	HBV	13	Fluency 8 × 60	Right	8 × 60	Fluency 8 × 60, SMART 8 × 60	24/8	No	3	Alive and asymptomatic
10	45/M	HBV	15	Fluency 8 × 40, SMART 8 × 60	Right	8 × 60	Fluency 8 × 40	15/9	No	3	Alive and asymptomatic
11	59/F	HCV	12	Fluency 8 × 40, SMART 8 × 60	Right	8 × 60	Fluency 8 × 80	32/10	No	1	Alive and asymptomatic

TIPS, transjugular intrahepatic portosystemic shunt; PPG, portosystemic pressure gradient; F, female; M, male; PBC, primary biliary cholangitis; AIH, autoimmune hepatitis; HE, hepatic encephalopathy; HBV, hepatitis B virus; HCV, hepatitis C virus.

The left internal jugular vein approach was used in 5 patients. In general, the standard access for *de novo* TIPS and revision procedure is the right jugular vein. But with the change of shunt orientation, the previous stent may come to an acute angle with the right hepatic vein. Under the circumstances, the catheter or puncture set from left jugular vein approach can take a diagonal course through the mediastinum and reach the stent in a more obtuse angle, allowing the easy entrance of the previous shunt (23). For puncture of the stent strut, using this access route facilitates a strong laterally orientated direction. Hence, this approach may become a viable alternative to the standard right internal jugular approach.

Our study had several limitations. First, it was a single-center and retrospective study, hence the external validity of the results needs further evaluation. Second, a control group was not available in this study, and a relatively small number of patients were evaluated, which made the results less convincing. Third, the Fluency stent-graft, with its rigid structure and radial forces, was not the same as the commonly used Viatorr stent, since the Fluency stent-graft straightens into its nominal configuration over time. The strategy of the stent deployment should be further evaluated and validated.

In conclusion, the present study reported a series of patients with occluded TIPS who underwent successful revision via combined Y-configured stents placement, providing an alternative method for TIPS revision. The preliminary results demonstrated that it is feasible and safe, and the shunt patency is also favorable.

Conflict of interest disclosure

The authors declared no conflicts of interest.

