Thrombocytopenia in Patients with Gastric Varices and the Effect of Balloon-occluded Retrograde Transvenous Obliteration on the Platelet Count

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ABSTRACT

Objectives: Gastric varices primarily occur in cirrhotic patients with portal hypertension and splenomegaly and thus are probably associated with thrombocytopenia. However, the prevalence and severity of thrombocytopenia are unknown in this clinical setting. Moreover, one-third of patients after balloon-occluded retrograde transvenous obliteration (BRTO) have aggravated splenomegaly, which potentially may cause worsening thrombocytopenia. The aim of the study is to determine the prevalence and degree of thrombocytopenia in patients with gastric varices associated with gastrorenal shunts undergoing BRTO, to determine the prognostic factors of survival after BRTO (platelet count included), and to assess the effect of BRTO on platelet count over a 1-year period.

Materials and Methods: This is a retrospective review of 35 patients who underwent BRTO (March 2008–August 2011). Pre- and post-BRTO platelet counts were noted. Potential predictors of bleeding and survival (age, gender, liver disease etiology, platelet count, model for end stage liver disease [MELD]-score, presence of ascites or hepatocellular carcinoma) were analyzed (multivariate analysis). A total of 91% (n = 32/35) of patients had thrombocytopenia (<150,000 platelet/cm³) pre-BRTO. Platelet counts at within 48-h, within 2 weeks and at 30-60 days intervals (up to 6 months) after BRTO were compared with the baseline pre-BRTO values.

Results: 35 Patients with adequate platelet follow-up were found. A total of 92% and 17% of patients had a platelet count of <150,000/cm³ and <50,000/cm³, respectively. There was a trend for transient worsening of thrombocytopenia immediately (<48 h) after BRTO, however, this was not statistically significant. Platelet count was not a predictor of post-BRTO rebleeding or patient survival. However, MELD-score, albumin, international normalized ratio (INR), and etiology were predictors of rebleeding. Conclusion: Thrombocytopenia is very common (>90% of patients) in patients undergoing}

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INTRODUCTION

Gastric varices have a high association (>80%) with spontaneous gastro-renal shunts in cirrhotic patients with portal hypertension.[1-5] Portal hypertension is associated with splenomegaly and thrombocytopenia.[6-9] The degree of thrombocytopenia is a reflection of the degree of portal hypertension and is associated with a higher risk of variceal bleeding.[6,7] Moreover, balloon-occluded retrograde transvenous obliteration (BRTO) of gastric varices is associated with worsening splenomegaly in greater than one-third of patients.[10,11] This increase in spleen size is probably because of the loss of the gastro-renal shunt, which, prior to the BRTO, acts as the outflow for the splenic venous outflow. Loss of the gastro-renal shunt due to BRTO potentially reduces the splenic outflow and causes engorgement of the spleen. This, hypothetically, may increase platelet sequestration and reduce the platelet count.

The aim of this study is to determine the prevalence of thrombocytopenia in patients with gastric varices associated with gastro-renal shunts and to evaluate the effect of BRTO on the platelet count. In addition, our aim was to determine if pre-BRTO platelet count is a predictor of post-BRTO hemorrhagic episodes (rebleeding rates) and patient survival.

MATERIALS AND METHODS

Study design and population studied

This is a retrospective study of consecutive adult patients undergoing BRTO for gastric varices from March 2008 to August 2011 (3.5 years) at a single academic center. Institutional review board approval was obtained. We used the electronic medical records to obtain patients’ demographics and laboratory data. Patients with a prior transjugular intrahepatic portosystemic shunt (TIPS) and those undergoing a combined BRTO and TIPS procedure were excluded from the study. Technically failed BRTO procedures were excluded from the study. Patients without any laboratory follow-up data (platelet count) were excluded from the analysis evaluating the effect of BRTO on platelet count but were included in the evaluation of predictors of post-BRTO rebleeding and patient survival. Of the patients that were included, there was no patient who had undergone pre- or post-BRTO endoscopic guided prophylactic treatment directed at the gastric varices. A total of 44 consecutive patients undergoing BRTO were reviewed. Nine were excluded (7 had TIPS and 2 were BRTO technical failures) leaving 35 patients for the study purpose. Sixteen were female (43%) with a mean age of 57 years (range 23-83 years). Nine patients had nonalcoholic steatohepatosis, seven had alcohol and hepatitis C-related liver cirrhosis, seven had alcohol-related cirrhosis, four had hepatitis C cirrhosis, two had cryptogenic cirrhosis, two had cirrhosis due to autoimmune hepatitis, two had primary biliary cirrhosis, one patient had hemochromatosis-related liver cirrhosis, and one patient had cirrhosis-related to cystic fibrosis.

