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LETTERS FROM THE FRONTLINE

Liver Transplantation is pleased to introduce a new section of the Journal, which will be devoted to short, rapid communication of innovative clinical techniques and surgical problems. As the field of liver transplantation continues to evolve rapidly, clinical surgeons need incorporate novel approaches to the complex problems which we face in the OR. *Letters from the Frontline* will provide the opportunity for our community to present innovative solutions or pose difficult technical questions to the community at large.

Communications to this new section need to be addressed in the form of a letter to the editor of *Liver Transplantation*. They may include one or two illustrations or images and a limit of 5 references. We encourage you to submit small series or even single cases which illustrate your innovations or solutions. As the section develops, we hope to present debates about the merits of alternative approaches to clinical liver transplantation. Thank you for considering Liver Transplantation and we look forward to your feedback and suggestions for future topics.

There Is Plenty for Everyone: Transection of the Infracardiac Inferior Vena Cava During Organ Recovery

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TO THE EDITORS:

Several recent cases at our institution involving injury to the hepatic veins during heart-liver procurement have highlighted the importance of a team approach to the division of the infracardiac inferior vena cava (IVC). Since the first successful heart and liver transplants were described by Barnard[1] and Starzl et al.[2] in the 1960s, proper transection of the IVC has steadfastly remained an important issue. Recent advances in modern heart transplant techniques, including the bicaval anastomotic technique, have obligated the cardiac recovery team to include a segment of the IVC with its specimen to provide an adequate length for anastomosis.[3] On the opposite side of the diaphragm, techniques in liver transplantation have evolved over the last 40 years, especially with respect to the management of the venous outflow of the liver. Popularized techniques include the standard technique with bicaval anastomoses, the piggyback technique (which uses the donor's suprahepatic IVC as a pedicle to the recipient's IVC), and the Belghiti modified piggyback technique (which requires closure of the donor's suprahepatic IVC and side-to-side cavocavostomy).[4] To prevent compromise of the coronary sinus or hepatic venous outflow with these techniques, we propose that a length of 1 cm is needed below the coronary sinus and above the hepatic veins (Fig. 1).

These advances in technique have continued to highlight the importance of the length of the IVC included with each donor organ. Anatomical studies have shown that the average length of the IVC between the coronary sinus and the hepatic veins is only 3.7 cm.[5,6] Thus, in the hurried events of a deceased donor organ recovery operation, it is easy to imagine situations in which an organ could be left with an insufficient IVC cuff. The failure to include a sufficient length of the infracardiac IVC can lead to injury of the closely opposed right coronary artery or coronary sinus.[7] Conversely, a short cuff of the suprahepatic IVC can increase the risk of venous outflow

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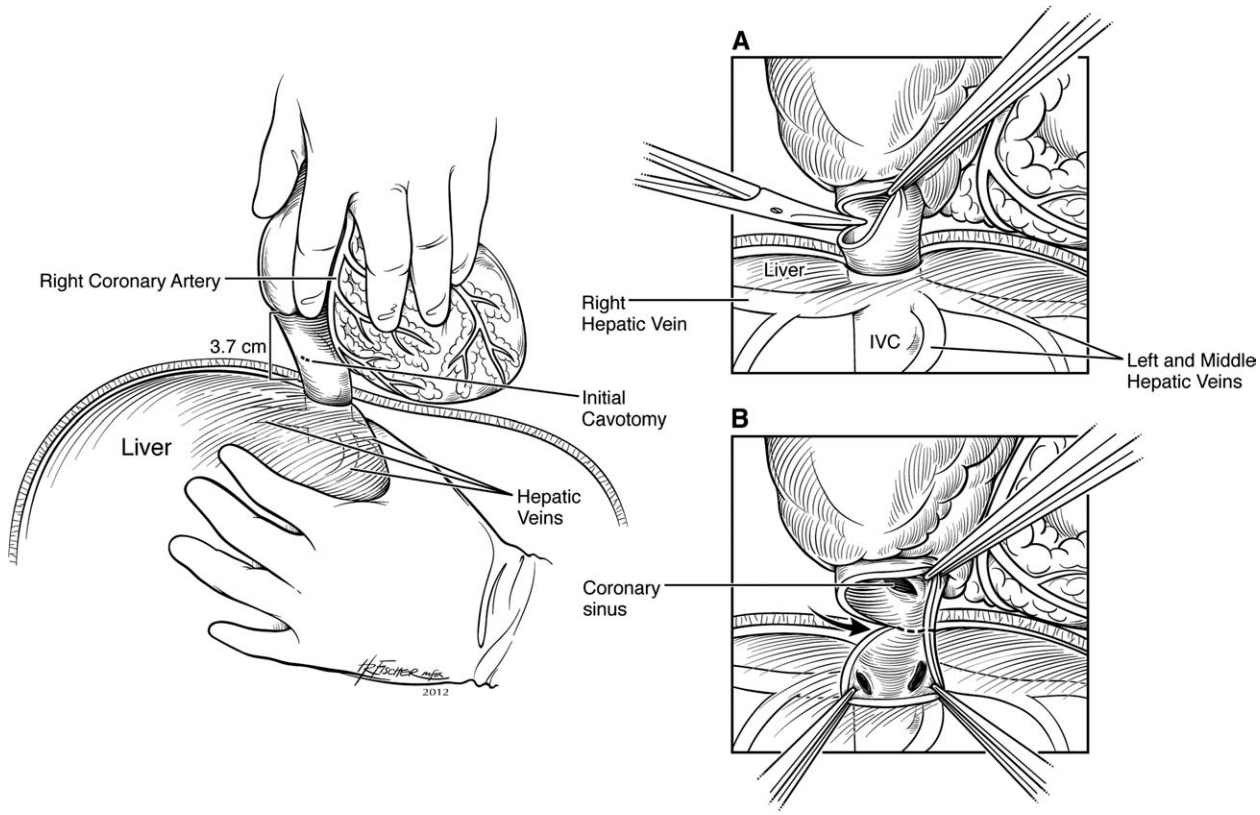

