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Outcomes of piggyback and side to side cavostomy techniques in hepatic venous reconstruction in liver transplantation—A single centre experience

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Abstract

Background: Over the past few years the hepatic venous reconstruction techniques during liver transplantation have evolved to achieve better outcomes. Apart from Conventional Technique (CT), Piggyback (PB) and Side to Side cavostomy (SS) techniques are increasingly used. **Methods:** A retrospective single centre analysis was done using the data available at the University Vascular and Transplant Surgical Unit of National Hospital of Sri Lanka. Data on patients' demography, type of hepatic venous reconstruction, type of liver transplantation, complications and follow up details were collected. **Results:** 23 patients underwent liver transplantation including 15 for PB, 7 for SS and 1 for CT groups. There was no difference between PB and SS groups in terms of gender, age and type of liver transplantation. Complications were common in PB group (80%) compared to SS group (43%) (P = 0.15). Hepatic Venous Outflow Obstruction (HVOO), primary non function, biliary sepsis were the common complications in two groups. No HVOO occurred in SS group. Overall follow up was 125.1 weeks; 137.3 weeks for PB group and 177.6 weeks for SS groups. **Conclusions:** Although statistically not significant, higher complication rates were found in PB group compared to SS group. Occurrence of HVOO should specially be highlighted.

Keywords: *Liver transplantation, Hepatic venous reconstruction, Piggyback technique, Side to side cavostomy, Hepatic venous outflow obstruction*

1. Introduction

Liver Transplantation (LT) remains the mainstay curative treatment for end stage liver disease of a variety of

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origin. In 2023, over 10000 LT have been carried out in the United States of America (US). According to US data, the commonest causes needing transplantations are alcohol associated and metabolic dysfunction associated liver diseases (Kwong *et al.*, 2023). Over the last few decades, the surgical techniques related to the LT gradually evolved to improve the patient outcomes. The venous reconstruction techniques are one of them (Mehrabi *et al.*, 2009).

The traditionally used caval anastomosis technique is called the Conventional Technique or caval interposition (CT), where recipient undergoes hepatectomy with the removal of the retrohepatic Inferior Vena Cava (IVC) and an end to end caval anastomosis is performed between donor and recipient IVC. For this technique, the Veno Venous Bypass (VVB) is often needed to minimise the haemodynamic instability (Starzl *et al.*, 1963). However, this technique, decreases the venous return to the heart causing multiple metabolic derangements, renal impairment and haemodynamic alternations in the recipient (Mehrabi *et al.*, 2008). To minimize these shortcomings Piggyback (PB) technique was introduced. This technique involves direct anastomosis of the recipient's hepatic veins with the donor's IVC without removal of the recipient's IVC. Even though Hepatic Venous Outflow Obstruction (HVOO) is rare with CT, it was noted that there was a rising trend in HVOO with PB (Arudchelvam *et al.*, 2017). The reported incidence ranges between 1.5% to 4.6% leading to mortality rate up to 23% (Ye *et al.*, 2017). These patients were managed with hepatic venous thrombectomy, venoplasty or stenting. Some patients developed severe HVOO needing retransplantation. To overcome this disadvantage in PB, the technique was modified by performing a cavocaval anastomosis in a Side to Side (SS) fashion. This technique offers theoretical benefits like preservation of caval flow, improved visualization during caval reconstruction, and a decrease in the risk of outflow stenosis (Lee *et al.*, 2020) (Figure 1).

