Vessel Identifications Tags for Open or Laparoscopic Associating Liver Partition and Portal Vein Ligation for Staged Hepatectomy

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Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS)[1] has recently been proposed as the further evolution of the 2-stage hepatectomy technique (2SHT). The first step consists of left clearance, right portal branch occlusion, and in-situ splitting associated with middle hepatic vein section, and with the deportalized liver left in-situ. During the second step, section of the right branch of the hepatic artery, right portal vein, and right bile duct is followed by completion of the right hepatectomy.

Surgical trauma from liver partition associated with portal vein ligation (PVL), with the right liver (segments V, VI, VII, and VIII) left in-situ, seems responsible for faster hypertrophy of the future remnant liver (FRL).[2] Several small series in the literature describe an 80% to 200% increase in FRL volume, allowing 9 to 15 days between the 2 steps.[1,3,4] This is far from being a harmless procedure; the morbidity rate was as high as 74% in the original series (52% of which were Clavien-Dindo III to IV),[1] and the morbidity rate was reported to be as high as 90% in other series, with high rates of biliary fistula and procedure-related deaths.[5-7]

In classical 2SHT, the second step is often technically demanding due to fibrous adhesions, pedicular inflammation, and anatomic atrophy or hypertrophy. During the second step of ALPPS, mainly inflammatory adhesions are observed. In such setting, hemorrhagic dissection can make this phase particularly technically demanding.

This surgical procedure is still considered to be in an early development phase because surgical indications and technique are not standardized. In 2012, we described a new 2SHT technique involving tagging hilar structures with vessel loops during the first step, which allowed easier and faster identification of pedicular elements during the second step.[8] We decided to introduce this easy-to-perform and morbidity-free technique during ALPPS procedures.

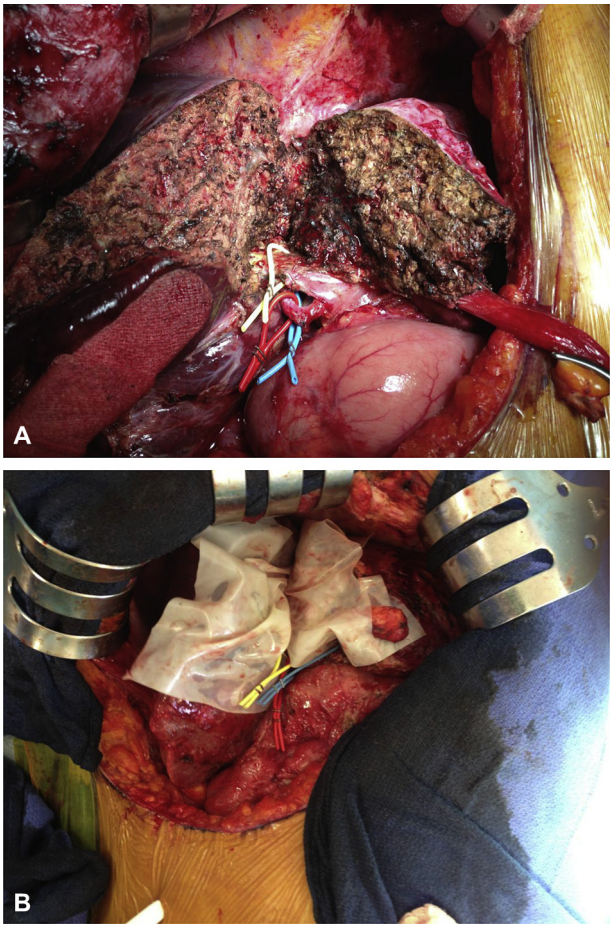

Figure 1. Intraoperative view at the end of the first step of the associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) procedure. (A) Color-coded vessel loops: yellow for right biliary duct, red for the right hepatic artery, blue for the right branch of portal vein. (B) Acellular collagen membrane to avoid adhesions.

