TIPS FOR CONTROLLING PORTAL HYPERTENSION COMPLICATIONS: EFFICACY, PREDICTORS OF OUTCOME AND TECHNICAL VARIATIONS*

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Abstract **OBJECTIVE: To evaluate the efficacy of TIPS (transjugular intrahepatic portosystemic shunt) for resolving clinical complications in patients with portal hypertension. MATERIALS AND METHODS: Forty-four caucasian patients, 30 men and 14 women, with a mean age of 52 years have been evaluated. Indication for TIPS has been gastrointestinal hemorrhage in 28 patients, and refractory ascites in 16. There has been 7 Child-Pugh A patients, 24 Child-Pugh B, and 11 Child-Pugh C. RESULTS: TIPS was successfully performed in all the patients (100%), with a decrease in the mean portosystemic pressure gradient of about 49.69% (from 18.98 mmHg to 9.55 mmHg). A clinical improvement was observed in 35 patients (79.55%). The general postoperative mortality rate was 13.64%, with higher incidence in Child-Pugh C patients (45.45%). The most relevant factors associated with a poor prognosis were increase in bilirubin and creatinine seric levels. The mean survival time was 11.5 months for Child-Pugh A patients, 10.97 months for Child-Pugh B patients, and just 5.9 months for Child-Pugh C patients. Complications directly related to the procedure have been observed in nine cases (20.44%). CONCLUSION: TIPS is efficient to reduce portosystemic pressure. TIPS-related complications and morbidity-mortality may be considered as acceptable. In the present study, mortality has been directly influenced by some clinical factors such as Child-Pugh class C, and increased bilirubin and creatinin seric levels.**

Keywords: Portal hypertension; Cirrhosis; TIPS; Esophageal varices bleeding; Ascites.

Resumo *TIPS para o controle das complicações da hipertensão portal: eficácia, fatores prognósticos associados e variações técnicas.*

OBJETIVO: Avaliar a eficácia do TIPS (*transjugular intrahepatic portosystemic shunt*) para tratar as complicações clínicas em pacientes com hipertensão portal. MATERIAIS E MÉTODOS: Quarenta e quatro pacientes, sendo 30 do sexo masculino e 14 do feminino e com idade média de 52 anos foram analisados. A indicação para realização de TIPS foi hemorragia gastrintestinal em 28 e ascite refratária em 16. Houve 7 pacientes Child-Pugh A, 24 Child-Pugh B e 11 Child-Pugh C. RESULTADOS: O TIPS foi realizado com sucesso em todos os pacientes (100%), verificando-se queda do gradiente pressórico porto-sistêmico médio de 49,69% (de 18,98 mmHg para 9,55 mmHg). Comprovou-se melhora clínica em 35 pacientes (79,55%). A mortalidade pós-operatóriaia foi de 13,64%, sendo mais incidente nos pacientes Child-Pugh C (45,45%). Os fatores mais relevantes de mau prognóstico foram o aumento da bilirrubina e do nível de creatinina. A sobrevida média de pacientes Child-Pugh A foi de 11,5 meses, nos Child-Pugh B foi de 10,97 meses e nos Child-Pugh C foi de apenas 5,9 meses. Foram observadas complicações em nove casos (20,44%). CONCLUSÃO: O TIPS é eficiente para reduzir a pressão portal. As complicações e a morbi-mortalidade relacionadas com o procedimento podem ser consideradas aceitáveis. A mortalidade foi influenciada por alguns fatores clínicos, tais como classe Child-Pugh C e elevação dos níveis séricos de bilirrubina e creatinina.

Unitermos: Hipertensão portal; Cirrose; TIPS; Sangramento por varizes esofagianas; Ascite.

INTRODUCTION

TIPS (transjugular intrahepatic portosystemic shunt) is a radiological percutaneous procedure consisting of establishing an intrahepatic communication between a branch of the portal vein and the inferior vena cava, aiming at decompressing the portal vein, and, therefore, controlling clinical complications resulting from the portal hypertension in patients with chronic hepatopathy. Under the technical point of view, TIPS is considered as one of the most challenging procedures in interventional radiology, for combining several techniques such as angiography, parenchymal viscus puncture, angioplasty, handling of stents, embolization, etc. The TIPS idea was initially conceived as an extension of the transjugular cholangiography, late in the sixties by radiologists at Oregon University, in Portland, USA[1,2]. However, its clinical application started to be universally developed only with the publication of the first case in 1989[3]. Since then, the technique has been refined, indications have been defined, and its effectiveness has been well documented in large series[4–8]. Presently, TIPS represents a great contribution developed by Radiologists as a minimally invasive alternative for treating patients with portal hypertension syndrome.

The present study describes an experience performed by a single operator in a

* Study developed at Hospital Santa Catarina – Service of Interventional Radiology, São Paulo, SP, Brazil.

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single institution, and discusses, under a technical and clinical viewpoint, indications and factors which might influence the results of the procedure.

MATERIALS AND METHODS

This was a retrospective, descriptive study consisting in a review of all the cases of patients submitted to TIPS performed by a single operator, in a single institution (Hospital Santa Catarina, São Paulo, SP, Brazil), during an eight-year period (1996–2004). In total, 44 patients (30 men and 14 women), with ages ranging between 34 and 67 years (mean age 52 years), were submitted to TIPS.

All of the patients presented with chronic hepatopathy and portal hypertension, the base disease being alcoholic cirrhosis in 22, chronic hepatitis B in 7, chronic hepatitis C in 4, autoimmune cirrhosis in 1, biliary cirrhosis in 2, and cryptogenic cirrhosis in 8. The main symptom originating the treatment for portal hypertension was: gastroesophageal variceal rebleeding in 28 patients, and refractory ascites in 16 — 5 of them with hepatorenal syndrome. Serum bilirubin, albumin, creatinine levels and prothrombin time were evaluated. Sixteen (36.36%) patients presented mild ascites, and other 16, tense ascites. Additionally, 11 (25%) patients had a previous history of mild encephalopathy. The hepatic function status of patients evaluated by the Child-Pugh classification[8] showed that 7 were Child-Pugh A, 24, Child-Pugh B and 11, Child-Pugh C.

