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ORIGINAL ARTICLE

Original Study: Transjugular Intrahepatic Portosystemic Shunt as a Bridge to Abdominal Surgery in Cirrhotic Patients

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Abstract

Background Transjugular intrahepatic portosystemic shunt (TIPS) has been suggested to reduce portal hypertension-associated complications in cirrhotic patients undergoing abdominal surgery. The aim of this study was to compare postoperative outcome in cirrhotic patients with and without specific preoperative TIPS placement, following elective extrahepatic abdominal surgery.

Methods Patients were retrospectively included from 2005 to 2016 in four centers. Patients who underwent preoperative TIPS ($n = 66$) were compared to cirrhotic control patients without TIPS ($n = 68$). Postoperative outcome was analyzed using propensity score with inverse probability of treatment weighting analysis.

Results Overall, colorectal surgery accounted for 54% of all surgical procedure. TIPS patients had a higher initial Child-Pugh score (6[5–12] vs. 6[5–9], $p = 0.043$) and received more beta-blockers (65% vs. 22%, $p < 0.001$). In TIPS group, 56 (85%) patients managed to undergo planned surgery. Preoperative TIPS was associated with less postoperative ascites (hazard ratio = 0.330 [0.140–0.780]). Severe postoperative complications (Clavien-Dindo > 2) and 90-day mortality were similar between TIPS and no-TIPS groups (18% vs. 23%, $p = 0.392$, and 7.5% vs. 7.8%, $p = 0.644$, respectively).

Conclusions Preoperative TIPS placement yielded an 85% operability rate with satisfying postoperative outcomes. No significant differences were found between TIPS and no-TIPS groups in terms of severe postoperative complications and mortality, although TIPS patients probably had worse initial portal hypertension.

Keywords Cirrhosis · Abdominal surgery · Colorectal surgery · Preoperative TIPS · Postoperative outcome

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Introduction

Prevalence of cirrhosis has been estimated at 300 per 100,000 population in a French screening program and its annual incidence at 15.3–132.6 per 100,000 population in the UK and Sweden.[1] Patients presenting with compensated cirrhosis have an estimated mortality rate of 1 to 3.4% per year[1] and are therefore likely to require emergent or elective extrahepatic abdominal surgery.

Extrahepatic abdominal surgery is associated with higher postoperative morbidity and mortality in cirrhotic patients. Reported postoperative mortality varies between 0 and 17% in Child-Pugh (CP) class A, 10 and 54% in CP-B, and 40–100% in CP-C patients. Reported postoperative morbidity is around 30% in CP-A, 42% in CP-B, and more than 80% in CP-C patients.[2, 3] Risk factors for postoperative morbidity and mortality are emergent surgery, preoperative ascites, decreased serum sodium levels, severe comorbidities (renal and cardiopulmonary), and

decompensated cirrhosis.[4, 5] Many authors have also reported that cirrhotic patients who presented with portal hypertension (PHT) had worse postoperative outcomes than cirrhotic patients without PHT and had increased intra- and postoperative bleeding and blood transfusion requirement.[2–6]

Currently, transjugular intrahepatic portosystemic shunt (TIPS) placement is recommended by the American Association for the Study of Liver Diseases in secondary prevention of variceal bleeding and refractory ascites.[7] Although there are no clear recommendations regarding preoperative TIPS, some authors suggested its placement as a bridge to surgery in patients presenting with severe PHT in order to reduce the risk of perioperative bleeding and postoperative ascites. Although the concept seems appealing, the safety and effectiveness of elective preoperative TIPS placement have yet to be proven. Recently, a systematic review summarized the evidence on the use of TIPS as a preparation for extrahepatic surgery in cirrhotic patients with PHT (mainly including case reports and small cohorts leading to a total of 64 patients) and concluded in favor of this two-step strategy.[8] However, no comparative study has yet been published.

The aim of this study was to compare the morbidity and mortality following elective extrahepatic abdominal surgery between cirrhotic patients with preoperative TIPS placement (in a bridge to surgery setting) and cirrhotic patients without TIPS.