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Abbreviations and Acronyms

ALPPS = associating liver partition and portal vein ligation for staged hepatectomy
FLV = full liver volume
FRL = future remnant liver
PVL = portal vein ligation
2SHT = 2-stage hepatectomy

METHODS

First step

We begin with FRL clearance (left liver or left lateral section), followed by liver parenchyma transection until the surface of the inferior vena cava is reached. A hanging maneuver is performed only in the case of right hepatectomy, with transection along the middle hepatic vein. The pedicular dissection is performed according to the pure Glissonian intrafascial approach[9]: the right hepatic pedicle is dissected and the right portal branch and right hepatic artery are isolated and tagged. Each pedicular structure is encircled by a color-coded silastic vessel loop: blue for the right portal branch, red for the right hepatic artery (Fig. 1A). The parenchymal transection is performed using an ultrasound dissector. When the hilar plate is reached, the right bile duct and hilar plate are dissected and tagged using a yellow vessel loop. When the middle hepatic vein is reached, the right portal branch is ligated and the middle hepatic vein is sectioned using a linear vascular stapler. The right liver is not mobilized for oncologic reasons.[10] To avoid postoperative adhesions, a type-I acellular collagen membrane (Cova+Abdo, Biom'up) is systematically applied (Fig. 1B). Finally, an abdominal drain is placed along the parenchymal transection surface.

Interval

There is a 7- to 10-day interval between the 2 procedures. Liver function tests are routinely performed on postoperative days 1, 3, 5, and 7. A CT scan is performed 1 week after the first-step operation to make sure that the FRL has increased in adequate proportion (Fig. 2). The FRL/full liver volume (FLV) ratio is expected to be at least 30% in order to plan the second step of the procedure.

Second step

The approach is the same as in the first step (laparoscopy/laparotomy). After the removal of the cellular collagen membrane (Fig. 3A) and cautious removal of the inflammatory adhesions, the silastic vessel loops are identified (Fig. 3B). Ligation and section of the right hepatic artery and right bile duct are easily performed using these landmarks. The right hepatic vein is dissected free and sectioned using a linear vascular stapler. The last step of the right hepatectomy is to section the right triangular ligament, and is usually done with an anterior approach.

RESULTS

From April 2012 to May 2013 we performed 6 ALPPS procedures (Table 1). The hanging maneuver was performed in 3 of 6 patients: in 2 patients it was not performed because the scheduled procedure was a trisectionectomy with the transection line along the falciform ligament, and in the third patient it was not done because the two steps were performed using the laparoscopic approach rendering its use less relevant. In the remaining 3 patients, the hanging maneuver was performed without difficulty. One ALPPS was performed by a pure laparoscopic approach for both steps, in a patient who had benign liver disease. As with the few cases described in the literature, the procedure is difficult, and careful patient selection is the key factor for success.[11,12] Even if adhesions are less extensive and are easy to lyse, we found that tagging hilar structures was extremely useful because of the difficulty represented by the laparoscopic approach and the Glissonian intrafascial pedicle dissection.

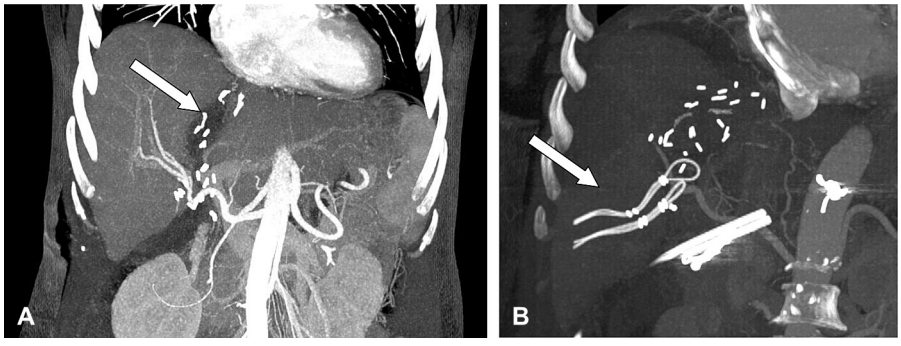

Figure 2. Postoperative day 7 CT scan reconstructions. (A) The liver transection line and the disconnection of the right portal vein are clearly seen (white arrow). (B) Silastic vessel loops and clips along the liver transection line (white arrow).