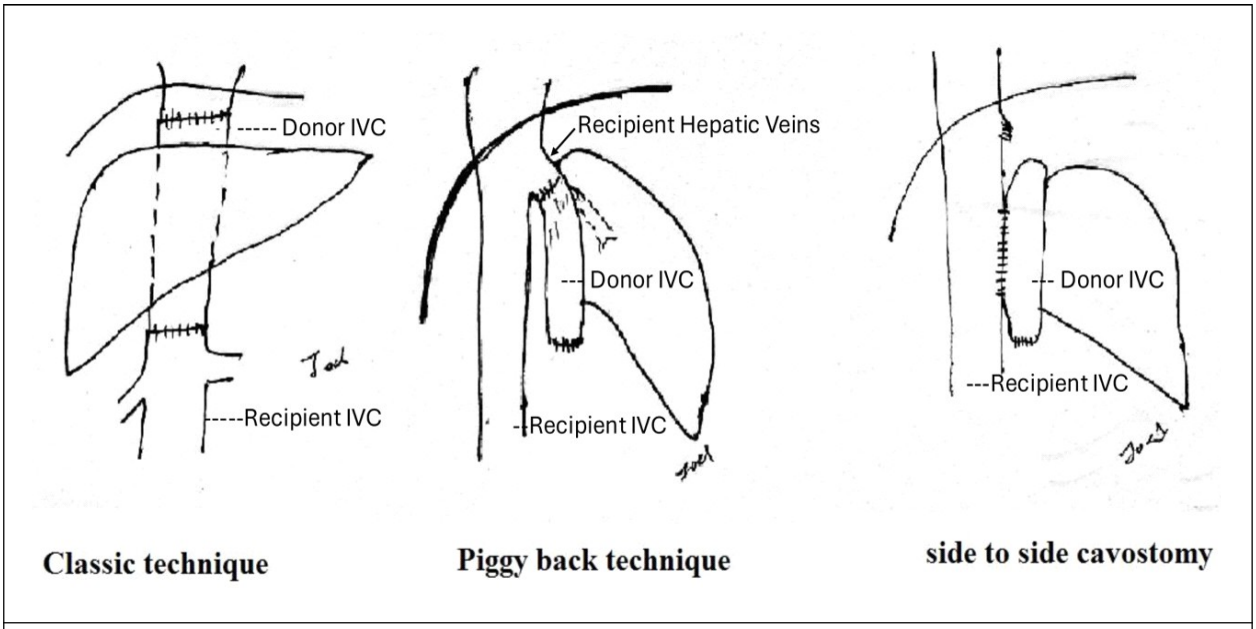

Figure 1: The three techniques used in hepatic venous reconstruction in liver transplantation. In classic technique donor inferior vena cava (IVC) is anastomosed to recipient IVC with a venous bypass. In Piggyback technique donor IVC is anastomosed to recipient hepatic veins. In side to side cavostomy technique donor IVC is anastomosed to recipient IVC with a side to side anastomosis

This rapid communication reports the outcome of the hepatic venous outflow reconstruction during LT at a single liver transplant unit in Sri Lanka.

2. Materials and methods

A retrospective single centre analysis was done using the data available at the University Vascular and Transplant Surgical Unit of National Hospital of Sri Lanka. Patients were identified from a prospectively maintained electronic database. 23 patients who received liver transplantations during the period of 2010-2025 were included. Data on patients' demography, type of hepatic venous reconstruction (i.e., CT, PB and SS), type of LT (live donor or deceased donor), complications and follow up details were collected.

Statistical analysis was performed using Python (version 3.12). Only the patients who had hepatic venous reconstruction using PB and SS techniques were considered for comparison of outcomes. Continuous variables were summarized as means ± standard deviations (SD) for normally distributed data. Categorical variables were reported as frequencies and percentages. Follow up data were reported as mean (range). A two-sided p-value <0.05 was considered statistically significant.

3. Results

23 patients who underwent LT were included, where 19(82.6%) were males and 4(17.4%) were females. Mean age was 51.1 ± 10.9 years. 22(95.7%) patients received deceased donor transplantation while only one (4.3%) patient received live donor transplantation. The cohort comprised of 15 patients (65%) in the PB group, 7(30%) in the SS group, and 1(4%) in the CT group.

The mean age was 50.64 ± 7.30 years in the PB group, 53.57 ± 3.46 years in the SS group (p = 0.35). Males comprised 86.7%(13/15) of the PB group and 85.7%(6/7) of the SS group. Females comprised 13.3%(2/15) of the PB group and 14.3%(1/7) of the SS group. Therefore no significant difference in sex distribution in two groups were found (p = 1.00) (Table 1).

Table 1: Demographics and outcome comparisons between piggyback and side to side cavostomy groups

	Piggyback (n = 15)	Side to Side Cavostomy (n = 7)	p-value
Age (years)	50.64 ± 7.30	53.57 ± 3.46	0.35
Gender %(n)			
Male	86.7(13)	85.7(6)	1.00
Female	13.3(2)	14.3(1)	
Type of Surgery %(n)			
Live Donor	0(0)	14.3(1)	0.68
Deceased Donor	100(15)	85.7(6)	
Complications %(n)	80(12)	42.9(3)	0.14
Follow up (weeks)	137.3(0.1-693.4)	177.6(0.7-524.4)	0.82

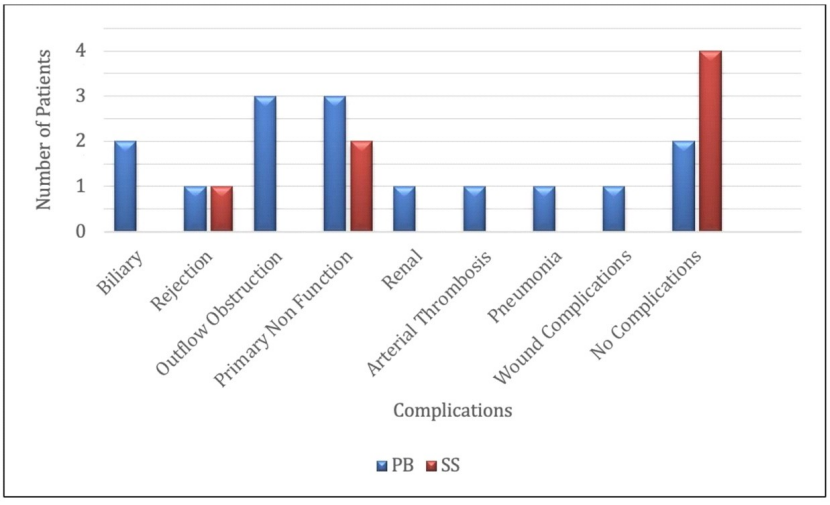

Figure 2: Complications associated with the two techniques of venous reconstruction (PB - Piggyback, SS - Side to Side cavostomy)