References

1. Boyer TD, Haskal ZJ. Role of transjugular intrahepatic portosystemic shunt (tips) in the management of portal hypertension: Update 2009. Hepatology 2010; 51:306–306. [Crossref]
2. Weber CN, Nadolski GJ, White SB, et al. Long-term patency and clinical analysis of expanded polytetrafluoroethylene-covered transjugular intrahepatic portosystemic shunt stent grafts. J Vasc Interv Radiol 2015; 26:1257–1265. [Crossref]
3. LaBerge JM, Ferrell LD, Ring EJ, Gordon RL. Histopathologic study of stenotic and occluded transjugular intrahepatic portosystemic shunts. J Vasc Interv Radiol 1993; 4:779–786. [Crossref]
4. Haskal ZJ. Improved patency of transjugular intrahepatic portosystemic shunts in humans: Creation and revision with ptfe stent-grafts. Radiology 1999; 213:759–766. [Crossref]
5. Terayama N, Matsui O, Kadoya M, et al. Transjugular intrahepatic portosystemic shunt: Histologic and immunohistochemical study of autopsy cases. Cardiovasc Intervent Radiol 1997; 20:457–461. [Crossref]
6. Luo XF, Zhao M, Wang XZ, et al. Long-term patency and clinical outcome of the transjugular intrahepatic portosystemic shunt using the expanded polytetrafluoroethylene stent-graft. PloS one 2019; 14:e0212658. [Crossref]
7. Tanaka T, Gunther RW, Isfort P, Kichikawa K, Mahnken AH. Pull-through technique for recanalization of occluded portosystemic shunts (tips): Technical note and review of the literature. Cardiovasc Intervent Radiol 2011; 34:406–412. [Crossref]
8. Chan CY, Liang PC. Recanalization of an occluded intrahepatic portosystemic covered stent via the percutaneous transhepatic approach. Korean J Radiol 2010; 11:469–471. [Crossref]
9. Pereira K, Baker R, Salsamendi J, Doshi M, Kably I, Bhatia S. An approach to endovascular and percutaneous management of transjugular intrahepatic portosystemic shunt (tips) dysfunction: A pictorial essay and clinical practice algorithm. Cardiovasc Intervent Radiol 2016; 39:639–651. [Crossref]
10. Luo XF, Nie L, Tsauo JW, Wang Z, Tang CW, Li X. Parallel shunt for the treatment of transjugular intrahepatic portosystemic shunt dysfunction. Korean J Radiol 2013; 14:423–429. [Crossref]
11. Raissi D, Yu Q, Nisiewicz M, Krohmer S. Parallel transjugular intrahepatic portosystemic shunt with viatorr(®) stents for primary tips insufficiency: Case series and review of literature. World J Hepatol 2019; 11:217–225. [Crossref]
12. Gwon DI, Ko GY, Yoon HK, et al. Safety and efficacy of percutaneous y-configured covered stent placement for malignant hilar biliary obstruction: A prospective, pilot study. J Vasc Interv Radiol 2012; 23:528–534. [Crossref]
13. Yun JH, Jung GS, Park JG, et al. Malignant hilar biliary obstruction: Treatment by means of placement of a newly designed y-shaped branched covered stent. Cardiovasc Intervent Radiol 2016; 39:582–590. [Crossref]
14. Lefevre T, Louvard Y, Morice MC, Loubeyre C, Piechaud JF, Dumas P. Stenting of bifurcation lesions: A rational approach. J Interv Cardiol 2001; 14:573–585. [Crossref]
15. Dariushnia SR, Haskal ZJ, Midia M, et al. Quality improvement guidelines for transjugular intrahepatic portosystemic shunts. J Vasc Interv Radiol 2016; 27:1–7. [Crossref]
16. Clark TWI, Agarwal R, Haskal ZJ, Stavropoulos SW. The effect of initial shunt outflow position on patency of transjugular intrahepatic portosystemic shunts. J Vasc Interv Radiol 2004; 15:147–152. [Crossref]
17. Bai M, He CY, Qi XS, et al. Shunting branch of portal vein and stent position predict survival after transjugular intrahepatic portosystemic shunt. World J Gastroenterol 2014; 20:774–785. [Crossref]
18. Tsauo JW, Li X. Viatorr tips endoprosthesis versus generic expanded polytetrafluoroethylene-covered stent-grafts. AJR Am J Roentgenol 2015; 205:W463–W463. [Crossref]
19. Miraglia R, Maruzzelli L, Luca A. Recanalization of occlusive transjugular intrahepatic portosystemic shunts inaccessible to the standard transvenous approach. Diagn Interv Radiol 2013; 19:61–65. [Crossref]
20. Dabos KJ, Stanley AJ, Redhead DN, Jalan R, Hayes PC. Efficacy of balloon angioplasty, restenting, and parallel shunt insertion for shunt insufficiency after transjugular intrahepatic portosystemic stent-shunt (tipss). Minim Invasive Ther Allied Technol 1998; 7:287–293. [Crossref]
21. Ahmed M, Keshava SN, Moses V, et al. Transjugular intrahepatic portosystemic shunt through the strut of a previously placed stent: Technical feasibility and long-term follow-up results. Cardiovasc Intervent Radiol 2018; 41:1794–1798. [Crossref]
22. Altenbernd J, Wetter A, Lauenstein T. Ungewöhnliche tips-rekanalisation – ab durch die maschen. Rofo 2014; 187:194–196. [Crossref]
23. Hausegger KA, Tauss J, Karaic K, Klein GE, Uggowitzer M. Use of the left internal jugular vein approach for transjugular portosystemic shunt. AJR Am J Roentgenol 1998; 171:1637–1639. [Crossref]