All of the TIPS procedures were performed in the Sector of Angiography – Center of Diagnostic Imaging at Hospital Santa Catarina, which is equipped with a GE Advantx® digital subtraction angiography device. Amongst the patients submitted to TIPS, 34 were inpatients in the institution and nine came by ambulance from other places, returning to their hospital of origin after being submitted to the procedure. In 30 cases (68.18%), the procedure had been previously scheduled and was performed in an elective fashion, but, in 14 (31.82%) cases, the procedure was performed with no previous scheduling, given the urgency of the situation. Thirty-seven (84.09%) patients were submitted to the procedure under local anesthesia and conscious intravenous sedation with a hypnotic drug (Midazolan) and analgesia (Fentanyl), but 7 (15.91%) patients underwent general anesthesia in assisted respiration because they already were under this condition.

The TIPS technique comprised the following steps (Figure 1):

• Puncture and catheterization of the right femoral artery with the purpose of angiographically studying the liver and the portal system;

• puncture and catheterization of the right internal jugular vein with a 10 F introducer sheath anti-reflux valve;

• insertion of a multipurpose catheter to perform the central venous pressure measurement and venographic study of hepatic veins;

• insertion of a Rosch-Uchida® needle to perforate the hepatic parenchyma;

• portal catheterization with a multipurpose catheter to perform the central venous pressure measurement and venographic study of the portal vein (portography);

• intrahepatic route dilatation with an angioplasty balloon (10 mm in diameter);

• placement of a self-expandable stent in the intrahepatic route;

• measurement of central and portal venous pressures;

• portal angiography;

• supplementary procedure, if necessary (dilatation, collaterals embolization, etc.).

All the patients were clinically followed-up during their stay in the hospital. Contacts were made with both the patients and their assisting physicians, during the first year following the procedure.

All the information necessary for the research and obtained by means of the medical dossiers review was recorded on

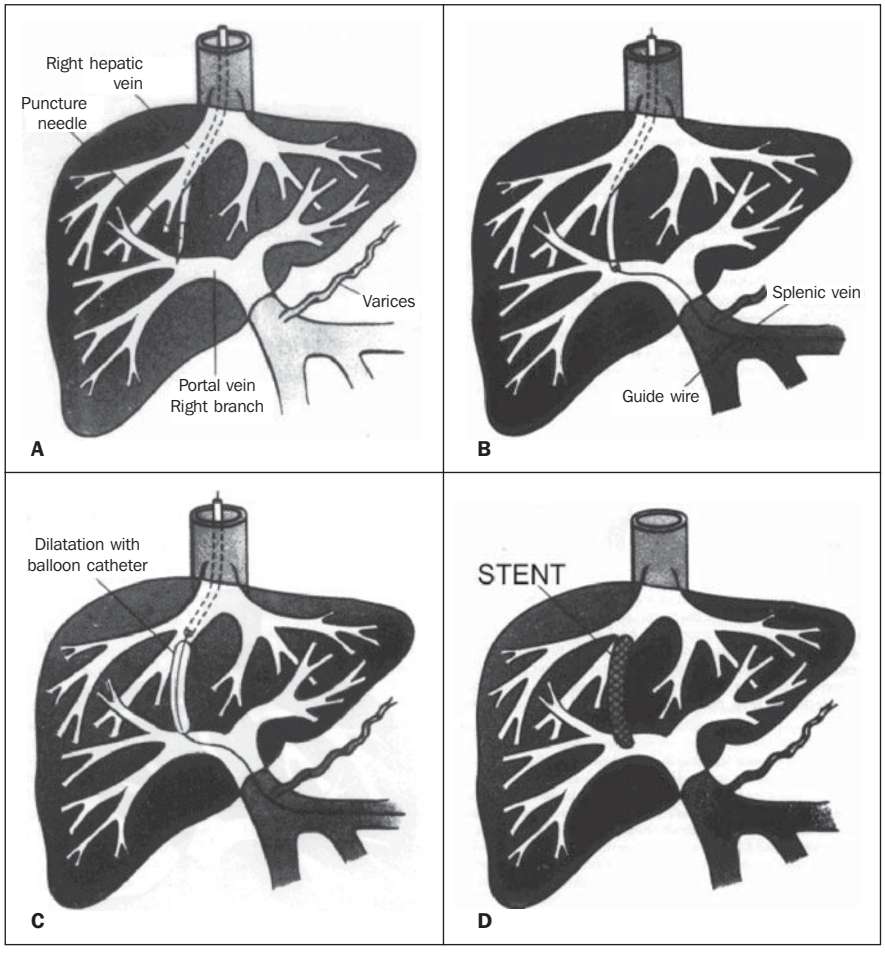


Figure 1. Schemes for TIPS technique comprehension. **A:** Insertion of an appropriate needle for puncturing the portal vein from the right hepatic vein. **B:** Insertion of guide-wire into the portal system. **C:** Dilatation of hepatic parenchyma between the portal vein and the hepatic vein. **D:** Stent placement in the newly formed course.

a precodified form especially designed for the present study. The information register was entirely made by the responsible researcher.

For digital data recording of the variables involved in the present study, the Excel worksheet application database managing system was employed. The following softwares were utilized: SAS (Statistical Analysis System) for Windows, version 8.02 (SAS Institute Inc., 1999-2001, Cary, NC, USA); SPSS for Windows, version 10.0.5 (SPSS Inc., 1989-1999, Chicago, IL, USA).

For data analysis, the following statistical methodology was employed:

• Data descriptive analysis: statistical, descriptive analysis of continuous variables and frequency of categorical variables;

• the comparison between pre- and post-treatment pressures was performed with the Wilcoxon non-parametric test for paired values;

• in the comparison of survival time to death, the Kaplan-Meyer life table was employed for calculating the survival curves for each class, the death being considered as an event. The Breslow test was employed for comparing survival groups;

• factors influencing the post-surgical mortality were investigated by the Cox regression model;

• the Fisher's exact test was employed to analyze the mortality ratio/class;

• the level of statistical significance was 5% (p-value < 0.05).

For the results analysis, the following concepts were employed:

Technical success: Is associated with the TIPS feasibility, allowing the passage of the portal blood to the systemic circulation[8].

Clinical success: Is associated with the post-surgical clinical management of the primary symptom which has motivated the procedure.

Hemodynamic success: Is associated with procedure capacity of reducing the portosystemic pressure gradient.

Post-surgical mortality: Is associated with the amount of deaths in the 30-day period following the procedure.

Survival: Is associated with the amount of patients who remain alive during the whole study period.

Censorship time: Represents the 12-month observation period following the procedure.

