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ORIGINAL ARTICLE

Triangular and self-triangulating cavocavostomy for orthotopic liver transplantation without posterior suture lines: a modified surgical technique

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Summary

A modified caval preservation technique with the potential for decreased incidence of venous outflow obstruction and haemorrhage.

Introduction

Following orthotopic liver transplantation (OLT) technical complications still account for the loss of about 10% of grafts [1], the majority of complications occurring at the site of the anastomoses. The standard type of inferior vena cava (IVC) anastomosis is an end-to-end cavocavostomy [2] after excision of the recipient cava. Caval preservation techniques were developed to avoid the use of venovenous bypass (VVB) and to address the drawbacks of the end-to-end anastomosis, namely venous outflow obstruction, retrocaval dissection, bleeding from the posterior suture line and disparity in donor/recipient caval size. With an increase in paediatric and live related liver transplantation it is important to develop safer and better methods of caval preservation. We present two modifications of the caval preservation technique, the triangular cavocavostomy and the self triangulating cavocavostomy. Both of these techniques have been designed with the inherent added advantage of having no posterior suture line.

Methods

In both these methods the shape of the cavocavostomy is triangular with the apex being inferior and the base superior. The widest points are the corners of the bases and these represent the points where the hepatic veins of the donor liver lie. All suture lines are anterior.

Technique No. 1 – triangular cavocavostomy

Recipient hepatectomy is performed with preservation of the posterior and side walls (270°) of the IVC. The

Figure 1 Recipient vena cava with the bridge between the trunks of the hepatic veins excised and a 6–8 cm vertical slit in the anterior wall of the vena cava.

recipient hepatic vein orifices are opened out into the IVC and the excess IVC trimmed (Fig. 1).

Three sutures are placed: left and right top IVC anteriorly and lower IVC anteriorly. The donor IVC is bisected from the top posteriorly for a length of 6–8 cm (or totally if shorter) (Fig. 2).

The sutures are then placed in the opposing sections of donor IVC and the liver lowered in. All three sutures can be tied at this time. The sutures are then run from left to

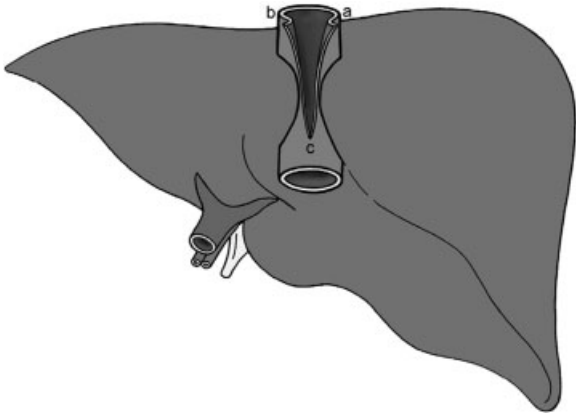

Figure 2 Donor vena cava with a 6–8 cm vertical slit in its posterior wall. The excess cava is not trimmed. Points a, b and c correspond to points of placement of sutures. The lower end of the vena cava is left open for flushing out the portal effluent.

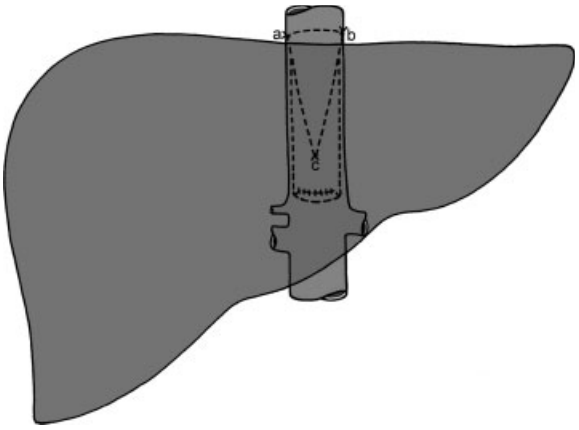

Figure 3 The completed triangular anastomosis with the lower end of the donor cava sutured.

right at the top and then down each side, all anteriorly. There is no posterior suture line (Fig. 3).