BRTO procedure

The BRTO procedure was performed in the standard trans-renal approach from a jugular or femoral access utilizing standard catheter techniques.[11-18] Occlusion of the gastrorenal shunt by balloon-occlusion catheters was followed by placement of a coaxial microcatheter in the gastric varices. The sclerosant utilized was 3% sotradecol (STS; Sodium Tetra-decyl Sulfate, Angiodynamics, Inc., Queensbury, NY) as mixed 1-part lipiodol, 2-parts 3% sotradecol, and 3-parts air.[19,20] Occlusion catheters were left inflated and in position for 4-36 h and then deflated.[19,20] Technical success of the BRTO procedure was considered when the gastro-renal shunt is successfully cannulated, balloon-occluded, and the sclerosant completely fills the gastric variceal system (gastric varices and gastrorenal shunt) in its entirety. Filling of the entire gastric variceal system was monitored by intraprocedural fl uoroscopy and cone-beam rotational computer tomography (CT).

Thrombocytopenia and platelet count

Thrombocytopenia was defined as a platelet count less than 150,000/cm³. The time-lapse before and after the BRTO procedure when the platelet counts were sampled was noted. Some variability was evident due to a lack of

Key words: Balloon-occluded retrograde transvenous obliteration, bleeding, balloon-occlusion, gastric varices, platelet count
Forty-four consecutive patients underwent BRTO procedures in the 3.5-year study period. Seven patients had BRTO in the presence of a patent TIPS and thus were excluded from the study. Of the remaining 37 patients who underwent BRTO only (without a TIPS) 2 were technical failures (technical success of 95%, n = 35/37). The intent to treat (technical failures included) hemodynamic (obliterative) success rate was 89% (n = 33/37). All the 37 patients included had an index bleed within 30 days prior to the BRTO-procedure except 2 who had never bled but underwent BRTO for high-risk gastric varices (impending bleeding). All the 37 patients were hemodynamically stable without active bleeding at the time of the procedure, thus all the BRTO-procedures were performed on elective basis.

Of the 37 patients, 92% (n = 34/37) were thrombocytopenic (platelet count < 150,000/cm³). Table 1 demonstrates the distribution of the 37 patients according to platelet count [Figure 1] of which 17% (n = 6/37) had severe thrombocytopenia (platelet count < 50,000/cm³) [Table 1 and Figure 1]. Twenty-five patients had adequate post-BRTO follow-up platelet counts and were included in the detailed analysis of the effect of BRTO on platelet count. The results are shown in Table 2 and Figure 2. There was no statistically significant change in the platelet count over the 180-day-period after BRTO. However, there was a trend for a slight reduction in platelet count (P = 0.057, from 98,000+/-36,000/cm³ to 79,000+/-27,000/cm³) in the immediate post-BRTO period (within 2 weeks after the BRTO-procedure) [Table 2 and Figure 2]. The baseline platelet sample time was at a mean of 0.7 days +/-1.6 (median: 0 days, range: 0-7 days) prior to BRTO. The immediate (<14 days) post-BRTO platelet sample time was at a mean of 4.0 days +/-3.1 (median: 3 days, range: 1-14 days) post-BRTO. The last (labeled >180 days post-BRTO in Table 2) post-BRTO platelet sample time was at a mean of 450 days +/-176 (median: 430 days, range: 183-793 days) after BRTO.

### RESULTS

Forty-four consecutive patients underwent BRTO procedures in the 3.5-year study period. Seven patients had BRTO in the presence of a patent TIPS and thus were excluded from the study. Of the remaining 37 patients who underwent BRTO only (without a TIPS) 2 were technical failures (technical success of 95%, n = 35/37). The intent to treat (technical failures included) hemodynamic (obliterative) success rate was 89% (n = 33/37). All the 37 patients included had an index bleed within 30 days prior to the BRTO-procedure except 2 who had never bled but underwent BRTO for high-risk gastric varices (impending bleeding). All the 37 patients were hemodynamically stable without active bleeding at the time of the procedure, thus all the BRTO-procedures were performed on elective basis.

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#### Statistical analysis

All demographic values, model for end stage liver disease (MELD) score values (and components), platelet count are presented as mean, median, and range with standard deviation. Similarly, the sampling dates for the platelet count pre- and immediately (within 2 weeks) post-BRTO was expressed as mean, median, and range with standard deviation. Comparison between all pre- and post-BRTO platelet values (in the different time brackets above) was by Mann–Whitney test. A multivariate Cox-proportional hazard analysis for post-BRTO upper gastrointestinal bleeding and patient survival was used for age, gender, MELD score, albumin, bilirubin, creatinine, INR, platelet count, model for end stage liver disease (MELD) score values (and components), presence of ascites and/or hepatocellular carcinoma at the time of the BRTO-procedure. A P value of less than 0.05 was considered statistically significant.