Complications: Events directly related to the procedure, resulting in hospital stay prolongation or additional therapies.

TIPS occlusion: Is associated with the moment where the absence of portal flow in the TIPS is proved, regardless the presence of symptoms.

RESULTS

Technical success: The procedure has technically succeeded in all of the cases (100%).

In 11 (25%) cases, collaterals embolization was performed as a supplement to the primary procedure (TIPS) (Figure 2).

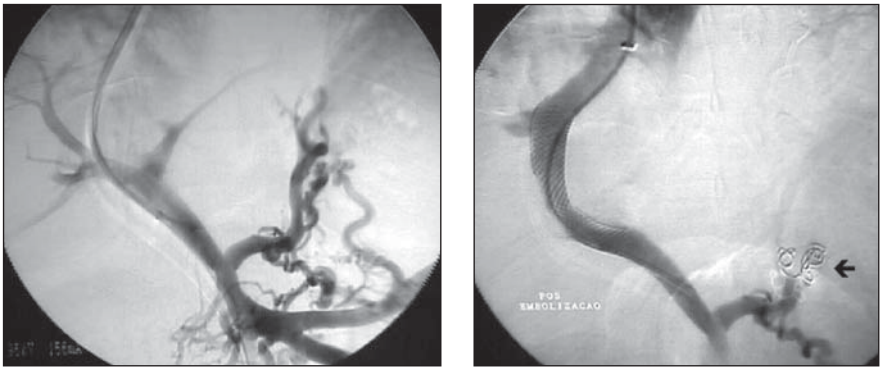
In 31 (70.45%) cases, naked metal stents of several brands were employed, and in 13 (29.55%), a new polytetrafluoroethylene-covered stent-graft (Viatorr®) was utilized (Figure 3).

One case (2.27%) required the placement of two stents in a parallel TIPS (Figure 4).

Hemodynamic success: The TIPS has caused a change in the pressure values in all of the patients. Previously to the TIPS placement, the mean portosystemic pressure gradient — established by the difference between the portal pressure and the central venous pressure — was 18.98 mmHg, and has fallen, after the TIPS placement, to a mean 9.55 mmHg, corresponding to a statistically significant 49.69% decrease (Table 1).

Clinical success: Regarding the clinical condition which has motivated the procedure, a clinical improvement has been proved in 35 patients (79.55%), and, of the 28 patients (63.64%) with indication of TIPS for treating bleeding, 24 (85.71%) have stopped bleeding; additionally, amongst 11 patients with refractory ascites, 8 (72.72%) had their condition controlled, and three (60%) of five patients with hepatorenal syndrome have achieved reversion after TIPS placement (Table 2).

Post-surgical mortality: The 30-day post-surgical follow-up demonstrated the death of six (13.64%) patients, five of them Child-Pugh C, and one Child-Pugh B. Half of these procedures were performed with no previous scheduling, given the urgency of the situation, and the other half were elective (Table 3).



A B

Figure 2. Portography by direct transhepatic puncture. **A:** Before TIPS performance, an intense portal reflux through collaterals towards the gastroesophageal transition zone. **B:** As a supplement to TIPS, the collaterals were occluded with metal coils (arrow).

Table 1 Comparison of pre- and post-TIPS P/S gradient (values in mmHg).

Portosystemic gradient						
Time	N	Mean	Standard deviation	Minimum	Median	Maximum
Pre	44	18.98	3.87	12.00	19.00	29.00
Post	44	9.55	2.14	5.00	10.00	14.00
Post–Pre	44	–9.43	4.49	–21.00	–9.00	–3.00
Wilcoxon test: p-value < 0.0001.						

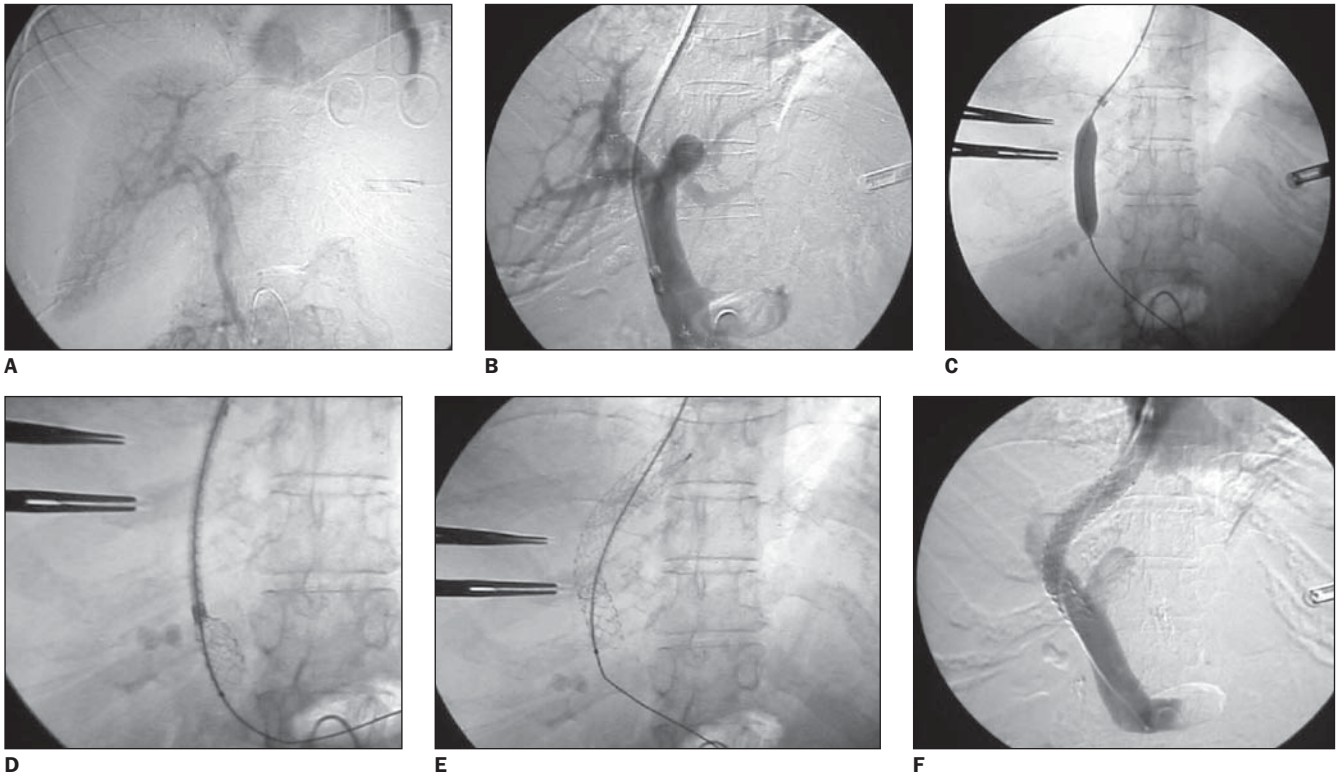


Figure 3. Angiography images documenting the utilization of a covered stent. **A:** Portal angiographic study. **B:** Transhepatic portography. **C:** Dilatation of the intrahepatic portosystemic shunt. **D:** Covered stent insertion with the stent naked portion inside the portal vein. **E:** Stent positioning in the place appropriate for release. **F:** Portography following complete stent release.