If the whole length of the donor IVC has been bisected then a small space needs to be left for pre-reperfusion flush in standard fashion. If (as is more commonly the case) only about two thirds of the length of the donor IVC has been bisected, then it is simpler to complete the suture lines and allow the pre-reperfusion flush effluent to escape from the lower donor IVC. At the end of the flush, the lower donor IVC can be simply stapled with a vascular stapler or oversewn. After a standard portal vein anastomosis the liver is reperfused. The triangular shape of the IVC anastomosis prevents venous outflow obstruction. There is no possibility of IVC stenosis as 270° of the recipient IVC remains intact and the transverse top suture line holds the anastomosis widely open.

Technique No. 2 – self triangulating cavocavostomy

Recipient hepatectomy is performed with preservation of the IVC. The minor hepatic veins are ligated and divided, and the three major hepatic veins are clamped and oversewn or closed with a vascular stapler. A side-biting vascular clamp is placed on the recipient IVC, enabling creation of a 6–8 cm cavotomy anteriorly and extending down from the level of the major hepatic veins. A rim of IVC is excised (Fig. 4). It is important to stretch the recipient IVC anteriorly with the help of two vascular forceps and then apply the side – biting clamp carefully without occluding the IVC. A large enough rim of IVC can then be excised without interference from the clamp.

The donor IVC is bisected from the top posteriorly for a length of 4–6 cm and the excess IVC from the split is excised to within 5 mm of the liver edge on either side (Fig. 5).

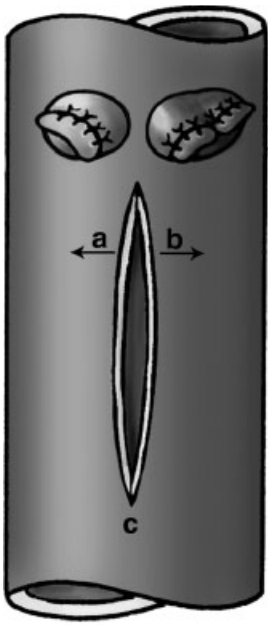

Figure 4 Recipient vena cava with the trunks of the hepatic veins sutured. A 6–8 cm vertical slit has been made in the anterior wall of the cava and a rim of vena cava excised.

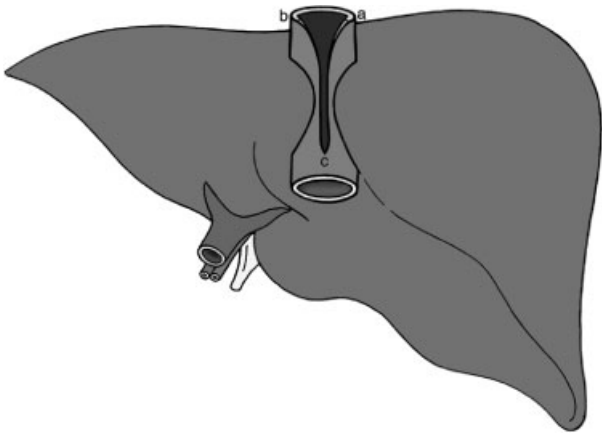

Figure 5 Posterior wall of the donor vena cava with a 4–6 cm vertical slit from the top end. The excess cava has been trimmed to 5 mm of the edges of segment 1 of the liver. Points a, b and c represent the apices of the triangular anastomosis. The lower end of the vena cava is left open for flushing out the portal effluent.

Two sutures are used to run across the top and down the sides of the IVC anastomosis, beginning in the centre anteriorly (usually between the insertions of the right and middle hepatic veins). After completion and ligation of the sutures, the lower donor IVC allows the pre-reperfusion flush effluent to escape, and then the lower donor IVC is stapled or oversewn prior to liver reperfusion (Fig. 6).

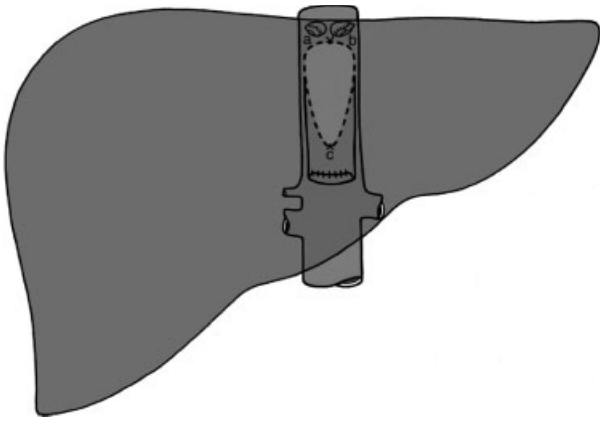

Figure 6 The completed anastomosis. Note that there are only two knots – at the top in the midline and at the lower apex. The triangulation is achieved because of the elasticity of the caval wall and the swelling of the liver with blood.

