Original Article

Effect of large volume paracentesis performed just prior to transjugular intrahepatic portosystemic shunt on the anesthetic management during the procedure

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Abstract

Background and Aims: Patients often undergo paracentesis prior to a transjugular intrahepatic portosystemic shunt (TIPS) procedure to improve respiratory mechanics. However, the effect of large volume paracentesis (LVP) on intraoperative hemodynamics and anesthetic management when it is performed immediately before the TIPS procedure is not well documented.
Material and Methods: This is a retrospective study in patients undergoing the TIPS procedure between 2004 and 2017. Patients were divided into two groups based on the volume of preoperative paracentesis, namely, small volume paracentesis (SVP), defined as paracentesis volume less than 5 L and LVP, defined as paracentesis volume of at least 5 L. Patients' demographics and perioperative information were collected through chart review. The Wilcoxon signed-rank test, student's t-test, and Fisher's exact test were used when appropriate. Uni- and multivariate linear regression analyses were used to determine the predictive value of paracentesis volume in relation to intraoperative hemodynamics and management of hypotension.
Results: Of 49 patients, 19 (39%) received LVP and the remainder received SVP. Baseline demographics were comparable between groups as were intraoperative hypotension and volume of infused crystalloid and colloid. However, vasopressor use ($P = 0.02$) and packed red blood cell transfusion ($P = 0.01$) were significantly higher in the large volume group. Paracentesis volume was an independent predictor of the phenylephrine dose ($P = 0.0004$), and of crystalloid ($P = 0.05$) and colloid ($P = 0.009$) volume administered after adjusting for age, sex, body mass index, alcohol use, hemoglobin, and model for end-stage liver disease score.
Conclusion: The anesthetic management of patients who undergo LVP just prior to a TIPS procedure may require larger doses of vasopressors and colloids to prevent intraoperative hemodynamic instability during the TIPS placement but may be as well tolerated as SVP.

Keywords: paracentesis, transjugular intrahepatic portosystemic shunt

Introduction

Current management options for ascites refractory to medical management include serial paracentesis and transjugular intrahepatic portosystemic shunt (TIPS).[1] TIPS is effective in decompressing the portal venous system; however, due to the incidence of hepatic encephalopathy in up to 35% of cases,[2] it is recommended only as a second-line therapy.[3] Serial paracentesis, on the other hand, is generally safe, effective, and well-tolerated by most patients, especially when less than 5 L of ascitic fluid is removed, and is therefore considered to be first-line therapy.[4] Hemodynamic perturbations may occur, however, when larger volumes are removed as in the so-called large volume paracentesis (LVP).[5] In our institution, patients scheduled to receive a TIPS in the interventional radiology suite routinely undergo paracentesis just prior to the TIPS

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to improve respiratory mechanics; however, physicians had varying opinions on the most appropriate volume of the fluid to be removed. Our search in current published literature did not yield any prior study that provided sufficient evidence supporting one way or the other. We, therefore, decided to conduct a retrospective analysis of patient data to examine whether the volume of preoperative paracentesis has any effect on the anesthetic management during the TIPS procedure.

Material and Methods

This study was an institutional review board approved retrospective review of electronic medical records in an academic medical center in adult patients who had a TIPS procedure performed between January 1, 2014 and June 1, 2017. Patients who had undergone paracentesis immediately prior to an elective TIPS procedure to treat portal hypertension and who had a complete anesthesia record were included in the study. The patients were divided into two groups based on the volume of preoperative paracentesis. Small volume paracentesis (SVP) was defined as paracentesis volume less than 5 L and LVP was defined as paracentesis volume of ≥5L. Patient's age, sex, body mass index (BMI), status of alcohol use, model for end-stage liver disease (MELD) score, pre-TIPS hemoglobin, and paracentesis volume immediately prior to the TIPS procedure were collected. Periprocedural outcomes of interest included volume of infused colloids and crystalloids, transfused packed red blood cells (PRBC) and fresh frozen plasma, phenylephrine dosage, and the length of time that mean arterial pressure (MAP) was below 55 mmHg, 60 mmHg, and 65 mmHg. Patients in Groups SVP and LVP compared.