The logistic regression analysis of variables conditioning the post-surgical mortality demonstrated a significant influence of serum bilirubin/creatinine levels and prothrombin time (Table 4).

On the other hand, the multivariate analysis showed bilirubin and creatinine levels as the factors most significantly influencing the post-surgical mortality, and patients with hyperbilirubinemia with a 6.7 times higher chance of dying immediately after the procedure, while patients with high serum creatinine levels have a 22.9 times higher chance (Table 5).

Survival: Thirty-three patients (75%) survived during the censorship period — 8 of 9 Child-Pugh A Patients, 20 of 24 Child-Pugh B, and only 5 of 11 Child-Pugh C patients. So, a statistically significant difference in the patients survival associated with the Child-Pugh classification was evidenced. Mean survival time for Child-Pugh A patients was 11.50 months, for Child-Pugh B, 10.97 months, and 5.90 months for Child-Pugh C patients (Figure 5; Table 6).

Table 2 Evolution of symptoms in patients submitted to TIPS.

Clinical improvement	Frequency	Percentage	Accumulated frequency	Accumulated percentage
Improvement				
No	9	20.45	9	20.45
Yes	35	79.55	44	100.00
High digestive hemorrhage improvement				
No	4	14.29	4	14.29
Yes	24	85.71	28	100.00
Ascites improvement				
No	3	27.27	3	27.27
Yes	8	72.72	11	100.00
Hepatorenal syndrome improvement				
No	2	40.00	2	40.00
Yes	3	60.00	5	100.00

Complications: Immediate, unexpected events associated with the procedure occurred in nine (20.44%) patients (Table 7).

One patient has developed a hematoma on the neck, and another, a hematoma on the inguinal region. In both patients, the hematomas were resolved with clinical treatment. One patient presented with hemobilia on the 14th post-surgical day, which has caused a new hospitalization. An angiography demonstrated an accidental lesion in the right branch of the hepatic artery, requiring metal coil embolization (Figure 6).

Six patients presented with encephalopathy, five of them with moderate degree which has been resolved with clinical treatment. Another patient, besides severe en-