Removal of the clamp allows triangulation, by virtue of the fact that the donor IVC has been trimmed close to the liver which will open the anastomosis transversely when the graft is lying in its position. Reperfusion further widens the anastomosis by means of an increase in the liver volume, preventing venous outflow obstruction or IVC stenosis.

Discussion

With the use of VVB decreasing, especially in Europe, more units are moving towards caval preservation techniques [3,4]. The 'piggyback' technique had been initially described by Calne and Williams in 1968 [5] but it was the publication by Tzakis *et al.* [6] in 1989 that resulted in a resurgence of interest in alternative techniques for IVC anastomosis with recipient caval preservation. The 'piggyback' technique has the advantage of avoiding the retrocaval dissection; however, it still has the inherent disadvantage of a posterior suture line. A further evolution of the cavocaval anastomosis with recipient IVC preservation has been the laterolateral or side-to-side cavocavostomy [1]. Problems with venous outflow have been encountered with this modification [7] although a postoperative Budd–Chiari syndrome is more probable with the 'piggyback' technique than with a side-to-side anastomosis [8]. By triangulating the cavocavostomy we are opening out the outflow tract even more than in previously described laterolateral cavocavostomies. We have one case of hepatic vein stenosis in our series of 75 patients (Table 1). This patient had a very difficult transplant requiring the surgeon to divide the liver in order to remove it. The patient required 14 units of blood transfusion. He had a self triangulating

Table 1. A breakdown of the use of the modified techniques at our centre for 75 patients, including patient demographics, warm ischaemia time, intraoperative blood requirements and follow up.

	Triangular cavocavostomy (43)	Self triangulating cavocavostomy (32)
Diagnosis		
Alcoholic liver disease	13	9
Hepatitis B	7	6
Hepatitis C	8	4†
Primary sclerosing cholangitis	0	1
Primary biliary cirrhosis	6*	5
Autoimmune hepatitis	4	4
Cryptogenic cirrhosis	3	1
Non-A and non-B hepatitis	1	1
Chronic rejection	0	1
Non-alcoholic steatohepatitis	1	0
Warm ischaemia time (median)	42 min	47 min
Intraoperative blood transfusion (median)	4 units	2 units
Follow up (median)	48 months	42 months

*One retransplant.
†One right hepatic vein stenosis post-transplant.

cavocavostomy and had troublesome bleeding from the IVC suture line. We hypothesize that in the process of controlling the bleeding, the sutures placed may have constricted the right hepatic vein. We do not routinely assess hepatic inflow and outflow in the long term. A Doppler ultrasound is always performed in the first week post-transplant and whenever clinically indicated in the immediate postoperative period.

Haemorrhage is most commonly as a result of the retrocaval dissection and from the suture lines. Bleeding from the posterior suture line in the standard end-to-end caval anastomosis and in the 'piggyback' technique can be troublesome. In both these methods manipulation of the graft to visualize the posterior suture line can lead to graft congestion and dysfunction. Sutures placed in trying to control haemorrhage can further compromise the anastomoses and lead to a higher rate of outlet obstruction. In the triangular cavocavostomy method the retrocaval dissection is performed as the IVC is cross clamped. A similar method has been described without retrocaval dissection but with crossclamping of the IVC [9]. Because of the variability of the vascular anatomy in that region we feel that cross clamping the IVC and performing a cavotomy without retrocaval dissection can lead to unwanted haemorrhage. However in the Self Triangulating method the retrohepatic dissection is avoided and a side biting clamp is used. This is reflected in the slightly lower transfusion requirements in this group when compared to the Triangular cavocavostomy group.

The self triangulating method can be used without VVB. This is an added advantage as most transplant units worldwide are moving away from VVB. Our unit continues to use VVB as our procedure related mortality and morbidity is very low as well as it being a useful tool from an educational point of view.

In our unit the technique used for the caval anastomosis depends on surgeon preference, size of the donor liver and indication for OLT. When transplanting for malignancy we prefer the standard implantation technique as a more radical caval resection is needed. We have noticed that in a large and steatotic liver the right sided suture line in the two methods described can sometimes be challenging because of the access. In the majority of cases the two described techniques are applicable and may offer a significant advantage in terms of ease of graft implantation, decreased haemorrhage and a wider anastomoses.

Acknowledgement

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