Materials and Methods

Patients' Selection

Cirrhotic patients who underwent TIPS placement (TIPS group) in the perspective of elective extrahepatic abdominal surgery were retrospectively included between 2005 and 2016 from four French tertiary centers. Surgical procedures were divided into five categories: (i) colorectal surgery, (ii) cholecystectomy, (iii) abdominal wall repair, (iv) upper gastrointestinal (GI) and pancreatic surgery, and (v) other abdominal procedures (urology and vascular surgery). Patients who had either emergent surgery or liver surgery including liver transplantation and patients who had a past history of TIPS placement (i.e., before the elective abdominal surgery was planned) were not included. Cirrhotic patients who underwent the same type of elective surgical procedures without previous TIPS placement were included during the same period in the four centers as a control group (no-TIPS group). This retrospective study was approved by the regional ethics comity and was declared to the French Data Protection Authority.

TIPS Procedure

Conventional technique is described elsewhere.[7, 9] In all four centers, 20 to 130 TIPS procedures per year were performed and a bridge to surgery setting was regularly decided in a multidisciplinary meeting including surgeons and hepatologists. Transjugular intrahepatic portosystemic shunt placement was suggested in patients with histologically confirmed cirrhosis who presented with previous history of complicated PHT (ascites and/or variceal rupture) and signs of PHT such as varicose upon upper endoscopy or imaging.[8, 10, 11] Obstacles to TIPS placement were sought out as recommended.[7, 12] The TIPS patency was preoperatively tested in all patients using ultrasonography.

Data Collection

Data were retrieved from the clinical files in each center. Child-Pugh score and Model for End-stage Liver disease and serum sodium concentration (MELDNa) scores were calculated according to the clinical assessment and biological values.[13, 14] Since January 2016, the original MELD score has been replaced by the Organ Procurement and Transplantation Network by MELDNa score (to include sodium serum value). The MELDNa takes into account serum sodium concentration, which has been reported as a morbidity and mortality risk factor when decreased. In our study, MELDNa cutoff was set at 15, which represents a 6% estimated postoperative mortality in cirrhotic patients undergoing extrahepatic surgical procedures.[15, 16] Child-Pugh score and MELDNa deltas represented score variations between the postoperative and immediate preoperative period. Cutoff was set at ≥ 2 for CP delta and ≥ 3 for MELDNa delta. Ascites was diagnosed through imaging (ultrasound or computed tomography) and/or paracentesis.

Patient Evaluation

In no-TIPS group, clinical and biological data were collected (i) preoperatively (up to 7 preoperative days) and (ii) in the postoperative course (between the third and seventh postoperative day). For patients in the TIPS group, clinical and biological data were collected at (i) initial assessment (decision to plan an elective extrahepatic abdominal surgery, before TIPS placement), (ii) preoperatively (up to 7 preoperative days), and (iii) in the postoperative course (between the third and seventh postoperative day) (supplementary material, S1). Varicose grading (0 to 3) according to the North Italian Endoscopic Index classification and hepatic venous pressure gradient (HVPG) (before and after stenting) were collected in all patients in TIPS group.[17] HVPG measurement was not available for patients in the no-TIPS group.

Intra- and Postoperative Course

Intraoperative and postoperative parameters were as follows: (i) intraoperative red blood cell (RBC) transfusion requirement, (ii) postoperative RBC transfusion requirement during inhospital stay, (iii) severe postoperative complications (> 2 according to the Clavien-Dindo classification[18]), (iv) 30- and 90-day postoperative mortality, (v) and the need for intensive care unit (ICU) stay. Postoperative hepatocellular insufficiency was diagnosed using the "50-50" criteria (prothrombin time < 50% and serum bilirubin > 50 μml/l) on postoperative day 5.[19] Postoperative sepsis was searched for if any sign of infection occurred (body temperature > 38 or < 36 °C and white blood cell count > 12×10^9/l or < 4×10^9/l).[20]