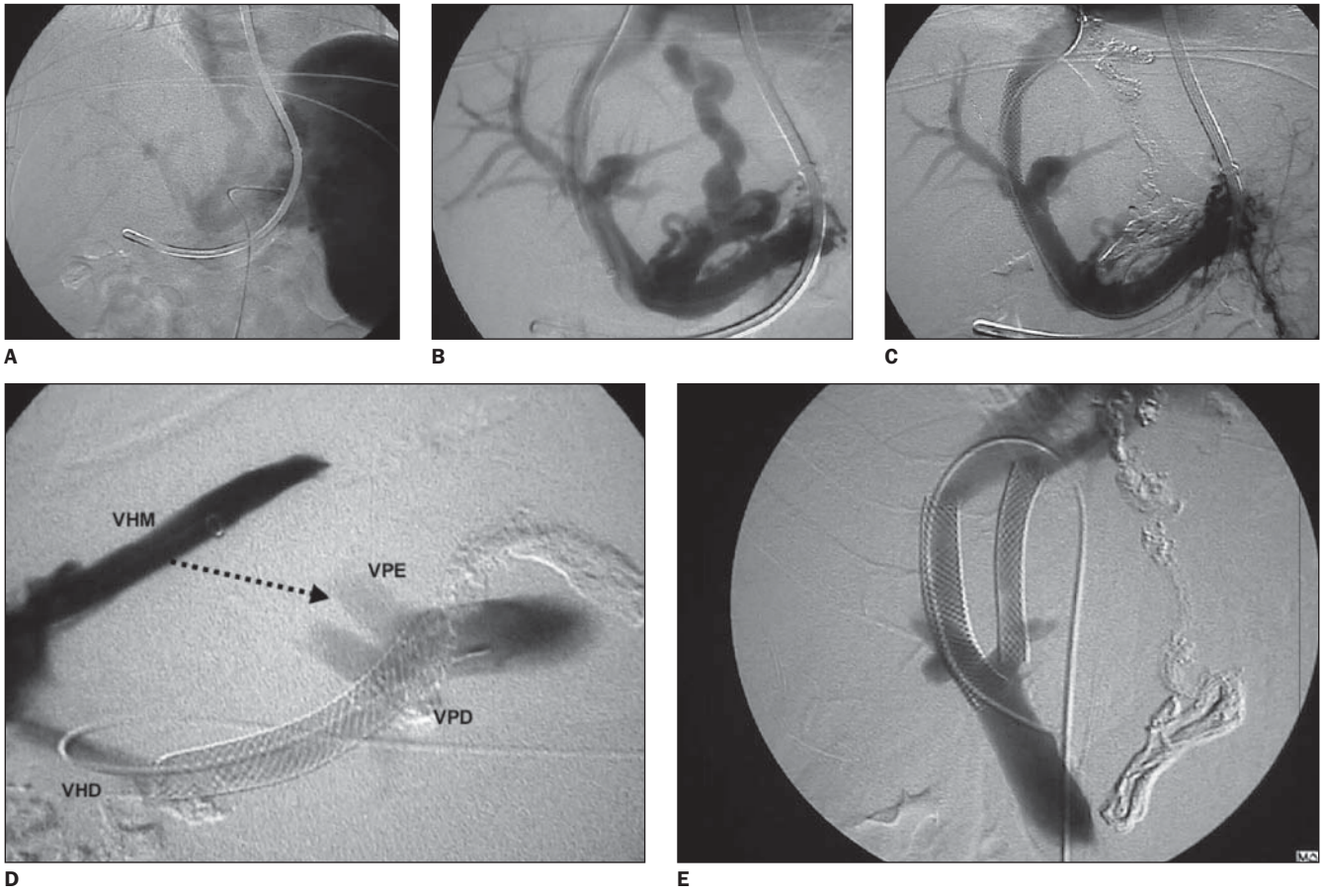


Figure 4. Documentation of some TIPS technical variables according to the strict portosystemic gradient control. **A:** Indirect portography performed by selective splenic artery catheterization, observing that, in the venous return phase, a great part of the portal flow is deviated towards the gastroesophageal transition zone. **B:** After TIPS placement, a 14 mmHg portosystemic gradient was observed, yet maintaining a significant reflux through the left gastric vein **C:** Then, the left gastric vein embolization was performed with an adhesive substance. Now, the portography shows an absent reflux, but the portosystemic gradient rises to 18 mmHg. **D:** We have decided to place a second stent to achieve the objective of reducing the portosystemic gradient; on the lateral angiographic image, one may observe the anatomical relation between hepatic veins and the right and left portal vein branch and the direction of the puncture for placement of a second stent (arrow) (VPD, right portal vein branch; VPE, left portal vein branch; VHD, right hepatic vein; VHM, middle hepatic vein). **E:** After placing a second stent aimed at reducing the pressure gradient to 9 mmHg. On the image, a parallel TIPS is observed, besides a first stent between the right hepatic vein and the right portal vein branch, and a second stent between the middle hepatic vein and the left portal vein branch.

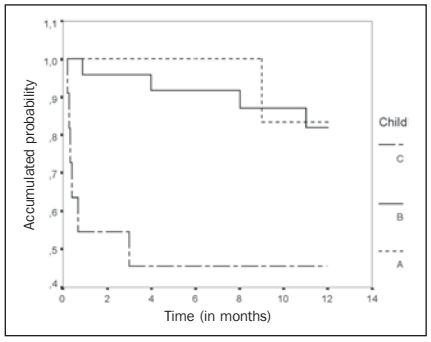


Figure 5. Survival curve estimated by the Kaplan-Meyer method, considering the death as an event (for nine Child-Pugh A patients, 24 Child-Pugh B, and 11 Child-Pugh C). Mean survival of patients was of 11.50 months for Child-Pugh A patients, 10.97 months for Child-Pugh B patients, and 5.90 months for the Child-Pugh C patients (p-value = 0.0015).

cephalopathy, presented a significant worsening of the liver function which compelled, initially, a reduction in the gauge of the TIPS, and later, its occlusion.

Amongst the six patients with encephalopathy, four (66.66%) had alcoholic cirrhosis as the base disease and a history of previous encephalopathy pre-operatively.

TIPS occlusion: TIPS occlusion occurred in five patients (11.36%), presenting acutely in two of them (eight and twenty days following the surgery), and in the other three, in a chronic fashion (seven, nine and eleven months post-operatively) (Figure 7).

Four patients have died because of symptoms worsening or recurrence. In one patient a TIPS revision was performed eight months post-operatively. At that occasion, a new stent was placed, allowing a good portal decompression, and extending the communication lifetime and the patient survival.

In all of the cases with TIPS occlusion, naked (uncovered) metal stents had been utilized. However, the relation between TIPS occlusion and stent type has not been statistically significant (Table 8).

DISCUSSION

Interventional radiology has undergone a deep transformation. The last decades technological development, both in imag-

Table 3 Post-TIPS mortality rate. General frequency related to Child-Pugh classification or urgency.

Post-surgical mortality rate (up to 30 days)	Frequency	Percentage	Accumulated frquency	Accumulated percentage
General				
No	38	86.36	38	86.36
Yes	6	13.64	44	100.00
Child A				
No	9	100.00	9	100.00
Yes	0	0.00	9	100.00
Child B				
No	23	95.83	23	95.83
Yes	1	4.17	24	100.00
Child C				
No	6	54.54	6	54.54
Yes	5	45.45	11	100.00
Urgency				
No	11	78.57	11	78.57
Yes	3	21.42	14	100.00
Elective				
No	27	90.00	27	90.00
Yes	3	10.00	30	100.00

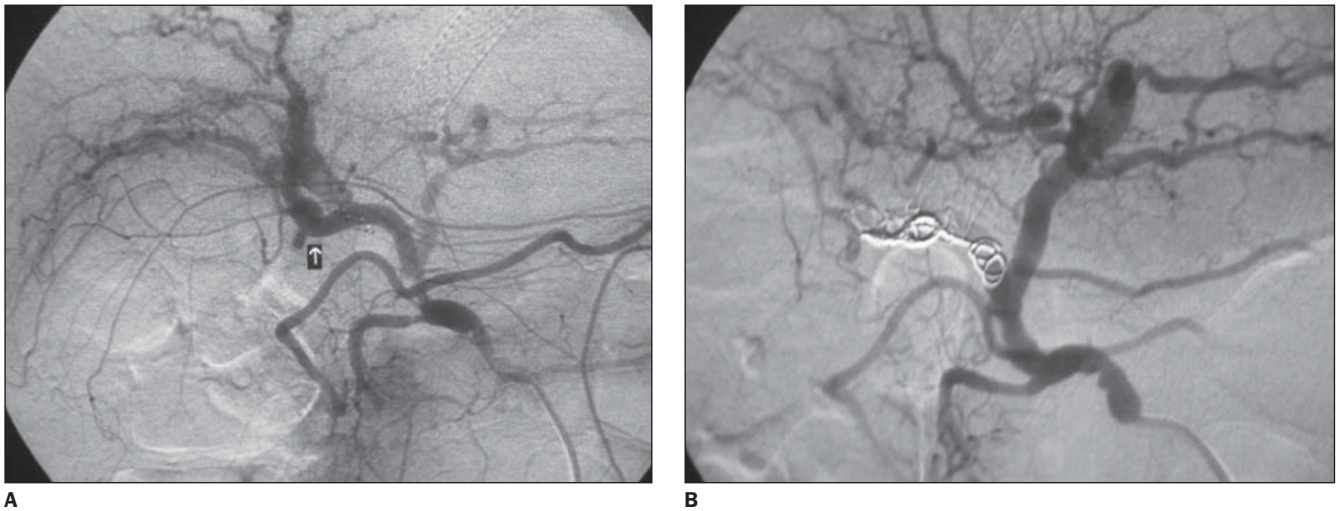
ing equipment and interventional instruments and materials, in conjunction with the imagination of researchers involved with the progress of medicine, have allowed the current utilization of minimally invasive procedures to manage cases of severe conditions. Undoubtedly, TIPS is an example of this progress. Before the advent of TIPS, thousands of patients with portal hypertension have died in the absence of an effective therapy, since, in many situations, neither the endoscopic nor the surgical alternative might offer a significant benefit[7].