Statistical analyses were performed using JMP Version 13.1 (SAS, Cary, NC). Statistical significance for continuous variables and nominal variables were determined by Wilcoxon signed-rank test and the Fisher's exact test, respectively. An association with a P value of 0.05 or less was deemed statistically significant.

Results

Of 49 patients, 19 (39%) received LVP. The mean paracentesis volume was 8.1 ± 3.7 and 2.8 ± 1.3 L in LVP and SVP groups, respectively. We found baseline characteristics to be comparable between the two groups except for the paracentesis volume [Table 1]. The duration of intraoperative hypotension and the volume of crystalloid and colloid used were also similar between groups. However, vasopressor use ($P = 0.02$) and PRBC transfusion ($P = 0.01$) were significantly higher in the LVP group.

All surgeries were performed under general anesthesia (GA). Propofol or etomidate was used for induction of anesthesia. Two out of 30 SVP patients received etomidate at induction while all LVP patients received propofol at induction [Table 2]. The average dose of propofol used for induction for SVP and LVP was 1.59 ± 0.51 and 1.42 ± 0.47 mg/kg, respectively. Arterial line placement was very common during TIPS. Central line placement was very rare only one patient in the SVP group received a central line. For maintenance of anesthesia, either inhalational or intravenous, or a combination of the two were used. Short-acting opiates (e.g., alfentanil, fentanyl) were used in carefully titrated doses to aid tube tolerance and cover stimulating parts of the procedure. A bolus or infusion of phenylephrine, norepinephrine, or vasopressin was used for prevention/treatment of systemic hypotension. One patient in the SVP group and two patients in LVP group were kept intubated at the end of surgery for airway protection because of GI bleeding.

Linear regression revealed a significant correlation between paracentesis volume and phenylephrine dose [Figure 1a], {phenylephrine (μg) = −50.5 + 70.1

Table 1: Patient characteristics and outcomes of interest pre-TIPS based on large vs. small paracentesis volume

	LVP Group (n=19)	SVP Group (n=30)	P
Age (years) (Mean±SD)	54±9	57±11	0.332
Male Sex, n (%)	13 (68)	21 (70)	1.0
BMI (kg/m2) (Mean±SD)	29.3±9.0	28.4±7.7	0.708
Alcohol Use (n)	13	18	0.762
Hb (gm/dl) (Mean±SD)	10.5±2.6	10.0±1.6	0.300
Pre-TIPS MELD (Mean±SD)	16.9±8.3	16.2±6.7	0.951
Phenylephrine Used (mg) (Mean±SD)	515±618	209±381	0.021*
PRBC Used (unit) (Mean±SD)	240±661	0±0	0.010*
Colloids Used (mL) (Mean±SD)	745±539	538±516	0.155
Crystalloids Used (mL) (Mean±SD)	1759±1168	1287±780	0.214
Minutes of Hypotension (MAP <55 mmHg) (Mean±SD)	3.8±9.7	2.3±4.2	0.962
Minutes of Hypotension (MAP <60 mmHg) (Mean±SD)	15.2±33.2	11.4±16.6	0.855
Minutes of Hypotension (MAP <65 mmHg) (Mean±SD)	37.0±52.2	27.7±32.1	0.543

LVP=large volume paracentesis; SVP=small volume paracentesis. P<0.05

* paracentesis volume (L), r = 0.286, 95% CI [0.006, 0.524]}; colloid infusion volume [Figure 1b] {total colloids (mL) = 418.6 + 42.1* paracentesis volume (L), r = 0.448, 95% CI [0.191, 0.647]}; and crystalloid infusion volume [Figure 1c] {total crystalloids (mL) = 848.2 + 117.8 * paracentesis volume (L), r = .534, 95% CI [0.298, 0.708]}. Furthermore, multivariate regression analysis suggests that paracentesis volume is an independent predictor of the phenylephrine dose [Figure 2a, $P = 0.0004$], crystalloid volume [Figure 2b, $P = 0.05$], and colloid volume [Figure 2c, $P = 0.009$] after adjusting for age, sex, BMI, alcohol use, hemoglobin, and MELD score.