Statistical Analysis

Statistical analysis was carried out using SPSS (version 20.0; IBM, Chicago, IL). Continuous variables are presented as median (range) and categorical variables as absolute numbers (percentages). The Student *T* test or Mann-Whitney test was used to compare continuous variables accordingly. Chi-square test or Fisher's exact test was used to compare categorical variables accordingly. Statistical significance was set at $p < 0.05$. TIPS patients were compared to no TIPS patients, and in order to overcome biases owing to the different distributions of covariates among patients with or without TIPS, a propensity score analysis with inverted propensity treatment weighting (IPTW) was carried out.[21, 22]

A propensity score with IPTW analysis of all patients who underwent surgery was carried out taking into account CP score, MELDNa score, presence of abdominal ascites at initial assessment, and type of surgical procedure to calculate the propensity score. Surgical procedures were considered at high risk of postoperative morbidity and mortality (colorectal surgery, upper GI and pancreatic surgery, and other urology and vascular procedures) or at low risk (cholecystectomy and abdominal wall repair). These factors were chosen because they were most likely to influence decision to perform preoperative TIPS. Propensity scores with and without IPTW are listed for all patients in supplementary material S2.

A subgroup analysis was carried out and propensity score was calculated, taking into account the following: (i) CP and MELDNa scores as well as presence of abdominal ascites at initial assessment for colorectal surgery subgroup; (ii) CP and MELDNa scores as well as presence of abdominal ascites at initial assessment and type of surgical intervention for HVPG subgroups (cutoff set at 13 mmHg, which represented median HVPG); (iii) MELDNa score, presence of abdominal ascites at initial assessment, and type of surgical procedure for CP subgroups; and (iv) CP score, presence of abdominal ascites, and type of surgical procedure for MELDNa subgroups.

Propensity score with IPTW analysis required generalized estimating equations in order to analyze effect of TIPS on postoperative outcome. Balance diagnostics were carried out to examine variables' distribution before and after IPTW. TIPS and no-TIPS groups were considered balanced if absolute standardized difference was inferior to 10 (reported in supplementary material S3).[23]

Results

Patients' Characteristics, Baseline Parameters, and Surgical Procedures (*n* = 134, Table 1, Fig. 1)

Mean number of procedures performed in all four centers was 40 [20–130]. During the study period, 66 patients were included in TIPS group and 68 in no-TIPS group. Median CP score was higher in TIPS group (6[5–12] vs. 6[5–9], $p = 0.043$) whereas MELDNa score was similar between both groups. Patients were older in no-TIPS group (65.8 vs. 60.9 years, $p = 0.002$). Ascites was present in 30% of patients in each group. PHT was more important in TIPS group, which translated into more beta-blocker users and more severe esophageal varicose (grades 1 to 3) compared to that in no-TIPS group. Median follow-up was of 29.2 months (0.5–180.0). Colorectal surgery accounted for 52% of procedures in TIPS group and 56% in no-TIPS group.

Analysis of Patients in the TIPS Group (*n* = 66, Table 2)

All centers mostly used polytetrafluoroethylene-covered stents. Median stent diameter was 8.0 [6–10] mm. The TIPS patency was preoperatively confirmed in the entire group although two patients required recalibration (for severe hepatic encephalopathy and worsened cirrhosis) and one revision. The presence of TIPS led to a significant reduction of PHT and ascites. Child-Pugh and MELDNa scores increased significantly after TIPS placement. Ten patients (15%) presented with hepatic encephalopathy and one patient (1.5%) presented with hepatocellular insufficiency. Three patients (4.5%) presented with various digestive bleeding. Ten patients (15%) never underwent planned surgery (Fig. 1). Failure to complete planned surgery was mainly related to (i) persistent PHT (surgeon dependent factor, *n* = 3), (ii) TIPS-related complications, and (iii) underlying pathology evolution (*n* = 1; Fig. 1, Table 2). All other patients (*n* = 56) were operated on after a median of 40 [6–188] days.

