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Effect of terlipressin on systemic and hepatic hemodynamics in patients undergoing liver transplantation

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ABSTRACT

Background and Aims: Liver transplantation is associated with hemodynamic instability. Systemic and Splanchnic circulations interact closely. Portal hypertension is linked to vasodilatory molecules resulting in arterial vasodilatation. Terlipressin, is a synthetic vasopressin analogue causes selective vasoconstriction of splanchnic arteriols, thus decreasing splanchnic blood flow and shifting blood from the splanchnic to the systemic circulation resulting in enhanced systemic hemodynamics.

This study aimed to assess the impact of intraoperative terlipressin on systemic and hepatic hemodynamics in recipients of living donor liver transplantation (LDLT).

Methods: The present longitudinal observational study was carried out at Ain Shams Center for Organ Transplant on 30 cases suffering from portal hypertension and chronic liver disease undergoing LDLT. Subjects were equally categorized into two groups: Group 1(control): patients did not receive intraoperative terlipressin, Group 2 (terlipressin): patients received terlipressin (1 mg intravenously over 10 min) just after exposure of the portal vein to maintain mean arterial blood pressure over 65 mmHg.

Results: Systolic and diastolic blood pressure were better preserved in the terlipressin group, with reduced norepinephrine requirements as well as a substantial decline in the heart rate during the anhepatic and reperfusion phases ($P < 0.05$). Terlipressin significantly decreases portal venous pressure with ($P = 0.03$) and portal vein flow ($P < 0.001$) without altering the hepatic artery resistivity index (HARI) ($P = 0.219$).

Conclusion: Intraoperative terlipressin during liver transplantation surgery was associated with improved systemic hemodynamics despite decreased portal venous pressure and blood flow, without affecting HARI.

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1. Introduction

Liver transplantation is linked to hemodynamic instability induced by comorbidities, an inherent hemorrhagic tendency, and surgical technique. It involves a complete porto-systemic collateral vessels dissection as well as great vessel clamping or nclamping with ischemia – reperfusion damage as a consequence. Therefore, vasopressor administration as well as, rational fluid significantly contribute to maintaining hemodynamic stability in liver transplant recepients [1]. Systemic and splanchnic circulation closely interacts with one another. In individuals with portal hypertension and liver cirrhosis, splanchnic circulation is principally responsible for maintaining the pressure and volume of the systemic blood pressure. Portal hypertension is linked to decline central blood volume, vasodilatory molecules overproduction, and consequent arterial vasodilatation along with declined arterial blood pressure as well as elevated heart rate (HR) and cardiac output (COP [2]. Therefore, splanchnic circulation's pharmacologic modulation using vasoconstrictors such as terlipressin can alleviate venous congestion, and maintain central blood flow, thereby optimizing control of blood volume during liver transplant surgeries [3]. Terlipressin decreases splanchnic blood flow and reduces portal hypertension in cirrhotic patients. Moreover, it transfers blood from the splanchnic to the systemic circulation, improving systemic hemodynamics [4]. The present study attempted to examine intra operative terlipressin`s impact on systemic and hepatic hemodynamics in (LDLT) recipients.

1.1. Patients and methods

After ethical approval of the study from the Ain-Shams University committee number FMASU MD79a/2019/2020/2021/2022/2023 and written informed patient consent, this longitudinal observation study was carried out in Ain Shams Center for Organ Transplant on 30 cases, the cases included suffering from portal

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hypertension , along with chronic liver disease and scheduled as recepients for LDLT. Portal hypertension diagnosed by preoperative non invasive liver Doppler ultrasound (portal pressure >20 mmHg or hepatic venous pressure gradient >5 mmHg) done by senior specialist.

Subjects were assigned to one of two groups: Group 1(control): Patients not receiving intraoperative terlipressin Group 2 (terlipressin): patients receiving introperative terlipressin.

Selection of patients who will receive intraoperative terlipressin was decided intraoperative by the responsible anesthesia team according to selection criteria (inclusion and exclusion criteria). The data collector was blinded to avoid bias of the results.