Discussion

LVP is often performed prior to TIPS in patients with tense ascites to improve functional residual capacity.[6,7] Immediately after LVP, there is an improvement in hemodynamics with an increase in cardiac output and associated decrease in systemic vascular resistance. However, over the ensuing 5–6 days, a complex interplay of various neuro-hormonal factors often occurs, causing a prolonged phase of splanchnic vasodilation and effective hypovolemia that is not spontaneously reversible and referred to as paracentesis-induced circulatory dysfunction.[8] These hemodynamic changes are best avoided by performing an LVP the day prior to the TIPS and by replacing volume with albumin; the general rule of thumb is to infuse 8 g albumin for every 2.5 L of ascites drained. With the recent trend of performing LVP and TIPS on the same day, the anesthetic management can be a challenge. The decrease in systemic vascular resistance can be accentuated by anesthetic agents resulting in severe hemodynamic collapse.

TIPS is usually performed at a remote site and the anesthesia team should always consider the complexity of delivery of care in an unfamiliar environment with personnel who are not necessarily trained in anesthetic practice. TIPS could be performed under conscious sedation, monitored care anesthesia or GA. Taking into consideration the long duration of the procedure, the possibility of intraoperative life-threatening events, poor oxygenation in presence of acute respiratory failure and degree of ascites (often complicated by hydrothorax), increased intragastric pressure or acute GI bleeding, and the challenges of working in a "remote environment," GA is accepted as the first option for most anesthesiologists at our institution for this procedure. In this study, either propofol or etomidate was used for induction. Usually, etomidate is the preferred induction agent for critically ill patients with minimal effects on blood pressure. Recently,

Table 2: Anesthetic management of patients for TIPS after large vs. small volume paracentesis

	LVP (n=19)	SVP (n=30)
Induction		
Propofol (n)	19	28
Etomidate (n)	0	2
Propofol dose (mg/kg)	1.42±0.47	1.59±0.51
Fentanyl dose (μg/kg)	1.01±0.48	1.1±0.48
A line placement (n)	12/19	20/30
Central line placement (n)	0	1
Extubation in the operating room (n)	17	29

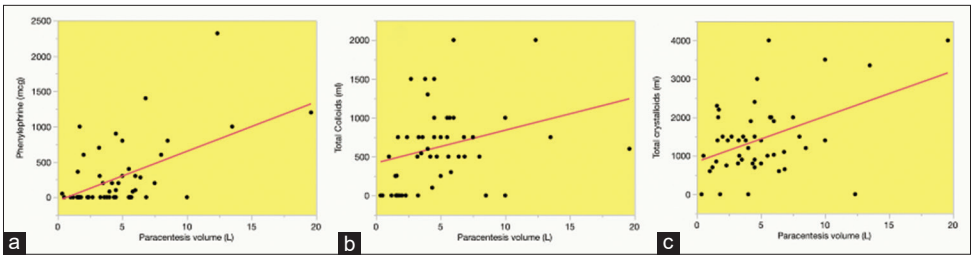

Figure 1: Univariate linear regression analysis of paracentesis volume vs. (a) phenylephrine dose administered; (b) total volume of colloids administered; (c) total volume of crystalloids administered.