Kaplan–Meier method was used to measure the transplant-free patient survival, upper gastrointestinal rebleeding rate (from all upper gastrointestinal bleeding sources), and variceal rebleed rate (all variceal bleeding sources) after technically successful BRTO-procedures. All documented upper gastrointestinal bleeding sources including variceal bleeding (esophageal varices, gastric varices, duodenal varices, as well as other ectopic varices), portal hypertensive gastropathy, and peptic ulcer disease.

### Table 1: Platelet count pre-balloon-occluded retrograde transvenous obliteration in the 37 patients included in the study

| Platelet count (per cm³) | Number of patients | Percentage of patients |
|--------------------------|--------------------|------------------------|
| >150,000                 | 3                  | 9                      |
| 125-149,000              | 4                  | 11                     |
| 100-124,000              | 5                  | 14                     |
| 75-99,000                | 14                 | 40                     |
| 50-74,000                | 3                  | 9                      |
| 25-49,000                | 6                  | 17                     |
| <25,000                  | 0                  | 0                      |

### Table 2: Platelet count pre- and post-balloon-occluded retrograde transvenous obliteration based on time brackets after BRTO (values are in thousands/cm³)

| Pre-BRTO | Post-BRTO |
|----------|-----------|
| 1-14 days*** | 79 79 27 | 32-153 | 0.057 |
| 15-30 days  | 90 91 32 | 33-160 | 0.505 |
| 31-60 days  | 92 96 38 | 34-208 | 0.716 |
| 61-90 days  | 93 98 38 | 35-190 | 0.883 |
| 91-120 days | 96 102 39 | 36-182 | 0.931 |
| 121-150 days| 100 102 39 | 36-182 | 0.789 |
| 151-180 days| 101 105 42 | 30-183 | 0.670 |
| >180 days*** | 101 110 45 | 38-238 | 0.432 |

*P-value is calculated utilizing the Mann-Whitney U test and compares with the pre-BRTO platelet count. **The platelet sample was obtained at a mean time of 0.7 days +/-1.6 prior to the BRTO procedure (median: 0 days, range: 0-7 days prior to BRTO). ***The platelet sample was obtained at a mean time of 4.0 days +/-3.1 after the BRTO procedure (median: 3 days, range: 1-14 days after BRTO). ****The platelet sample was obtained at a mean time of 450 days +/-176 (15 months) after the BRTO procedure (median: 430 days, range: 183-793 days after BRTO). BRTO: Balloon-occluded retrograde transvenous obliteration
Table 3 demonstrates the results of the multivariate analysis for determining risk factors for developing post-BRTO bleeding (upper gastro-intestinal rebleeding) and post-BRTO patient survival. From the multivariate analysis we did not identify any predictors of patient survival [Table 3]. Predictors of post-BRTO rebleeding were only MELD-score, serum albumin, INR, and the combined etiology of alcohol and hepatitis C related liver cirrhosis [Table 3]. The baseline platelet count was not a predictor for either post-BRTO bleeding or patient survival. Table 4 shows the rebleed rate and transplant-free patient survival rate up to 4-years after the BRTO-procedure.

Seven patients experienced post-BRTO bleeding at a mean interval of 21.3 months (Range: 0.4-34 months) after BRTO. Among these patients, four experienced bleeding from portal hypertensive gastropathy and were treated conservatively. One patient bled from a duodenal peptic ulcer at 29 months post-BRTO and was treated with endoscopic clips. Another patient bled 23 months after the BRTO procedure with no clear source. This patient was considered as a gastric variceal rebleed. The seventh patient exhibited esophageal variceal bleeding 7 months after the BRTO procedure. This patient eventually succumbed to hepatic failure and coagulopathy.

**DISCUSSION**

Majority of patients with gastric varices are patients with portal hypertension with or without cirrhosis and thus have presumed splenomegaly. The high prevalence of portal hypertension and splenomegaly in the cirrhotic population would lead to a high prevalence of thrombocytopenia. Thrombocytopenia and platelet dysfunction are common in patients with cirrhosis. The decreased platelet count in this population is mainly attributable to pronounced platelet sequestration in the enlarged spleen. Reduced
levels of liver derived thrombopoietin may further aggravate the thrombocytopenia in cirrhotic patients.\cite{21,22}

The majority of patients with gastric varices have splenomegaly due to underlying cirrhotic or non-cirrhotic portal hypertension.\cite{4,5} The exact incidence of splenomegaly due to underlying cirrhotic or non-cirrhotic portal hypertension is unknown and would depend on spleen size and the severity of liver dysfunction among other factors. Our study confirms that thrombocytopenia is very prevalent (>90%) in this population with 17% of the patients in our cohort having severe thrombocytopenia (<50,000 platelets/cm³).