During surgery, in the terlipressin group, terlipressin (Glypressin; FERRING, Switzerland)

was immediately initiated following portal vein exposure in the preanhepatic phase (T2) as a bolus dose (1 mg) over more than 10 mins every 4 hours to maintain MAP >65 mmHg in addition to other vasopressors if needed, while in the control group vasopressors supplementation with norepinephrine was used to maintain hemodynamic stability (MAP >65 mmHg)

The study's exclusion criteria included age <21 years, history of myocardial infarction or angina, cardiac decompensation, arrhythmias, uncontrolled hypertension, parenchymal renal disease (proteinuria, creatinine >3 mg/dl, glomerular filtration rate <60 ml/min by isotope scanning of the kidney) or obstructive uropathy,cases undergoing retransplantation, as well as those with hepatic encephalopathy and cerebrovascular diseases.

Preoperative patients' assessment was done according to the transplant center protocol which included age, sex, weight, height, BMI, severity of liver disease (MELD score, Child-Pugh class) and presence of comorbidities (e.g., diabetes, hypertension, bronchial asthma). Examination of conscious level, ascites, chest condition and examination for any sign of infection was done. Investigations included complete blood picture, albumin, coagulation profile, renal function, liver function, serum electrolytes, CRP, cultures, and functional cardiological and respiratory assessments.

In the operating room, patients were connected to the standard monitoring system for measuring heart rate, blood pressure, o2 saturation, and temperature. Vascular access was in the form of a suitable size (20 G) arterial cannula; for sampling and invasive blood pressure monitoring, two large-bore (14–18 G) peripheral venous cannulas, a percutaneous sheath (6 or 7 F) as well as a central venous catheter. General anesthesia was induced in the two groups using Fentanyl 2 µg/kg IV, Propofol 2 mg/kg IV, atracurium 0.5 mg/kg IV followed by endotracheal intubation and maintenance with a combination of air and oxygen 50% with isoflurane. Adjustments of mechanical ventilation were made targeting end-tidal CO2 (35–40 mmHg). Albumin 4% in Ringer acetate was used to maintain central venous pressure (CVP) less than 5 mmHg in the dissection phase and >5 mmHg. Afterward, packed red blood cells were transfused with a target hematocrit of 25% and Hb of 8 g/dL. Data were collected as regards systemic hemodynamics variables such as diastolic and systolic blood pressure, and heart rate. Additionally, the variables of acid base balance in the form of lactate and base deficit. Other variables examined included the blood product requirements, hourly urine output and total norepinephrine requirements.

Hepatic hemodynamics in the form of hepatic artery resistivity index, portal vein flow velocity, portal venous pressure, and hepatic artery blood flow was also measured by Doppler US by an experienced radiologist. Data were recorded at T1 (baseline): after induction of anesthesia, T2 (Preanhepatic): After an hour from the induction of anesthesia in the controls and after terlipressin in terlipressin group, T3 (Anhepatic): 30 mins after clamping of portal vein, andT4 (Neohepatic): 60 mins after reperfusion of portal vein.

The data collection including effect of terlipressin on systemic and hepatic hemodynamics was limited until 60 min after reperfusion of portal vein, hepatic artery and bile duct reconstruction

Primary outcome: effect of intraoperative terlipressin on hepatic hemodynamics (portal venous pressure, portal venous flow and hepatic artery resistive index)

Secondary outcome: effect of intraoperative terlipressin on systemic hemodynamics (blood pressure, heart rate, UOP and the amount of transfused blood products and doses of norepinephrine supplementation).

1.1.1. Sample size calculation

The calculation of sample size was determined utilizing the STATA program, setting the power at 80% (1-β) at 0.8 as well as the type-1 error (α) at 0.05. The findings of [5] demonstrated that mean arterial pressure was substantially elevated in the terlipressin group compared to controls throughout the LDLT surgery's anhepatic phase (67.4 ± 4.8 vs. 61.5 ± 3, respectively. Based on the statistical analysis results, the study should include a sample size of 12 subjects/group. Nevertheless, after considering a 20% drop-out rate, the number of cases was increased to 30.