Figure 1. Anatomy of the infracardiac IVC. (A) Creation of the initial lateral venting cavotomy. (B) Completion of the transection with direct visualization of the coronary sinus and hepatic veins.

complications and potentially require hepatic vein reconstruction.

During the donor bicaval cardiac recovery, the heart is explanted with a length of the IVC sufficient to protect the critical medially located structures (specifically the coronary sinus and the right coronary artery; Fig. 1B). Recent anatomical studies using computed tomography scans have shown that the distances between any 2 of the following vary from 1.13 to 3.27 cm and depend on the cardiac cycle stage: the right coronary artery, the IVC, the tricuspid valve, and the coronary sinus.[8] These short distances highlight the close proximity of these structures and emphasize the importance of a sufficient medial cuff of the IVC for the prevention of injury. As illustrated previously, maximizing the length of the recipient's IVC during cardiectomy allows for a more conservative transection of the deceased donor's IVC during recovery and ensures the safety of these critical medial structures.

Just as the IVC at the cavoatrial junction lies in close proximity to important cardiac structures, so too does the suprahepatic IVC lie in close proximity to the hepatic veins. A recent study has shown that injury to the hepatic veins occurs in up to 3% of deceased donor liver recoveries.[9] When we are considering the anatomy of the suprahepatic vena cava, it is important to remember that the origin of the right hepatic vein is only 0.86 cm on average from the overlying diaphragm.[5] Just distal to the ostium of the right hepatic vein lies the confluence of the middle and left hepatic veins, which lie on the left anterolateral surface of the IVC.[6] Each of these structures (Fig. 1B) can be easily injured if the transection of the IVC strays too close to the diaphragm or if the heart is retracted cephalad while the infracardiac IVC is being divided. These injuries can obligate repair of the hepatic veins with donor vein or a synthetic vascular conduit and can potentially increase the risk of graft failure or dysfunction related to venous outflow obstruction.

When we take into consideration constraints of both time and space during organ recovery, it seems that the best solution would include direct visualization of the involved structures. Because the infracardiac vena cava is more accessible during cardiac recovery, it seems natural that visualization of the closely approximated coronary sinus and right coronary artery would be the best technique for achieving the optimal length of the infracardiac cava. After aortic clamping, we propose a lateral venting cavotomy just above the diaphragm as the liver surgeon gently retracts the liver inferiorly (Fig. 1). If this cavotomy is made laterally, injury to the coronary sinus will not occur (Fig. 1A). After the completion of the cardiac flush, the ostium of the coronary sinus can be seen if we look medially through the cavotomy (Fig. 1B). Direct visualization during the completion of the transection can ensure a 1.0-cm infracardiac cuff of the IVC medially and can minimize excessive length. Minimizing the infracardiac length will then provide the hepatic organ recovery team a length sufficient to make a successful caval anastomosis during the liver transplant operation.

Taking additional time to make the IVC transection with precision (with the cava evacuated of blood or perfusate with adequate suction) will provide an opportunity for flexibility during the subsequent cardiac and hepatic transplant operations in the recipient.

In this discussion, we have highlighted the short distance of the IVC that exists between structures of critical importance in both the heart and the liver, and we have demonstrated the importance of an adequate IVC length for both transplant teams. Taking this into consideration, we propose that a technique of lateral venting cavotomy with direct visualization of the IVC transection should be used during every deceased donor organ recovery to increase the chance that both teams will retain a sufficient length of the IVC and, therefore, achieve optimal outcomes. As a transplant community, we must resist the urge to ask for more and must always consider the recipients of both organs.

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