BRTO obliterates the entire gastric variceal system (defined as the gastric varices and the draining portosystemic shunt: the gastro-renal shunt), thus the gastrorenal shunt is obliterated during the procedure.\cite{23-25} This is the natural outflow of, at least part, of the spleen. In theory, obliteration of this gastro-renal shunt would presumably cause engorgement of the spleen (aggravating splenomegaly) and thus may lead to further platelet sequestration and worsening of the thrombocytopenia. Indeed, worsening splenomegaly after BRTO has been reported in excess of one-third of patients.\cite{10,11} However, the effect of BRTO on the platelet count has not been studied. The current study shows that BRTO has no significant effect on the platelet count, although there was a trend for platelet count reduction (P = 0.057) within 14 days of the procedure [Table 2 and Figure 2]. This slight reduction, may be due to transient splenic engorgement, but also may be due to the hemolytic effect of the sclerosant used (3% sodium tetradecyl sulfate). In the long-term, the increased flow to the liver as a result of BRTO may increase thrombopoietin production from the liver, which compensates for the spleen engorgement. In other words, from a thrombocytopenia standpoint, the negative effect of BRTO on spleen size is nullified by the positive of liver function.

Platelet count has commonly been considered as a gauge of portal hypertension and surgical candidacy for cirrhotic patients.\cite{6-9} Moreover, platelet count has an integral part in hemostasis in general and variceal bleeding to be specific. Hemostasis in liver disease is a complex process with many variables that are not well elucidated. This is due to the alternations in both pro- and anticoagulant factors in this patient population.\cite{21,26} As a result, an evaluation of the pre-BRTO baseline platelet count as a predictor of both patient survival and rebleed rates after the BRTO-procedure was considered as an aim for this study. However, we could not find an association between lowered platelet counts (<100,000/cm³) and patient survival or rebleeding post-BRTO. In fact, we could not detect any predictors of survival after BRTO. The study did, however, find that INR, MELD-score, serum albumin, and etiology of ethanol abuse and viral hepatitis C are predictors of post-BRTO upper gastrointestinal rebleeding.

The threshold for thrombocytopenia (platelet count <150,000/cm³) is the standard definition for thrombocytopenia. However, over 90% of the population had a platelet count of less than 150,000/cm³. Due to the small sample size, we chose a cutoff of 100,000/cm³ to reach a comparative analysis. Further limitations to this study are its retrospective nature and its small sample size. Although 35 patients is not a small sample given the clinical nature of gastric varices it is statistically small. Moreover, the retrospective nature confined the platelet count sampling times to ranges because there was no set protocol (this is not a prospective and deliberate study but a retrospective audit of data).

The current study shows the impressive results of the BRTO procedure (utilizing 3% sodium tetradecyl sulfate) in controlling gastric variceal bleeding. The gastric variceal rebleed rate following successful BRTO is 4% at 12-18 months with an overall rebleed rate (regardless of source/etiology) of 7% at 12-18 months. Patient survival during the same time period (12-18 months post-BRTO) is approximately 80% (76-84%). The current authors believe that any mortality, worsening hepatic reserve, and bleeding from portal hypertensive gastropathy after 12-18 months is not related to the BRTO procedure or exacerbation of portal hypertension associated with BRTO, but is more likely due to the progression of liver disease and portal hypertension.

If the sample size had been larger, the findings (that are not significant in this study) may show a slight and transient reduction of platelet count within 10-14 days after the BRTO-procedure and then a gradual increase of the platelet count (above the pre-BRTO baseline count) over the next 6 months [Table 3]. We can only speculate that such a gradual increase in platelet count may be a reflection of increased hepatic volume, hepatic reserve, and the resultant increase in liver synthesized thrombopoietin. In the long-term, the increased flow to the liver as a result of BRTO may increase thrombopoietin production from the liver, which compensates for the spleen engorgement. In other words, from a thrombocytopenia standpoint, the negative effect of BRTO on spleen size is nullified by the positive of liver function.

**CONCLUSION**

In conclusion, thrombocytopenia is prevalent in patients with gastric varices undergoing BRTO-procedure (>90% of patients). However, the BRTO procedure has no effect on...
the platelet count up to 6 months following the procedure. In particular, BRTO of gastric varices does not exacerbate thrombocytopenia. However, there is a trend of reduced platelet count, which is slight (not statistically significant) and transient not lasting more than 14 days following the BRTO-procedure. The baseline pre-BRTO platelet count (of less than 100,000 platelets/cm³) is not a predictor of post-BRTO rebleeding or patient survival.

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