Complications occurred in 12/15 (80%) PB patients, 3/7 (43%) SS patients (p = 0.15). Hepatic venous outflow obstruction (HVOO) ooocured in three patients, where all were from PB group. None in the SS group had HVOO (p = 0.52). In the PB group in addition to HVOO, the other complications included biliary complications (n = 3) and renal dysfunction (n = 1). In the SS group, common complications were rejection (n = 1), and wound oozing (n = 1). Primary Non Function (PNF), Hepatic Artery Thrombosis (HAT), respiratory and wound complications are the other complications noted (Figure 2).

The mean overall follow up was 125.1(0.1-693.4) weeks. In PB group, mean follow up was 137.3(0.1-693.4) weeks. All patients who developed HVOO, developed it in the immediate post operative periods and died. Mean follow up of SS is 177.6(0.7-524.4) weeks. During this period there was no evidence of HVOO.

4. Discussion

Liver transplantation is considered as one of the most complex and time consuming organ transplantations, predominantly due to associated higher number of anastomosis. This includes vascular and biliary anastomosis. Vascular anastomosis include anastomosis between donor and recipient hepatic arteries and portal veins. Hepatic venous outflow reconstruction is one of the major steps in vascular reconstruction. During the early era of liver transplantation the conventional technique was used for hepatic outflow reconstruction. Often this technique had to depend on a veno venous bypass. Even with a veno venous bypass, this technique was associated with haemodynamic complications like interrupted blood flow, volume sequestration, renal dysfunction, volume overload and graft related complications like graft congestion. These complications were mainly due the anhepatic phase that occurred during total IVC clamping during the implantation process of the donor liver. To minimize these shortcomings Piggyback (PB) technique was introduced in 1968 (Calne and Williams, 1968). This technique involves direct anastomosis of the recipient's hepatic venous cuff fashioned by connecting either two middle and left hepatic veins or all three hepatic venous stumps of the recipient with the donor's IVC without removal of the recipient's IVC. This technique only involves application of a side biting clamp to the hepatic venous cuff. Therefore, the IVC flow is maintained. However when the liver is positioned in the recipient, the hepatic venous anastomosis can kink or twist in the early post LT period which is within four weeks, resulting in HVOO. In addition technical failures like tight anastomosis, can also result in early HVOO. Later after 4 weeks, neointimal hyperplasia and fibrosis of the PB anastomosis can result in delayed HVOO.

To overcome this disadvantage in PB, the cavocaval anastomosis in a Side to Side (SS) fashion was introduced in 1992 (Belghiti *et al.*, 1992). This technique could maintain the recipient venous return during the implantation process as well as minimized the chance of kinking of the anastomosis.

The university of Colombo LT unit, adopted SS technique recently. Since then there was no HVOO.

The higher incidence of HVOO in the PB group aligns with existing literature, which identifies these as significant risks due to the technical complexity of partial IVC clamping (Parrilla *et al.*, 2010; Sakai *et al.*, 2010). The PB technique, while avoiding venovenous bypass, can lead to HVOO if caval anastomosis is suboptimal, contributing to early graft failure (Gurusamy *et al.*, 2011). In contrast, the SS technique, often termed a modified piggyback approach, facilitates continuous venous return thus potentially lowering the risk of HVOO (Reddy *et al.*, 2006; Fleitas *et al.*, 1994).

Limitations of this study include the small cohort size (n = 23), inherent to single-center studies in low-volume transplant settings, which restricts statistical power and generalizability. Unmeasured confounders, such as Model for End-Stage Liver Disease (MELD) scores or ischemia times, were not fully captured, potentially influencing outcomes. The lack of adjustment for surgeon experience or learning curve, particularly as SS was used more recently, may also confound results. Future multicenter studies with larger cohorts and propensity score matching are needed to validate these findings and explore the role of patient selection and operative expertise.

The SS technique appears associated with low HVOO incidence and fewer complications compared to PB in this cohort, supporting its use in liver transplantation to optimize outcomes. These findings advocate standardizing SS as a preferred approach, particularly in low experience and low volume settings.

5. Conclusion

Conventional, piggyback and side to side cavostomy techniques are the common techniques that used in hepatic venous reconstruction during liver transplantation. However even though piggyback technique minimizes the haemodynamic complications occur in conventional technique, it is associated with life threatening hepatic venous outflow obstruction. Side to side cavostomy can be used as a safe alternative to piggyback technique.

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