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# Uncovering the truth about covered stents: is there a difference between covered versus uncovered stents with transjugular intrahepatic portosystemic shunts?

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**KEYWORDS:**
Transjugular intrahepatic portosystemic shunt; Portal hypertension; Surgical shunting; Covered transjugular intrahepatic portosystemic shunt; Variceal bleeding

**Abstract**

**INTRODUCTION:** Polytetrafluoroethylene (PTFE)-covered transjugular intrahepatic portosystemic shunt (TIPS) stents purportedly provide superior patency. This study was undertaken to determine whether covered stents provide better long-term patency and outcomes after TIPSs.

**METHODS:** Patients with portal hypertension undergoing TIPS at a large teaching hospital from 2001 to 2010 were studied. Median data are presented.

**RESULTS:** Two hundred forty-six patients underwent TIPS; 70 received uncovered stents, and 176 received covered stents. Patients who received uncovered stents had more severely impaired liver function (41% were Child class C cirrhotics). The follow-up was longer with uncovered stents (48 vs 24 months, $P < .01$). Reinterventions for stenosis were undertaken in 33% with uncovered stents versus 19% with covered stents ($P = .01$). Shunt dysfunction occurred in 57% with uncovered stents versus 21% covered ($P = .05$). A deterioration of hepatic function occurred in 31% with uncovered stents versus 30% with covered ($P = .32$). Survival with uncovered stents was 31 months versus 33 months with covered stents ($P = .55$, Kaplan-Meier).

**CONCLUSIONS:** Covered stents may improve patency but do not mitigate postshunt hepatic dysfunction and do not improve survival.



The application of a transjugular intrahepatic portosystemic shunt (TIPS) in patients with complicated portal hypertension has become standard practice. A recent randomized controlled trial showed that early TIPS placement is superior to endoscopic band ligation plus sclerotherapy by showing improved 2-year survival rates and lower rates of rebleeding.[1] Today, the application of polytetrafluoroethylene (PTFE)-covered TIPS stents have rapidly been embraced since Food and Drug Administration approval in 2004. The 2005 American Association for the Study of Liver Diseases (AASLD) practice guidelines were revised in 2009 to include the following statement: "PTFE stents are preferred to bare metal stents to lower the risk of shunt dysfunction."[2] There is a substantial body of literature that documents uncovered TIPS stents occlude at unacceptably

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high rates (50% to 80% at 1 year), and this type of shunt dysfunction can precipitate recurrent variceal bleeding.[3–5] We have previously described our findings that support TIPS functions as a large side-to-side portacaval shunt that decreases nutrient-rich or effective hepatic blood flow to the liver.[6–8] Decreased effective hepatic blood flow alters liver physiology, as evidenced by increased encephalopathy and liver failure after the placement of TIPSs.[9] In contrast, small-diameter prosthetic H-graft portacaval shunts are associated with a significantly lower decrease in effective hepatic blood flow.[7] Covered TIPS stents can be more challenging than bare metal TIPS stents to place. Problems with portal vein and hepatic vein stenosis or occlusion, the need for multiple stents to completely cover the outflow tract, and segmental liver ischemia are issues that arise in the context of covered TIPS stents.[9,10] This study was undertaken to better elucidate the purported advantages, if any, of covered TIPS stents. We hypothesized that the decline in hepatic function and survival would be similar between patients receiving covered and uncovered TIPS stents and that covered TIPS stents would provide better short-term shunt patency.