1.2. Statistical analysis

Data statistical analysis was done utilizing the 23rd version of the SPSS software version (Chicago, IL). The tests used were as follows:

When comparing two means, the independent-samples t-test of significance was applied. -The

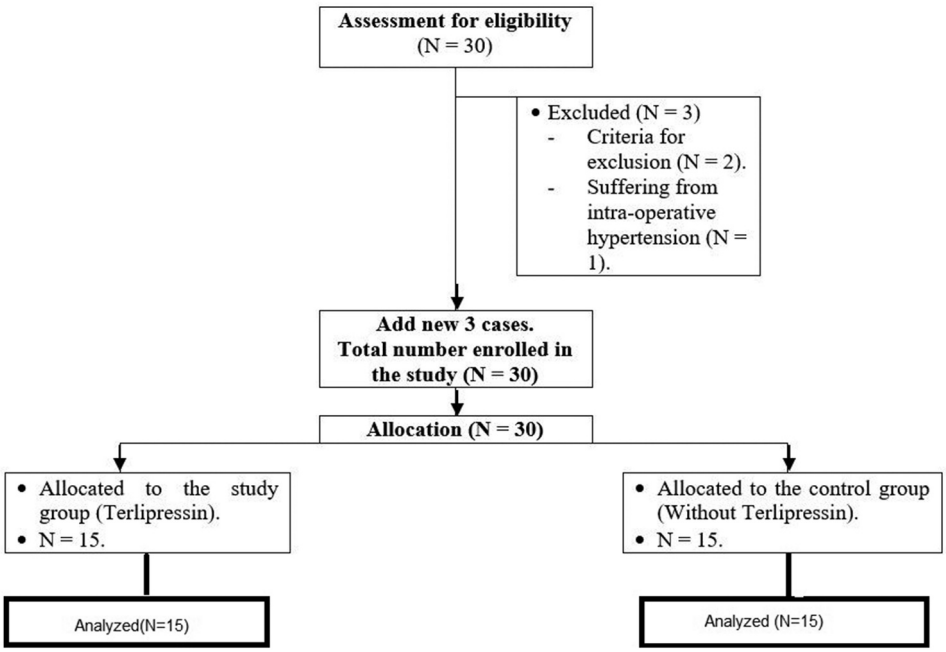

Figure 1. FLOW chart of the study.

proportions between two qualitative measures were compared using the Chi-square (X2) test of significance. For two-group comparisons in non-parametric data, use the Mann–Whitney U test. The confident interval was set to 95% and the margin of error accepted was set to 5%. So, the P-value was considered significant as the following.

The likelihood (P-value): A P-value of 0.05 or less was deemed significant.

P-values below 0.001 were deemed to be very significant.

2. Results

A total of 30 patients were enrolled in this study and allocated into two groups after each patient had been selected by the attending responsible anesthesia team according to selection criteria as shown in the CONSORT flow chart (Figure 1).

There were no substantial differences between groups as regards demographic data (BMI, age, sex, MELD score, and Child-Pugh score) and comorbidities (Table 1). Although there were no documented differences statistically between both groups among individuals diagnosed with end-stage liver disease, hepatitis B and C viruses, cryptogenic, hepatocellular carcinoma, sclerosing cholangitis & autoimmune hepatitis, a significantly more significant number of portal vein thrombosis cases were found in controls than in terlipressin subjects ($p < 0.001$) (Table 1).

As regards systemic hemodynamics, systolic blood pressure was better maintained in the terlipressin group than controls throughout the anhepatic phase (30 min following portal vein closure) ($P < 0.05$) and immediately after reperfusion ($P < 0.001$). As depicted in (Table 2), diastolic blood pressure in the terlipressin group was also substantially higher compared to controls at T4 ($p < 0.001$).

Norepinephrine requirements were lower in the terlipressin group compared to controls atT3 and T4 ($p = 0.035$ and 0.044, respectively) (Table 3).

Heart rate was comparable between the two groups at T1 and T2 but significantly lower in the terlipressin group at T3 and T4 compared to controls ($p = 0.047$, 0.028 respectively) (Table 2).

Compared with controls, base deficit and serum lactate levels in the terlipressin group were significantly higher at T3 ($p < 0.001$) but statistically significantly lower at T4 ($P < 0.05$) (Table 4).

The utilization of fresh-frozen plasma and packed red blood cells, amount of blood loss, were comparable between the two cohorts (Table 5).