Intra- and Postoperative Outcomes of All Patients Who Underwent Surgery (*n* = 124, Table 3)

Preoperative TIPS placement was not associated with reduced 30-day and 90-day postoperative mortality rates (hazard ratio (HR) = 0.650 [95%CI 0.260–1.780], and HR = 0.720 [0.180–2.920], respectively) or reduced severe postoperative

Table 1 Patients' characteristics and surgical procedures at initial assessment (before TIPS in TIPS group and preoperatively in no-TIPS group, raw analysis)

	TIPS ($n = 66$)	No TIPS ($n = 68$)	p
Age (years)	60.9 (38.0–81.0)	65.8 (42.0–80.0)	*0.002*
Male, *n* (%)	50 (75.8)	54 (79.4)	0.612
BMI (kg/m^2)	26.8 (15.8–42.0)	26.7 (16.7–54.5)	0.919
Underlying hepatopathy, *n* (%)			0.450
• Alcohol	53 (80.3)	50 (73.5)	
• Hepatitis C	6 (6.8)	7 (10.2)	
• NASH	4 (6)	3 (4.4)	
• Other*	3 (3.4)	8 (11.8)	
Elevated blood pressure, *n* (%)	23 (39)	38 (55.8)	0.057
Obstructive chronic bronchitis, *n* (%)	8 (13.6)	5 (7.4)	0.250
Beta-blocker treatment**, *n* (%)	38 (65.5)	11 (22.4)	*0.001*
Ischemic cardiomyopathy, *n* (%)	13 (22.3)	13 (19.1)	0.685
Diabetes mellitus, *n* (%)	22 (37.3)	24 (35.3)	0.774
Chronic renal failure***, *n* (%)	3 (4.5)	5 (7.2)	0.506
Child-Pugh score	6 (5–12)	6 (5–9)	*0.043*
Child-Pugh category, *n* (%)			0.303
• A (5–6)	40 (60.6)	47 (69.1)	
• B (7–9)	24 (36.4)	21 (30.9)	
• C (10–15)	2 (3)		
MELD score	11 (6–21)	11 (6–25)	0.376
MELDNa score	18.1 (9.7–29.7)	18.1 (8.6–28.5)	0.535
Ascites, *n* (%)	20 (30.3)	21 (30.9)	0.987
Varicose, *n* (%)			*< 0.001*
• 0	8 (14.3)	26 (54.2)	
• 1	8 (14.3)	8 (16.7)	
• 2	19 (33.9)	12 (25)	
• 3	21 (37.5)	2 (4.2)	
Surgery, *n* (%)			0.197
• Colorectal	34 (51.5)	38 (57.4)	
• Upper GI and pancreatic surgery	12 (18.2)	4 (5.9)	
• Hernia and incisional hernia	9 (13.6)	9 (13.2)	
• Cholecystectomy	5 (7.6)	10 (14.7)	
• Other****	6 (9.1)	7 (10.2)	

p values were written in italic characters when they were considered significant ($p<0.005$)

BMI body mass index, *NASH* non-alcoholic steatohepatitis, *MELDNa* model for end-stage liver disease with sodium serum value incorporated, *GI* gastrointestinal

*Other underlying hepatopathies included hemochromatosis, hepatitis B virus infection, and Wilson's disease

**Beta-blocker treatment present at initial assessment

***Chronic renal failure indicated renal clearance < 60 ml/min without renal epuration

****Other surgery categories indicated urology and vascular surgical procedures

complications (HR = 0.670 [0.270–1.680]). Preoperative TIPS placement was associated with reduced postoperative ascites (HR = 0.330 [0.140–0.780]) and increased MELDNa delta (HR = 2.320 [1.020–5.280]).

Intra- and Postoperative Outcomes in Colorectal Surgery Subgroup ($n = 68$, Table 4)

Preoperative TIPS placement was not associated with reduced 90-day postoperative mortality or severe postoperative complications but was associated with increased intraoperative RBC transfusion requirement (HR = 15.030 [1.710–132.170]). Ten patients in TIPS group and eight in no-TIPS group had simultaneous stoma placement ($p = 0.108$). Main postoperative complications consisted of anastomotic fistula (three TIPS patients vs. seven no TIPS patients, $p = 0.494$), incisional hernia (three TIPS patients vs. one no TIPS patient, $p = 0.314$), and incisional abscess (three TIPS patients and four no TIPS patients, $p = 1.000$).