## Materials and Methods

Patients who underwent TIPS from 2001 to 2010 at a large teaching hospital, with an associated transplant program, were studied and maintained in a database that was developed to include all patients who underwent TIPS. Patients who underwent TIPS after liver transplantation were excluded from this study. The decision to use a covered stent was at the discretion of the interventional radiologist. After Food and Drug Administration approval of covered TIPS stents in 2004, all stents placed were PTFE covered. Underlying hepatic function was codified using the model for end stage liver disease (MELD) score, Child-Pugh score, and Child classification. Patients were entered into the database with institutional review board approval. Data were stored in Microsoft Excel (Microsoft Corp, Redmond, WA) files. Statistical analysis was performed by using GraphPad InStat version 3.06 and GraphPad Prism 5 (GraphPad Software, Inc, San Diego, CA). Survival curve analyses were also undertaken on GraphPad Prism 5, which permitted the log-rank and Wilcoxon tests on the Kaplan-Meier survival curves. Deterioration of hepatic function was defined as the development of liver failure, encephalopathy, or hepatorenal syndrome after the placement of a TIPS. Shunt dysfunction was defined as rebleeding and/or angiographic evidence of occlusion/stenosis/thrombosis within the shunt. Where appropriate, data are presented as median, mean ± standard deviation. Nominal comparisons were made using the chi-square test. Nonparametric ordinal data were analyzed using the Mann-Whitney *U* test. *P* values less than .05 were considered significant.

## Results

From 2001 to 2010, 246 patients underwent TIPS; 61% were men with a median age of 56 years. One hundred seventy-six patients (72%) received PTFE-covered TIPS stents, and 70 patients (28%) received uncovered TIPS stents. The etiology of cirrhosis was primarily caused by alcoholism and/or viral hepatitis in both patient populations (Table 1). As measured by Child class but not MELD score

**Table 1** Baseline characteristics of patients

| | Covered stents | Uncovered stents | Total |
|---|---|---|---|
| Number of patients | 176 | 70 | 246 |
| Sex | 106 men/70 women | 45 men/25 women | 151 men/95 women |
| Median age (y) | 56 y | 55 y | |
| Median BMI (kg/m$^2$) | 27 kg/m$^2$ | 26 kg/m$^2$ | |
| Child Class A (%)* | 12 | 0 | *P* value |
| Child Class B (%)* | 75 | 59 | .0001 |
| Child Class C (%)* | 13 | 41 | |
| MELD score† | 11.1 | 12.6 | .248 |
| Child-Pugh score† | 8.0 | 9.0 | .5417 |
| Gradient after TIPS† | 5 | 6 | .999 |
| Gradient before TIPS† | 17 | 19 | .01 |
| Etiology of cirrhosis (%) | | | |
| Alcohol | 27 | 23 | .821* |
| Viral hepatitis | 31 | 24 | |
| Alcohol/viral hepatitis | 18 | 19 | |
| Cryptogenic | 7 | 8 | |
| Other | 17 | 26 | |

*Chi-square test.
†Mann-Whitney *U* test.

or Child-Pugh score, patients receiving uncovered stents had more severely impaired liver function; 41% were of Child class C ($P = .0001$). Most TIPS stents were placed on an elective basis (not in the setting of acute variceal hemorrhage). Most TIPS were undertaken as definitive therapy for portal hypertension; only 14% of patients eventually underwent liver transplant after TIPS. Both covered and uncovered stents effectively reduced the portosystemic gradient after placement (Table 1). The median follow-up for patients receiving covered stents was 19 months (24 ± 21.1) versus 42 months (48 ± 44.7) for those receiving uncovered stents ($P = .0001$).

Shunt dysfunction occurred in 22% of patients with covered TIPS stents and in 57% of patients with uncovered TIPS stents ($P = .05$). Angiographic reinterventions were undertaken for shunt dysfunction, progression of encephalopathy, recurrent and/or refractory ascites, and hepatic failure. Over 50% of these reinterventions were undertaken for stent stenosis, occlusion, or thrombosis in both patient populations. In total, 19% of patients who received covered stents required reinterventions, whereas 33% of patients with uncovered stents required reinterventions ($P = .01$). A deterioration of hepatic function occurred in 30% of patients with covered TIPS stents and 31% of patients with uncovered TIPS stents ($P = .3$). The overall survival for all patients was 33 months with no difference between patients who received covered TIPS stents and those who received uncovered TIPS stents (33 vs 31 months, $P = .5$) (Fig. 1).

## Comments

Covered TIPS are embraced as standard therapy in patients with variceal bleeding and portal hypertension based on data from small numbers of patients followed for relatively short periods. The existing clinical evidence combined with the higher cost associated with covered TIPSs do not yet warrant its acceptance as a gold standard therapy.