Portal venous blood flow after reperfusion substantially declined in the terlipressin group relative to controls (59.87 ± 10.35 vs. 79.07 ± 15.15 cm/s) ($P < 0.001$). In contrast, portal venous pressure was substantially decreased in the terlipressin group ($p = 0.030$), with no marked differences between groups in relation to hepatic artery resistivity index and the hepatic artery blood flow (Table 6).

3. Discussion

In this study, early intraoperative terlipressin administration in liver transplantation surgery was accompanied by improved systolic and arterial blood pressures, reduced norepinephrine requirements in the anhepatic and neohepatic phases, and improved tissue perfusion, as evident by lower serum lactate and base deficit during the neo-hepatic phase. These changes in systemic hemodynamics came in the face of reduced portal venous pressure and portal blood flow without affecting HARI.

Terlipressin works selectively on (V1) receptors in the vascular smooth muscle in the splanchnic vessels, causing vasoconstriction as well as a decline flow to the splanchnic blood flow, declined portal blood flow, thereby causing decreased portal blood pressure as well as improved systemic hemodynamics [6]. The results of the current study as regards systemic hemodynamics have been supported by previous studies.

References [7] and [8] studied the terlipressin impacts on systemic hemodynamics in cirrhotic cases and detected elevation in systolic blood pressure and systemic vascular resistance (SVR). They illustrated that normalizing diminished SVR in cirrhotic cases suffering from portal hypertension contributes to restoring hepatic splanchnic blood to the central compartment, in addition to enhancing perfusion into primary organs. In agreement with our study, references [9], [10] and [5] conducted a prospective study on LDLT recipients and demonstrated a decrease in cardiac output and heart rate in the terlipressin group ($p < 0.01$).

Terlipressin increases diastolic and systolic blood pressure, as well as lowers heart rate and cardiac output through its action on V1 receptors responsible for smooth muscle contraction, which is particularly prevalent in the splanchnic bed. Consequently, [9] hypothesized that terlipressin attenuates hyperdynamic circulation by increasing mean blood pressure and lowering heart rate reflexively.

Similar to the results of the current study as regards serum lactate and base deficit [11], showed that terlipressin resulted in a substantial decline in portal venous pressure with no signs of intraoperative splanchnic hypoperfusion evident by normal lactate and venous pH levels. On the contrary [4], concluded that there was no statistically significance between the terlipressin group and the control group as regards

Table 1. Comparison between Cases (with Terlipressin) and Control (without Terlipressin) according to demographic data, diagnosis and comorbidities.

	Cases (with Terlipressin)	Control (without Terlipressin) "number = 15"	Test value	p-value
Demographic data				
Age (years)				
Mean±SD	46.27 ± 13.48	51.33 ± 11.84	t:1.094	0.283
Range	28–60	30–60		
Sex				
Female	5 (33.3%)	6 (40.0%)	x^2:0.14	0.705
Male	10 (66.7%)	9 (60.0%)		
Body Mass Index (BMI [Kg/m2)				
Mean±SD	27.53 ± 4.66	27.60 ± 4.40	t:0.040	0.968
Range	18–32	20–34		
Model for End stage Live Disease (MELD) score:				
Mean±SD	13.40 ± 2.31	11.73 ± 3.28	t:1.612	0.118
Range	10–17	9–16		
Child score				
Mean±SD	10.10 ± 2.40	8.80 ± 2.70	t:1.394	0.174
Range	7–14	5–12		
Child-Pugh class				
A	0 (0.0%)	3 (20.0%)	x^2:3.692	0.158
B	7 (46.7%)	7 (46.7%)		
C	8 (53.3%)	5 (33.3%)		
Diagnosis				
ESLD	15 (100.0%)	15 (100.0%)	0.000	1.000
HCV	11 (73.3%)	11 (73.3%)	0.000	1.000
PVT	0 (0.0%)	8 (53.3%)	10.909	<0.001**
HBV	2 (13.3%)	2 (13.3%)	0.000	1.000
Cryptogenic	0 (0.0%)	2 (13.3%)	2.143	0.143
HCC	6 (40.0%)	5 (33.3%)	0.144	0.705
Sclerosing cholangitis	2 (13.3%)	0 (0.0%)	2.143	0.143
AIH	2 (13.3%)	0 (0.0%)	2.143	0.143
Comorbidities				
DM	10 (66.7%)	7 (46.7%)	1.222	0.269
HTN	5 (33.3%)	2 (13.3%)	1.623	0.203
BA	3 (20.0%)	6 (40.0%)	1.429	0.232
SLE	2 (13.3%)	0 (0.0%)	2.143	0.143