Most of times, TIPS is indicated for controlling variceal bleeding and/or refractory ascites[6]. Less frequent indications include management of Budd-Chiari syndrome[9], hepatic hydrothorax[10], hepatopulmonary syndrome[11] and ectopic varices[12], but the TIPS role in these situa-

Table 4 Analysis of variables influencing the post-TIPS mortality rate.

Parameters	df	Estimate	SE	χ^2	*p*-value	OR	CI 95%	
Age	1	0.0320	0.0545	0.3454	0.5567	1.033	0.928	1.149
Sex (F *vs*. M)	1	0.8979	0.8914	1.0147	0.3138	2.455	0.428	4.085
Symptom (H *vs*. A)	1	0.1541	0.9290	0.0275	0.8682	1.167	0.189	7.207
Condition (U *vs*. E)	1	0.8979	0.8914	1.0147	0.3138	2.455	0.428	14.085
Bilirubin	1	1.6263	0.5812	7.8292	**0.0051**	5.085	1.628	15.886
Albumin	1	–1.7621	0.9299	3.5906	0.0581	0.172	0.028	1.062
Prothrombin time	1	–0.0632	0.0322	3.8441	**0.0499**	0.939	0.881	1.000
Creatinine	1	2.4055	0.7810	9.4856	**0.0021**	11.084	2.398	51.227
Encefalopathy (Y *vs*. N)	1	0.4769	0.9464	0.2540	0.6143	1.611	0.252	10.296
Portosystemic gradient	1	–0.0115	0.1160	0.0098	0.9210	0.989	0.788	1.241

F, female; M, male; H, hemorrhage; A, ascites; U, urgency; E, elective; Y, yes; N, no; df, degrees of freedom; SE, standard error; OR, odds ratio; CI, confidence interval.



A **B**

Figure 6. TIPS complication. Unintentional injury of the hepatic artery during the TIPS performance caused post-procedural hemobilia, requiring a new intervention for right hepatic artery branch embolization. **A:** arteriography evidencing lesion on the right hepatic artery branch (arrow). **B:** Arteriography after the embolization of the injured branch.

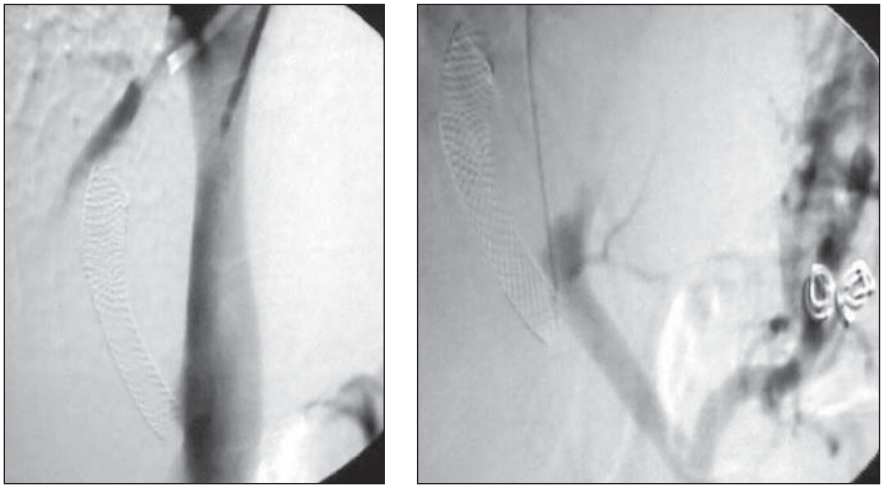


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Figure 7. TIPS occlusion. **A:** Angiography performed seven months following TIPS in a patient with recurrent bleeding, where the impossibility of TIPS retrograde catheterization from the hepatic vein is demonstrated. **B:** A new puncture is performed proving the TIPS occlusion and reflux into collaterals, despite the previous embolization.

Table 5 Multivariate analysis for evaluating preponderant factors influencing patients' death in up to 30 days – utilization of the stepwise selection method.

Parameters	gl	Estimate	SE	χ^2	*p*-value	OR	CI 95%	
Interceptum	1	–12.7187	5.2866	5.7879	0.0161	—	—	
Bilirubin	1	1.8973	0.9539	3.9561	**0.0467**	6.668	1.028	43.242
Creatinine	1	3.1331	1.4462	4.6936	**0.0303**	22.945	1.348	390.560

df, degrees of freedom; SE, standard error; OR, odds ratio; CI, confidence interval.

Table 6 Survival analysis according Child-Pugh classification.

	Total	Nbr. of events	Censored Nbr.	Censored %
Child A	9	1	8	88.89
Child B	24	4	20	83.33
Child C	11	6	5	45.45
Total	44	11	33	75.00

Survival equality statistical test – Child distribution

	Statistics	df	*p*-value
Breslow	13.03	2	**0.0015**

df, degrees of freedom.

Table 7 Complications resulting from TIPS.

Complication	Frequency	Percentage	Accumulated frequency	Accumulated percentage
Cervical hematoma	1	2.27	1	2.27
Inguinal hematoma	1	2.27	2	4.54
Hemobilia	1	2.27	3	6.81
Severe encephalopathy	1	2.27	4	9.08
Moderate encephalopathy	5	11.36	9	20.44
No	35	79.54	44	100.00

Table 8 Comparison between covered stent versus uncovered stent as cause for TIPS occlusion.

Tipe of stent	Permeable	Occlusion	Total
Covered	13	0	13
	29.55	0.00	29.55
	100.00	0.00	
	33.33	0.00	
Uncovered	26	5	31
	59.09	11.36	70.45
	83.87	16.13	
	66.67	100.00	
Total	39	5	44
	88.64	11.36	100.00

Fisher's exact test: *p*-value = 0.3005.
No statistically significant difference.

tions has not been accurately defined yet[13].