Intra- and Postoperative Outcomes According to HVPG Category at Initial Assessment (TIPS + HVPG $\leq$ 13 mmHg, $n = 30$; TIPS + HVPG > 13 mmHg, $n = 25$; No-TIPS Group, $n = 68$; Supplementary Material S4)

In HVPG $\leq$ 13 mmHg and HVPG > 13 mmHg subgroups, preoperative TIPS placement was not associated with reduced 90-day postoperative mortality or severe postoperative complications. Preoperative TIPS placement was however associated with increased postoperative sepsis and intraoperative

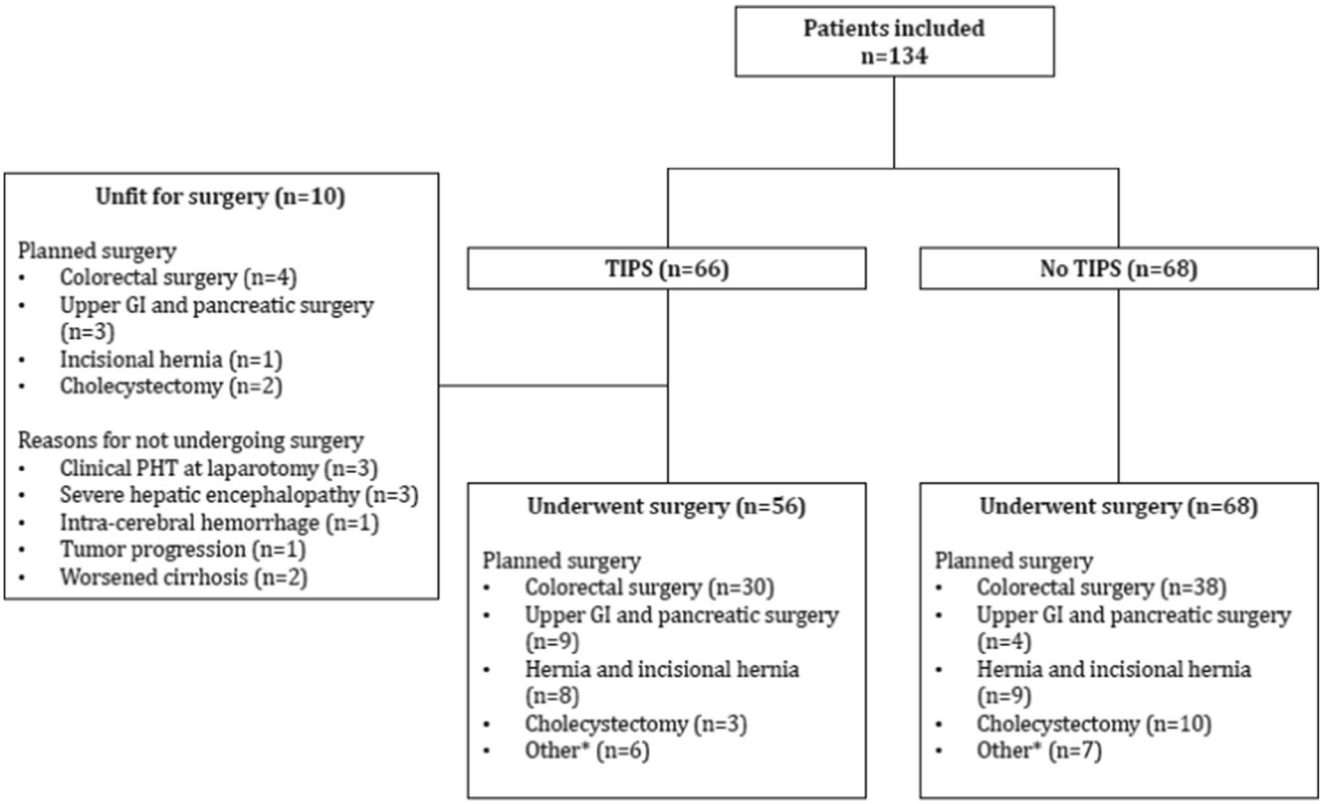

Fig. 1 Flow Chart. TIPS transjugular intrahepatic portosystemic shunt, PHT portal hypertension, GI gastrointestinal, Other* includes abdominal non-digestive surgical procedures (vascular and urological surgeries)

RBC transfusion requirement in HVPG > 13 mmHg subgroup (HR = 2.820 [1.020–7.760] and HR = 4.100 [1.160–14.470], respectively).