ESLD: end stage liver disease. HCV: hepatitis C virus. PVT: portal vein thrombosis. HBV: hepatitis B virus. HCC: hepatocellular carcinoma. AIH: Autoimmune hepatitis.
DM: diabetes mellitus. HTN:hypertension. BA: bronchial asthma.SLE: Systemic lupus erythematosus.
Using: t-Independent Sample t-test; x2: Chi-square test.
*p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.001 is highly significant.*

acid – base balance and lactate level with mean lactate level 4.0 mmol/L (2.5 to 12.4) in the terlipressin group and 5.6 mmol/L (3.1 to 8.1) in the controls ($P > 0.05$).

In this study, the requirements of blood transfusion were comparable in both groups as in the prior studies [6,12] found no substantial differences in transfusions, fluid requirements, and estimated blood loss between terlipressin and control groups ($p > 0.05$). These results may be because of the usage of piggy-pack techniques to control bleeding and the usage of cell savers in both terlipressin and control groups. Intraoperatively surgical procedures control bleeding as a venovenousbypass (VVB) and portocaval and portosystemic shunts. Moreover, options for anesthesia management, like lowering CVP and minimum hemodilution with restricted crystalloid infusion, reduce the need for blood product requirements. In other studies [13], and [5] estimated that intraoperative blood loss was substantially elevated in controls than in the terlipressin group. Hence, units of transfused packed RBCs and colloids were considerably elevated in controls ($P = 0.03$ and 0.003, respectively). They stated that one of the advantages of intraoperative terlipressin administration in major prolonged procedures is the marked decline in blood loss estimated in the terlipressin group, as evidenced by the substantial decline in the transfused packed RBC units. This result can be attributable to terlipressin leading to peripheral vasoconstriction in the vasculature and primarily redistribution of blood from the cutaneous, splanchnic bed, and skeletal muscle to the brain and heart through its act on V1 receptors. This finding suggests that terlipressin may have two benefits in uncontrolled bleeding in liver transplantation surgeries, as it can lower bleeding first via diverting blood away from the lesion and by increasing blood supply to vital organs [14].

Our study revealed no substantial differences between groups as regards urine output (UOP). These results come in concordance with the work of [15]. [4] found that higher UOP during anhepatic phase in the terlipressin group compared with the control group is explained to be related to the surgical process,

Table 2. Comparison between Cases (with Terlipressin) and Control (without Terlipressin) according to systolic and diastolic blood pressure (mmHg) and heart rate at different intraoperative stages.

Time	Cases (with Terlipressin) "number = 15"	Control (without Terlipressin) "number = 15"	t-test	p-value
Systolic Blood Pressure (mmHg) SBP				
T1				
Mean±SD	114.67 ± 26.69	108.00 ± 12.07	0.881	0.386
Range	60–140	90–120		
T2				
Mean±SD	100.67 ± 22.51	104.00 ± 12.42	−0.502	0.619
Range	60–130	90–120		
T3				
Mean±SD	110.67 ± 12.80	99.07 ± 13.15	2.448	0.021*
Range	80–130	80–130		
T4				
Mean±SD	132.67 ± 7.99	107.33 ± 16.68	5.306	<0.001**
Range	120–140	90–140		
Diastolic Blood Pressure (mmHg) DPB				
T1				
Mean±SD	75.33 ± 13.56	72.00 ± 10.14	0.762	0.452
Range	50–90	60–80		
T2				
Mean±SD	67.33 ± 15.80	61.33 ± 12.46	1.155	0.258
Range	50–90	50–90		
T3				
Mean±SD	69.33 ± 17.51	66.67 ± 9.76	0.515	0.610
Range	40–90	60–80		
T4				
Mean±SD	88.00 ± 4.14	66.00 ± 14.04	5.821	<0.001**
Range	80–90	50–90		
Heart rate(beat per minute)				
T1				
Mean±SD	72.00 ± 9.41	77.33 ± 14.86	−1.174	0.250
Range	60–80	60–100		
T2				
Mean±SD	82.67 ± 4.58	86.87 ± 9.16	1.588	0.123
Range	70–80	70–120		
T3	76.67 ± 12.52			
Mean±SD	60–120	85.33 ± 10.23	2.075	0.047*
Range		70–120		
T4				
Mean±SD	81.67 ± 9.89	89.40 ± 8.32	2.316	0.028*
Range	70–110	77–130		