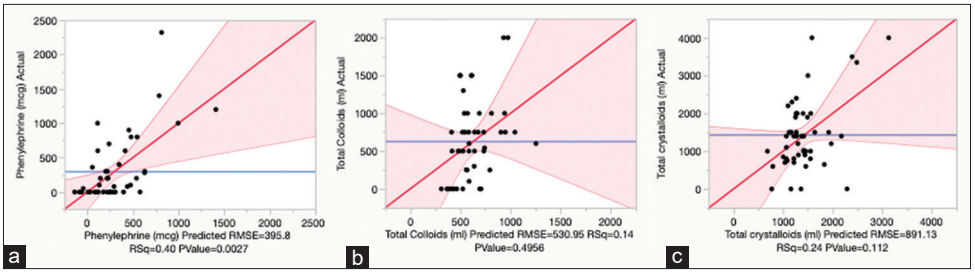

Figure 2: Multivariate linear regression analysis of paracentesis volume vs. (a) phenylephrine dose administered; (b) total volume of colloids administered; (c) total volume of crystalloids administered.

however, it does appear that etomidate has the potential to increase the risk of adrenal gland dysfunction and multiorgan system dysfunction to a small degree,[9] which could be the reason why the anesthesiologists chose propofol most of the times. The induction dose of propofol was similar between two groups, but was lower than the general dose 2–3 mg/kg.

Hemodynamic stability may be challenging with ongoing variceal bleeding. Intravenous fluid and blood product administration is required to maintain circulating volume and correct coagulopathy to an acceptable level for jugular and hepatic puncture. While hypovolemia is not uncommon from acute hemorrhage, volume overload also could be a problem in patients with marginal cardiac performance during the procedure. Accurate fluid balance and, when needed, forced diuresis with loop diuretics may be used to avoid acute cardiac decompensation and pulmonary edema. In our study, we did not see a significant difference on the volume of crystalloid fluid infusion between two groups. However, the LVP group received higher dose of phenylephrine. The choice of vasopressors was based on the anesthesiologist's preference and the severity of the hypotension. Phenylephrine, norepinephrine, and vasopressin were the most commonly used vasoactive medications to treat intraoperative hypotension, either as boluses or intravenous infusions.

In our cohort, there were no reports of hemodynamic collapse during induction of anesthesia or thereafter even when more than 8 L of ascitic fluid was drained. Patients remained hemodynamically stable regardless of the volume drained. Moreover, the volume of crystalloids and colloids administered was not significantly different. In addition, patients with LVP did not spend significantly more time in a hypotensive state, defined either as MAP <55, <60, or <65mmHg, than their small volume counterparts. This is in part due to prompt correction of hypotension by the anesthesiologist, as evidenced by the significantly higher use of phenylephrine in the LVP group, suggesting that the hemodynamic changes caused by an LVP are amenable to vasopressors. Mechanistically, the hypotension seen after LVP likely derives from vasodilatory adenosine or nitric oxide overproduction by inducible synthases as is the case in dialysis hypotension and septic shock.[10] With vasopressor use, the alpha-adrenergic agonist effects directly counteract the increases in cAMP from adenosine in smooth muscle cells and thus the hypotension responds swiftly.

In summary, this study answers an important question that, as far as we know, has not been described in existing literature by demonstrating that removal of large amounts of paracentesis fluid immediately prior the TIPS procedure may lead to some intraoperative hemodynamic changes but does not lead to hemodynamic collapse and that such perturbations can be safely managed by experienced anesthesiologists with fluids and vasopressors. The anesthesiologist should expect to use proportionately more vasopressors and colloids, especially when a larger amount of paracentesis fluid is removed.

Conclusion

To the best of our knowledge, this is the first attempt to understand the hemodynamic response of patients to anesthesia when LVP has been performed on the same day as a TIPS procedure. LVP just prior to a TIPS procedure may not increase the occurrence of intraoperative hemodynamic instability in patients compared to preprocedural small volume paracentesis; however, paracentesis volume does appear to be an independent predictor of the phenylephrine dose as well as colloid volume when adjusting for various demographic variables.

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Conflicts of interest
There are no conflicts of interest.

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