In the experiment reported by the present study, there were two predominant indications for TIPS: 1) high digestive hemorrhage caused by rupture of gastroesophageal varices or congestive gastropathy; 2) refractory ascites, patients with hepatorenal syndrome being included in the latest. The clinical improvement observed in almost 80% of patients allows us to affirm that TIPS is an efficient method for controlling both situations, mainly when compared with other therapeutical alternatives.

Results from previous experiments with surgical portal decompression were discouraging, because of the high mortality rates (31% to 77%), principally when the surgery is performed in compelling urgency circumstances[14].

Also, TIPS has shown to be more efficient than the endoscopic treatment for controlling digestive hemorrhage in patients with portal hypertension. In 1999, a meta-analysis study reviewed 11 studies comparing TIPS *versus* endoscopic treatment, and demonstrated a lower incidence of hemorrhage recurrence in patients submitted to TIPS[15]. These studies reported hemorrhage recurrence in 40% to 50% of patients submitted to endoscopic treatment, and 15% to 25% of percutaneously treated patients, during a variable, 15 to 33-month follow-up period.

In relation to refractory ascites, The TIPS has been compared with the treatment by means of repetitive paracentesis. Re-

cently, a meta-analysis study gathering five studies and including more than 300 cases, has been published[16]. Amongst patients submitted to TIPS the mean symptomatic improvement was of 66%, while in those treated with parencentesis the improvement was of only 24% in a four-month follow-up period. In the one-year follow-up period, improvement with TIPS compared favorably (55%) with paracentesis (19%).

Several factors which could affect negatively the post-surgical survival should be taken into consideration for TIPS indication. Child-Pugh classification, serum bilirubin level, serum creatinine level, coagulation status, and indication in a compelling urgent situation are some of these factors[17].

A multicentric study developed in the USA, has reported bleeding management in 93.6% of patients submitted to TIPS in urgent circumstances, with early recurrent hemorrhage in 12.4% of these patients. However, in-hospital mortality in up to six weeks was considered as high (35,8%)[18].

Another study developed in France, has reported that, in 58 patients with uncontrollable bleeding and submitted to urgent TIPS, the post-surgical mortality rate up to 30 days was 29%, and 35% up to 60 days[19].

Encarnacion *et al*., in the USA, have reported 65 consecutively performed TIPS for variceal bleeding management. In this study, 60% of patients were hemodinamically unstable, and were submitted to TIPS in compelling urgent circumstances[20]. The authors have clearly documented that patients submitted to TIPS in such circumstances have a significantly poor prognosis than those submitted to elective TIPS. Thirty-day mortality rate for the first ones was 28%, while for the latest was only 4% ($p = 0.013$).

In the experiment reported in the present study, no statistically significant difference was found in mortality of patients submitted to TIPS, in the comparison between elective and urgent procedures. This may be due to different interpretations of the words "urgent" or "emergency" by different services or communities. In fact, there was an evident difference in the patients´ evolution according their clinical characterization by the Child-Pugh classification. Additionally, a potentially higher risk of death has been observed in patients with increased serum bilirubin and creatinine levels, and these factors are the most significant for determination of a poorer prognosis following TIPS. Generally, there is a consensus among the majority of authors on the concept that Child-Pugh C patients scoring 12 or more points, present a high risk of early death when submitted to TIPS[21].

A study developed in the USA with 231 patients submitted to elective TIPS, has identified four factors influencing patient's survival: serum creatinine level, serum bilirubin level, International Normalized Ratio (INR) and cause of cirrhosis[22]. The authors have developed a formula for calculating the risk applying these four variables, and have observed that patients scoring more than 1.8 presented a mean survival of 2.8 months, and patients scoring less than 1.8 presented a mean survival of 1.3 year. Then, it has been established that a score higher than 1.8 implies a poor prognosis. The authors have considered this model quite effective, with 77% sensitivity, and 79% specificity, 63% positive prognostic value, and 88% negative prognostic value[22]. The original model developed by Malinchoc *et al*. has been slightly modified: small changes in the formula including the elimination of the cause of cirrhosis and multiplication of the score by 10 aiming at facilitating its application[23]. The new model has been called model for end-stage liver disease (MELD) and currently is universally employed for TIPS candidates selection.

Invariably, TIPS is performed by an interventional radiologist, i.e., a specialist in minimally invasive imaging-guided percutaneous procedures. In experienced hands, this procedure can be successfully completed in more than 95% of cases[7,8,24,25].

Notwithstanding the 100% technical success achieved by TIPS in the present study, it is important to note that just a partial experience is reported by the author, since it was developed in a single institution, under ideal conditions, and after completing a learning curve with this procedure. The author has already performed more than 150 TIPS during the last ten years, in several institutions in Brazil and abroad, also experimenting some technical failures[7].

The main step for a successful TIPS completion is the portal puncture. Some authors have suggested certain anatomical parameters or technical variants aiming at facilitating the portal puncture[26–29]. Nevertheless, results are unpredictable when one does not know the degree of hepatic atrophy and displacement of vascular structures in a cirrhotic liver.

The primary goal of TIPS is the portal system decompression to avoid variceal bleeding and/or reduce ascites formation. As regards varices, it is well established that the reduction of the portosystemic gradient to a level < 12 mmHg causes a significant decrease in the bleeding risk. Other concept utilized is the proportional reduction of the portosystemic gradient. Rossle *et al*. have shown that, after TIPS, the rebleeding risk was 18%, 7% and 1%, respectively, in patients whose the portosystemic gradient had been reduced in 0%, between 25% and 50%, and more than 50%[30].

Another study has reported that a 50% reduction of the initial portosystemic gradient is associated with a rebleeding rate of 11%/year, and patients with lower gradient reduction presented a rebleeding rate of 31%[31]. In this latest study, the only absolute value preventing rebleeding was a portosystemic gradient lower than 12 mmHg, which in some way equates both concepts. It is important to note that an excessive reduction of the portosystemic gradient may be associated with a higher incidence of post-TIPS encephalopathy.

In 2001, the Society of Interventional Radiology (SIR) developed and published standards for TIPS creation, and a consensus has been reached, establishing that the technical success (creation of the communication and reduction of the portosystemic gradient to 12 mmHg) must be achieved in 95% of patients, and the clinical success (resolution of the portal hypertension complication) must be achieved in 90% of patients[8].