Intra- and Postoperative Outcomes According to MELDNa Category at Initial Assessment (MELDNa ≤ 15, *n* = 26; MELDNa > 15, *n* = 96, Supplementary Material S5)

Considering initial assessment (before TIPS procedure in TIPS group and preoperatively in no-TIPS group), in MELDNa ≤ 15 and MELDNa > 15 subgroups, preoperative TIPS placement was not associated with reduced 90-day postoperative mortality or severe postoperative complications. Preoperative TIPS placement did not affect perioperative RBC transfusion requirements in MELDNa ≤ 15 or MELDNa > 15 patients.

Intra- and Postoperative Outcomes in Subgroups According to CP Score at Initial Assessment (CP-A, *n* = 83; CP-B, *n* = 40; Supplementary Material S6)

No differences were found between TIPS and no TIPS patients regarding postoperative outcome in CP-A and CP-B subgroups.

Intra- and Postoperative Outcomes in TIPS Patients According to Time Lapse Between TIPS Placement and Surgical Procedure (Supplementary Material S7)

CP and MELDNa scores at initial assessment were significantly higher in patients who underwent surgery > 40 days following TIPS placement, compared to those who underwent surgery < 40 days ($p = 0.033$ and $p = 0.027$, respectively). No difference was found between both groups regarding postoperative outcome.

Discussion

Transjugular intrahepatic portosystemic shunt placement in cirrhotic patients is safe and feasible as a bridge to elective surgery and successful in reducing postoperative ascites. However, this study did not demonstrate a significant benefit in terms of severe postoperative complications and perioperative RBC transfusion requirement.

In TIPS group, deterioration of hepatocellular function was noted (elevated CP and MELDNa scores) along with new hepatic encephalopathy (15%) after TIPS placement. This is in accordance with current reported incidence.[24] In addition, our results show that this adverse side effect of TIPS placement persisted postoperatively (CP and MELDNa deltas)

Table 2 TIPS patients: clinical and biological assessment before and after TIPS placement ($n = 66$)

	Before TIPS	After TIPS	*p*
Child-Pugh score	6 (5–12)	7 (5–12)	*0.028*
Child-Pugh category, *n* (%)			*0.001*
• A (5–6)	40 (60.6)	28 (43.8)	
• B (7–9)	24 (36.4)	32 (50)	
• C (10–15)	2 (3)	4 (6.2)	
MELDNa score	18.1 (9.7–29.7)	20.1 (13.8–33.3)	*0.001*
Ascites, *n* (%)	17 (25.7)	12 (18.2)	*0.018*
HVPG (mmHg)	13.8 (6.0–23.0)	5.4 (1.0–11.0)	*0.001*
Total bilirubin (μml/l)	18.5 (5.0–95.0)	29.0 (7.4–105.0)	*0.001*
Platelet count (10^6/l)	122,500 (42,000–339,000)	116,000 (43,000–292,000)	0.051
Albumin (g/l)	35.0 (24.0–47)	33.0 (20.0–45.0)	*0.001*
Prothrombin time (%)	69.0 (27.0–96.0)	65.0 (25.0–93.0)	*0.001*

p values were written in italic characters when they were considered significant ($p<0.005$)

MELDNa model for end-stage liver disease with sodium serum value incorporated, *HVPG* hepatic venous pressure gradient

despite being performed in expert centers[25] and a mean interval of 51 days between TIPS placement and planned surgery.