Our data indicate that covered TIPS stents provide no survival advantage. This finding is corroborated by other similar studies with shorter follow-up, including a randomized controlled trial.[11–13] Also, consistent with the findings of other recently published data, we found that patients receiving covered TIPS stents require less interventions, which is a reflection of less stenosis and thrombosis within the stent.[11,12] We did not see a difference in the rates of deterioration of hepatic function between patients receiving uncovered TIPS stents (31%) and patients receiving covered TIPS stents (30%, $P =$ not significant). This is not surprising given the alterations in hepatic physiology that TIPS induces and the predictable loss of hepatic function over time most of these patients experience.[14]

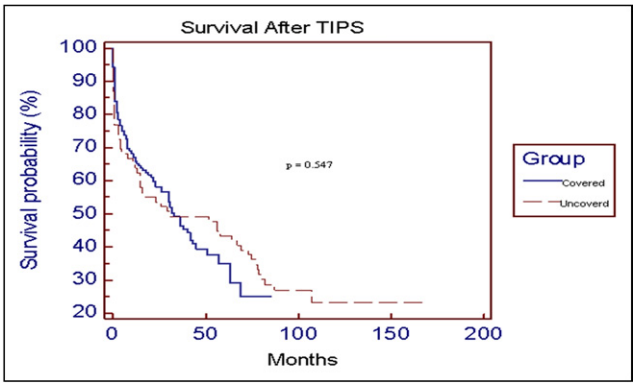


**Figure 1** Kaplan-Meier survival analysis of patients undergoing covered versus uncovered TIPSs.

The 2009 AASLD update has undoubtedly influenced many clinicians to use a covered TIPS stent over a bare metal TIPS stent. It is noteworthy that the coauthors of the 2009 AASLD guidelines are paid consultants by WL Gore (Delaware, USA), the manufacturers of the PTFE-covered Viatorr TIPS stent. Interestingly, the recommendation to use a covered TIPS stent in these guidelines is based on data from 2 studies, both of which used the Viatorr device in every single patient undergoing PTFE-covered TIPS.[11,15]

Improved intrashunt patency comes at a substantial cost. The creation of a covered TIPS requires the covered portion of the stent to extend from the intrahepatic portion of the liver through the hepatic vein until the inferior vena cava is reached; many times, 2 stent devices are required. One recent study noted that 68% (106/157) of patients undergoing covered TIPS required more than 1 stent.[12] On average, covered TIPS stents cost between 2 and 2.5 times that of bare metal stents, so the use of 2 of these devices would result in up to a 5-fold increase in cost, not to mention the additional time under anesthesia, dye load, and fluoroscopy required. The authors eagerly await the results of an ongoing cost analysis trial in France comparing covered TIPS stents with uncovered stents.

The malposition of covered TIPS stents has resulted in a distinct new subset of complications. Bureau et al[10] reported up to a 5% rate of segmental liver ischemia after the placement of a covered TIPS. This complication is the result of hepatic venous outflow obstruction from the covered portion of the stent. Although occlusion inside the covered portion of the stent is rare, hepatic vein and portal vein stenoses are rather frequent with covered TIPS stents.[13] One article noted with covered versus uncovered TIPS stents, a 50% versus 9% hepatic vein stenosis rate and a 33% versus 3% portal vein stenosis rate, respectively.[13]

We have established that covered TIPS stents do not slow the onset of hepatic dysfunction and do not promote a survival advantage, but they probably have better short-term patency rates. The real, unresolved issue remaining with covered TIPS stents is cost, not outcomes. It is unclear if the need for less intervention in the short-term is justified by the increased cost associated with using covered TIPS stents. The need for one or more expensive devices, longer procedure times, and no survival or hepatic functional advantage seems like a "long run for a short slide." In the future, larger

randomized trials of covered TIPS stents versus uncovered TIPS stents including long term follow-up and cost analysis are needed before the establishment of a new gold standard can be made.

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