Note: T1: after induction (as baseline),T2: after one hour of induction,T3: Anhepatic phase T4:Neohepatic phase.
Using: t-Independent Sample t-test.
*p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.001 is highly significant.*
Data are presented as mean ± SD.

Table 3. Comparison between Cases (with Terlipressin) and Control (without Terlipressin) according to norepinephrinedose"microgram/kg/hour".

Time	Cases (with Terlipressin) "number = 15"	Control (without Terlipressin) "number = 15"	t-test	p-value
T1				
Mean±SD	2.00 ± 0.00	2.30 ± 0.60	1.910	0.066
Range	2–2	2–4		
T2				
Mean±SD	2.00 ± 0.00	2.00 ± 0.00	0.000	1.000
Range	2–2	2–2		
T3				
Mean±SD	3.03 ± 1.03	3.90 ± 1.12	2.214	0.035*
Range	2–4	1–6		
T4				
Mean±SD	2.10 ± 1.19	3.75 ± 1.96	2.111	0.044*
Range	1–4	1–6		

Note: T1: after induction (as baseline),T2: after one hour of induction,T3: Anhepatic phase T4:Neohepatic phase.
Using: t-Independent Sample t-test.
p-value >0.05 is insignificant.

Table 4. Comparison between Cases (with Terlipressin) and Control (without Terlipressin) according to Base deficit and serum lactate.

Time	Cases (with Terlipressin) "number = 15"	Control (without Terlipressin) "number = 15"	t-test	p-value
Base deficit				
T1				
Mean±SD	−1.06 ± 4.74	−2.43 ± 3.34	0.917	0.367
Range	−5.2–5.5	−9_2		
T2				
Mean±SD	−2.29 ± 4.49	−1.17 ± 4.50	−0.686	0.498
Range	−6_5	−10_5		
T3				
Mean±SD	−7.51 ± 1.56	−1.59 ± 3.98	−5.358	<0.001**
Range	−10_-5	−11_1.4		
T4				
Mean±SD	−2.89 ± 1.32	−4.27 ± 2.07	2.177	0.038*
Range	−10_-1	−9_-1		
Serum lactate				
T1				
Mean±SD	1.53 ± 0.40	1.96 ± 1.31	−1.204	0.239
Range	1–2	0.8–5		
T2				
Mean±SD	2.62 ± 1.38	2.51 ± 1.90	0.176	0.862
Range	1–4	0.9–6		
T3				
Mean±SD	5.86 ± 1.55	3.54 ± 1.04	4.825	<0.001**
Range	4.6–8.7	2–5		
T4				
Mean±SD	2.37 ± 0.83	3.55 ± 1.53	−2.642	0.013*
Range	1–3.5	1–5.1		

T1: after induction (as baseline), T2: after one hour of induction, T3: Anhepatic phase T4: Neohepatic phase.
Using: t-Independent Sample t-test.
*p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.001 is highly significant.*
Data are presented as mean ± SD.

Table 5. Comparison between Cases (with Terlipressin) and Control (without Terlipressin) according to blood loss and blood product given.

	Cases (with Terlipressin) "number = 15"	Control (without Terlipressin) "number = 15"	Test value	p-value
Blood loss (ml)				
Mean±SD	2026.67 ± 904.33	1584.00 ± 600.06	U:1.580	0.125
Range	1000–3000	780–2700		
PRBC(packed RBC)(ml)				
Mean±SD	1933.33 ± 1032.80	1584.00 ± 600.06	U:0.677	0.504
Range	1000–3000	780–2700		
Plasma given				
No	11 (73.3%)	9 (60.0%)	x^2:0.600	0.439
Yes	4 (26.7%)	6 (40.0%)		
Plasma given (ml)				
Mean±SD	1050.00 ± 866.03	900.00 ± 328.63	U:0.393	0.704
Range	300–1800	600–1200		

Using: U=Mann–Whitney test; x2: Chi-square test.
p-value >0.05 is insignificant.