Preoperative TIPS placement was associated with increased intraoperative RBC transfusion requirement in colorectal surgery and HVPG > 13 mmHg subgroups, but with a relatively weak lower endpoint of the 95% confidence interval. Owing to the retrospective and multi-institutional nature of this study, the intraoperative blood losses and number of RBC packs were not available for most patients (exact quantification of intraoperative blood loss and specific transfusion characteristics, which were manually transcribed into patient files in two centers, were not found during file reviewing). Results should therefore be carefully interpreted and solid conclusions can hardly be drawn on this specific point. Nonetheless, this result remains surprising

Table 3 Postoperative outcome analysis of TIPS and no-TIPS groups using IPTW

	TIPS ($n = 56$)	No TIPS ($n = 68$)	HR	IC 95%	*p*
30-day postoperative mortality, *n* (%)	1 (1.8)	2 (3)	0.650	0.260–1.780	0.355
90-day postoperative mortality, *n* (%)	4 (7.5)	5 (7.8)	0.720	0.180–2.920	0.644
Severe postoperative complications, *n* (%)	10 (17.9)	16 (23.2)	0.670	0.270–1.680	0.392
ICU stay, *n* (%)	17 (31.5)	17 (24.6)	1.070	0.407–2.420	0.878
Postoperative sepsis, *n* (%)	19 (33.9)	22 (32.4)	0.920	0.410–2.020	0.828
Perioperative RBC transfusion requirement, *n* (%)	17 (30.4)	9 (13.2)	1.940	0.640–5.890	0.240
Intraoperative RBC transfusion requirement, *n* (%)	11 (20.4)	6 (9)	1.960	0.650–5.910	0.232
Postoperative hemorrhage, *n* (%)			1.230	0.410–3.720	0.716
• Intra-abdominal	13 (23.2)	5 (7.4)			
• Digestive	2 (3.6)	4 (5.9)			
Redo surgery, *n* (%)	9 (16.4)	9 (13.2)	1.060	0.370–3.040	0.909
Postoperative ascites, *n* (%)	11 (20.4)	26 (38.2)	0.330	0.140–0.780	*0.012*
Postoperative hepatocellular insufficiency, *n* (%)	8 (14.5)	2 (2.9)	4.460	0.870–22.860	0.073
CP delta	2.0 (− 2.0–8.0)	1.0 (− 2–8)	2.030	0.940–4.380	0.072
MELDNa delta	4.1 (− 5.7–31.9)	1.3 (− 7.7–18.4)	2.320	1.020–5.280	*0.046*

Propensity score was calculated using MELDNa score, CP score, and presence of ascites at initial assessment as well as type of surgery

p values were written in italic characters when they were considered significant ($p<0.005$)

MELDNa model for end-stage liver disease with sodium serum value incorporated, *CP* Child-Pugh score, *ICU* intensive care unit, *RBC* red blood cells

Table 4 Colorectal surgery group analysis using IPTW

	TIPS ($n = 30$)	No TIPS ($n = 38$)	HR	95%CI	p
90-day postoperative mortality (n)	1	4	0.260	0.030–2.500	0.243
Severe postoperative complications (n)	4	11	0.400	0.110–1.490	0.172
ICU stay (n)	7	10	0.780	0.250–2.470	0.671
Postoperative sepsis (n)	11	17	0.650	0.230–1.850	0.421
Perioperative RBC transfusion (n)	8	4	1.110	0.250–5.020	0.893
Intraoperative RBC transfusion (n)	8	1	15.030	1.710–132.170	*0.015*

Propensity score was calculated using Child-Pugh score, MELDNa score, and presence of ascites at initial assessment

p values were written in italic characters when they were considered significant ($p<0.005$)

MELDNa model for end-stage liver disease with sodium serum value incorporated, *ICU* intensive care unit, *RBC* red blood cells

because TIPS placement was decided with the specific aim to reduce bleeding during surgery. One possible explanation would be that liver function and coagulopathy were more altered postoperatively in TIPS group compared to those in no-TIPS group (CP and MELDNa deltas). Indeed, there seemed to be more cases of postoperative hepatocellular insufficiency although this result did not reach statistical significance (HR = 4.460 [0.870–22.860]). This highlights the importance of perioperative anesthetic care, especially in patients presenting with post-TIPS coagulopathy; preoperative TIPS placement should be taken into consideration in perioperative management strategy.