An interesting aspect is the decision to supplement the TIPS with collaterals embolization. It is important to note that in 25% of the patients included in our study, this supplementary procedure was considered necessary in the cases where the presence of two types of collaterals was identified: collateral with hepatofugal flow to-

wards the gastroesophageal transition zone (left gastric and/or tributary vein) and natural splenorenal anastomosis. This decision is based on the fact that we have already observed cases where collaterals with considerable caliber persist after TIPS with high incidence of persistent bleeding or early rebleeding, even though the post-TIPS portosystemic gradient is below 12 mmHg. On the other hand, natural portosystemic anastomosis follow the intent to prevent the competence between two portosystemic communications, which could lead to thrombosis and early TIPS dysfunction.

It is important to mention that, usually, when a pathway is occluded, there is a change in the local hemodynamics and, therefore, the portosystemic gradient must be constantly measured following collaterals embolization to avoid portal hypertension.

TIPS has shown to be a reasonably safe procedure with an acceptable complications level[32].

Most of times, death following TIPS occurs because of the liver disease progression, a situation probably influenced by the portal flow shunt, but not as a result of a procedural complication itself, like a portal or hepatic perforation with intraperitoneal hemorrhage. It is estimated that the occurrence of this type of major complication is not superior to 3%[8,32].

The two mostly-feared post-TIPS negative effects are encephalopathy and shunt dysfunction caused by stenosis or occlusion.

The central factor in the onset of encephalopathy is the presence of a portosystemic communication, and, by definition, TIPS may cause this complication in up to 30% of patients[33,34].

This complication, most of times, can be clinically controlled with no difficulty, but, in about 5% of cases, encephalopathy may be an extremely limiting condition, compelling a new intervention which may consist in the shunt caliber reduction or occlusion[35–37].

The encephalopathy incidence amongst the patients of the present study casuistic was 25%. However, we have observed that the majority of patients who presented encephalopathy had alcoholic hepatopathy or presented a history of previous encephalopathy.

Some risk factors for the onset of encephalopathy have already been mentioned: age higher than 60 years, female patient, alcoholic disease, hypoalbuminemia, previous history of encephalopathy, the caliber of the created communication, the final pressure gradient, and the base disease severity[33,34].

In patients at high encephalopathy risk, it might be interesting to create a lower caliber 8 mm) communication, or even two parallel communications, and complete the procedure with collateral embolization through the TIPS[38,39].

The major concern of TIPS is its short durability. In 25% to 50% of cases, a > 50% communication stenosis is observed and may lead to portal hypertension recurrence within a period of time between 6 and 12 months following the TIPS creation[40–44].

In 1993, LaBerge *et al*. reported in detail their findings in patients with stenotic and occluded TIPS[45]. The authors proposed that small bile pools resulting from rupture of biliary ducts during the portal puncture procedure, caused an inflammatory reaction contributing to coagula formation and TIPS occlusion[45].

An important aspect that should be observed by the time of the TIPS creation is a good coverage of the hepatic vein with stent prolongation to the confluent between the hepatic vein and the inferior vena cava. We have observed that the hepatic vein diameter is reduced in up to 50% as a response to TIPS, and so the communication outflow is limited, making its occlusion frequent and likely to occur[46]. This was observed in a case where TIPS occlusion was demonstrated seven months after the procedure. By the time of the angiographic follow-up, we found a retraction and deformity of the stent placed proximal to the hepatic parenchyma and with poor coverage of the hepatic vein (Figure 7).

Many researches have been developed indicating several alternatives to extend the TIPS permeability. The majority of investigators have focused their attention on the idea of utilizing new stents covered with biocompatible, impermeable prosthetic material. This has been the origin of the stent-graft concept.

An array of prosthetic materials was evaluated for covering metal stents, including silicone, polytetrafluoroethylene (PTFE), polyethylene terephthalate (PET), dacron.

In 2001, The American company W.L. Gore launched in the market a covered stent specifically developed for TIPS creation and denominated Viatorr®. It is a nitinol (a nickel and titanium alloy) internally and externally covered with a special type of expanded PTFE that minimizes transmural permeation of bile and mucin (ePTFE).

In 2004, Charon *et al*. retrospectively analyzed the Viatorr® stent utilization in Europe[47]. The stent produced by Gore was utilized in 100 patients submitted to TIPS for portal hypertension. The primary permeability in the first year follow-up was of 84%, which represented an evident improvement in relation to the historical TIPS permeability[47].

In Italy, Rossi *et al*., utilizing the same material observed a primary permeability of 84% and a secondary permeability of 98% in the first year follow-up [48].

Hausegger *et al*., in Austria, have created TIPS with Viatorr® stent in a 71-patient population[49]. Four occlusions, and three stenosis have been found during the first year follow-up, generating 11.3% new interventions. The primary permeability six months and one year after was, respectively, 87.4% and 80.8%.

Bureau *et al*. have compared, in a randomized study, the TIPS durability in two groups of patients submitted to the procedure with covered stents, or with classical uncovered stents[50]. After a mean 300-day follow-up period, they have observed 13% of TIPS dysfunction in the group with covered stents and 44% in those who received the classical uncovered stents.

In our experiment, we proved the TIPS occlusion in five patients, all of them with the classical metal uncovered stent. From 2001 on, with the Viatorr® stent availability in the market, we started using it. In none of the 13 cases where the covered stent was utilized there was TIPS dysfunction. However, in spite of showing a favorable trend, no statistically significant difference was found in comparison with utilization of uncovered stents, which probably is due to the small number of patients or the short follow-up period.

CONCLUSION

In the present study, we have observed that TIPS is an excellent method for reducing portal hypertension and controlling symptoms in patients with chronic hepatopathy and portal hypertension.

Additionally, we have observed that the survival of patients submitted to TIPS is acceptable, and can constitute an invaluable alternative for patients who are waiting for a liver transplant as a definite therapy. The complications resulting from the procedure are note frequent and the mortality rate is acceptable, considering the clinical complexity of the patients' condition. The mortality is directly influenced by some clinical factors, with higher incidence in patients clinically classified as Child-Pugh C, with increased serum bilirubin or creatinine levels. The latest constituted factors implying the worst prognosis for patients submitted to TIPS.

The eventual variation of the technique, with utilization of covered stents, has not altered the result with statistical significance, although we have observed that in none of these patients there was a communication occlusion, differently from those patients who had received classical metal uncovered stents.

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