Table 6. Comparison between Cases (with Terlipressin) and Control (without Terlipressin) according to hepatic hemodynamic.

Hepatic Hemodynamics	Cases (with Terlipressin) "n = 15"	Control (without Terlipressin) "n = 15"	Test value	p-value
Hepatic artery resistive index				
Mean±SD	0.65 ± 0.10	0.61 ± 0.04	t:1.257	0.219
Range	0.53–0.76	0.6–0.71		
Portal vein flow velocity (cm/sec)				
Mean±SD	59.87 ± 10.35	79.07 ± 15.15	t:4.052	<0.001**
Range	50–78	60–100		
Portal venous pressure (mmHg)				
Mean±SD	7.13 ± 1.63	8.93 ± 2.58	t:2.284	0.030*
Range	6–10	4–11		
Hepatic vein flow				
Triphasic	15 (100.0%)	15 (100.0%)	x^2:0.00	1.000

Using: t-Independent Sample t-test; x2: Chi-square test.
*p-value >0.05 is insignificant; *p-value <0.05 is significant; **p-value <0.001 is highly significant.*

clamping of the portal vein and inferior venacava causes vasoconstriction of the renal arteries, which was more severe in the control group than in terlipressin group. Also he described that overall (mean) hourly UOP did not differ significantly between two groups.

However, in contrast to our study [11], *and* [6] concluded that urine output was markedly elevated in the terlipressin group relative to controls throughout the intraoperative period.

Infusion of terlipressin was documented to lower renal vascular resistance, in addition to elevating renal blood flow, as terlipressin seems to reverse splanchnic vasodilatation without elevating vascular resistance due to the V1 receptors'preferential distribution in the splanchnic area. It has been found that terlipressin administration contributes to lowering aldosterone and renin's plasma concentrations, thereby elevating UOP. Similar to the results of the current study regarding norepinephrine requirements [4]; [12] and [6] revealed that norepinephrine requirements decreased significantly in the terlipressin group relative to controls. The decline in portal flow was not associated with variations in HARI in this study, implying that terlipressin is not responsible for hepatic arterial vasoconstriction and maintaining the flow in the face of decreasing portal perfusion.

A randomized controlled trial by [16] and [17] revealed that intraoperative terlipressin administration during LDLT reduced intraoperative portal venous pressure.

According to [18], vasopressin administration might reduce portal vein pressure and the flow in the native liver, with no reduction in intestinal perfusion or cardiac output in liver-transplanted patients through its selectivity on (V1) receptors inducing vasoconstriction as well as decreased arterial blood flow to the splanchnic area with a subsequent decline in portal blood flow, thereby decreasing portal blood pressure. In addition, [11] found that terlipressin infusion did not reduce HARI in cirrhotic cases with ascites. Fayed et al. [5] found that declined portal blood flow was linked to a reduction in hepatic artery resistance and an increase in hepatic blood flow. Hepatic arterial buffer response (HABR) is an intrinsic regulatory system that maintains the overall blood flow to the liver (when portal venous blood flow declines, the blood flow in hepatic arteries elevates, and vice versa). Some cirrhotic individuals with ascites may have attenuated HABR, which may be a result of hyposensitive adenosine receptors in arteries.

4. Conclusion

Intraoperative bolus terlipressin (not infusion) during liver transplantation surgeries had proved to be effective in improving systolic and diastolic blood pressure and so elevating SVR at anhepatic phase and post-reperfusion phase (Neohepatic phase) and so decreasing the requirements of Norepinephrine and improving tissue perfusion in the form of decreasing serum lactate level and improving metabolic acidosis during neohepatic phase, but it had no effect in the current study neither on blood products requirements nor urinary output through operation. Also it decreases heart rate at anhepatic phase and neohepatic phase.

As regards hepatic hemodynamics, peak portal blood flow and portal venous pressure were reduced with terlipressin without effect on HARI or signs of splanchnic hypoperfusion.

However, further multicentric studies with larger sample size are still needed to support the results of the study.

Disclosure statement

No potential conflict of interest was reported by the authors.

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