Preoperative TIPS placement leads to a significant reduction in HPVG and postoperative ascites, but this did not clearly translate into better postoperative outcomes (90-day mortality and severe postoperative complications). A subset of patients with less severe PHT (HVPG ≤ 13 mmHg) and less advanced underlying hepatopathy (MELDNa ≤ 15) seemed to benefit from preoperative TIPS placement in terms of severe postoperative complications although these results did not reach statistical significance (HR = 0.210 [0.050–1.020] and HR = 0.160 [0.030–1.050], respectively), probably due to an insufficient number of patients.

During the study period, all cirrhotic patients who underwent elective extrahepatic abdominal surgery in the four centers were not included in control group, and this would have represented an important bias if not for IPTW analysis. Indeed after weighing, both groups could be considered similar regarding variables used to calculate propensity score (CP and MELDNa scores, ascites, and surgical procedures). These variables were chosen because they were considered critical by all four centers in the decision to place preoperative TIPS. Nonetheless, 70% of TIPS patients had varicose grade 2 or 3 whereas 70% of patients without TIPS placement had grade 0 or 1 (Table 1, $p < 0.001$), and significantly, more TIPS patients received beta-blocker treatment. Because HVPG and varicose development are correlated (Lee et al.), these results most likely indicate that TIPS group presented with more severe PHT. Unfortunately, HVPG, which is considered as an invasive measure,[26] was not available in patients without TIPS placement.

Patients who underwent surgery less than 40 days following TIPS placement presented with more severe underlying hepatopathy (CP and MELDNa scores). Despite surgical heterogeneity, the fact that no differences were found in terms of postoperative outcomes might indicate that postponing surgery to > 40 days following TIPS placement might be beneficial. Low patient volume and data heterogeneity are to take into account in the interpretation of these results.

Currently, there is no robust evidence to support systematic preoperative TIPS placement. Recently, a systematic review including 64 patients (from 19 studies)[8] and a conference consensus on TIPS management including a brief summary on unusual TIPS indications such as before general surgery[12] were published. Most of the published series analyzed in these reports were descriptive. TIPS were not always specifically preoperatively placed, and some studies analyzed outcomes in patients who had previous TIPS placement and those who had specific preoperative placement alike. Furthermore, few series had a control group.[11, 27]

To our knowledge, this is the largest multicenter series to address the issue of TIPS in a bridge-to-surgery setting. Several points need to be underlined. Because of its retrospective and multi-institutional nature as well as a study period spanning over 11 years, the indication for preoperative TIPS placement varied between centers and in time. Clear preoperative TIPS placement indications cannot be drawn from current data. The TIPS management and time lapse between TIPS placement and surgical procedure also varied according to physicians and center habits. Despite these limitations, TIPS placement allowed for 56 (85%) patients to undergo planned surgery, with favorable postoperative morbidity and mortality rates.[2, 3] Furthermore, with postoperative ascites significantly reduced in TIPS group, events such as postoperative albumin transfusion and overall inhospital stay might have been favorably affected, but due to lacking data, conclusions cannot be drawn regarding these points. Although comparative analysis

between TIPS patients and no TIPS patients was performed using IPTW in order to reduce the selection bias usually associated with retrospective studies, chosen variables do not entirely reflect the complexity of the clinical situation.

Transjugular intrahepatic portosystemic shunt placement yielded an 85% operability rate with satisfying postoperative outcomes. No significant differences were found between TIPS and no-TIPS groups in terms of severe postoperative complications and mortality, although TIPS patients probably had a worse initial PHT. Our results suggest that preoperative TIPS placement might reduce severe postoperative complications in patients with mild hepatopathy (MELDNa ≤ 15 and HVPG ≤ 13 mmHg), but more robust evidence is required to draw conclusions.

Authorship NT collected the data, did the statistical analysis, and wrote the manuscript.

LB supervised statistical analysis and wrote the manuscript.

BM, FM, NF, LdA, PJV, JD, AA, and JL collected the data and corrected the manuscript.

CB and ES designed the study and corrected the manuscript.

Compliance with Ethical Standards

This retrospective study was approved by the regional ethics comity and was declared to the French Data Protection Authority.

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