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Bimanual 'bi-finger' liver hanging maneuver: an alternative and safe technique for liver hanging

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Abstract

Background. Currently, a popular method for right hepatectomy is hepatic resection with the liver hanging maneuver. The aim of this study is to present an alternative and safe approach during this maneuver without using any instrument, thus avoiding injury. *Patients and methods.* From March 2005 to April 2006, a bimanual 'bi-finger' liver hanging maneuver (BBLHM) was planned in 22 right hepatectomies and the data were collected prospectively after operation. *Results.* BBLHM was performed in 21/22 patients (95%). The maneuver was stopped in one patient, due to manual detection of an accessory hepatic vein during finger dissection in the retrohepatic space. This vein did not allow completion of the BBLHM. The indications for right hepatectomy included 11 primary hepatic tumors (52%), 8 metastatic right hepatic tumors (38%), and 2 hydatid cysts (9%). Intraoperative ultrasound (IOUS) demonstrated the normal anatomical configuration type of the hepatic veins. Bleeding occurred in one patient (4%), which was interrupted with the use of continuous 6/0 polypropylene suture. *Discussion.* The most important step during the liver hanging maneuver is to develop the avascular space without any complication. In the present study, the index fingers were used instead of forceps during the blind dissection. BBLHM not only reduced the rate of damage to the hepatic veins but was also predictive for the presence of any accessory vein by its manual detection prior to injury. This maneuver allowed easier clamping of the hepatic veins and controllable hepatic resection. Dissection of retrohepatic space with the BBLHM produces a safer method, using both index fingers instead of a surgical instrument.

Key Words: *Right hepatectomy, retrohepatic avascular tunnel, bimanual 'bi-finger' liver hanging maneuver*

Introduction

Many different surgical techniques have been established for the liver hanging maneuver – an important technical procedure first described by Belghiti et al. [1]. Recently, the liver hanging maneuver has become a very popular technique for safe hepatectomy. Complete hepatic mobilization prior to parenchymal transection is the conventional technique used for right hepatectomy. When a huge tumor invades the diaphragm, liver mobilization may be difficult. In these cases Lai et al. reported an 'anterior approach' with parenchymal transection from the anterior surface down to the inferior vena cava (IVC) [2]. Without control of the posterior surface of the liver, there is a potential danger of difficult homeostasis on a deeper transected plane. To control bleeding at the deeper parenchymal plane during right hepatectomy without liver mobilization, Belghiti et al. proposed a liver hanging maneuver using a tape passed between the anterior surface of the IVC and the liver parenchyma [1]. The key to the liver hanging maneuver is development of the retrohepatic tunnel [3]. This longitudinal avascular potential space is located between the retrohepatic IVC and the parenchyma of the caudate lobe in the deep plane. Insertion of the forceps may be managed more safely by performing intraoperative ultrasound (IOUS) [4] or video laparoscopy [3] during dissection of this tunnel. Is it possible to use the liver hanging maneuver in a safe way without insertion of forceps? Is it appropriate to use a bimanual 'bi-finger' method instead of the forceps during blind dissection?

To answer these questions, we designed this study to evaluate the results of patients who underwent right hepatectomy using the liver hanging maneuver without mobilization, in which both index fingers were

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inserted under control of IOUS between the IVC and liver parenchyma. This modified liver hanging maneuver, BBLHM, allows a safer dissection in the retrohepatic space. In addition, it is useful for avoiding injury to the accessory hepatic veins (AHVs) during blind insertion of forceps. This process facilitates and reduces the length of the retrohepatic tunnel required.

Patients and methods

Between March 2005 and April 2006, the BBLHM was planned in 22 right hepatectomies. Demographic variables, primary diagnosis of patients, the presence and numbers of the accessory left and right inferior hepatic veins, the numbers of ligated accessory right and left hepatic veins, and the occurrence of bleeding were recorded during operation. In addition, the anatomy of the hepatic veins or AHVs were demonstrated by IOUS before hepatic resection.

Procedure

In all cases, the liver was exposed through a Mercedes-like incision. IOUS was performed using the Siemens Omnia system with a convex 5.2 MHz broad bandwidth transducer. IOUS was performed in all patients to evaluate the anatomy of the hepatic veins and determine the main short hepatic vein draining the caudate lobe. Cholecystectomy was then performed and the portal pedicle was encircled. The upper surface of the liver was exposed up to the anterior surface of the suprahepatic IVC. Firstly, the space between the right and middle hepatic veins was dissected with a clamp. If there is a right inferior hepatic vein, it may appear during dissection of the anterior surface of the inferior IVC. If present a right inferior AHV ($\leq$4mm) is ligated and divided and left AHVs are also dissected and divided (Figure 1a and b). This process maintains less length of retrohepatic tunnel to pass through and facility for entrance of right index finger to the tunnel, at the same time. The dissection of the anterior plane of the IVC determines the most important part of the liver hanging maneuver. The dissection starts with the index finger of the right hand posterior to the caudate lobe on the left side of the right inferior hepatic vein, proceeding cranially with care along the middle plane of the IVC (Figure 2a and b). At the same time, the index finger of the left hand on the suprahepatic IVC between the right and middle hepatic veins pushes on with mild extension–flexion movement along the same plane toward the right finger. After 3–5 cm of blind dissection the index fingers of both hands make contact. The index fingertip of the right hand is dressed with a penrose tape and pushed through the tunnel (Figure 3a and b). The penrose tape appearing between the right and middle hepatic veins is picked up with a forceps and

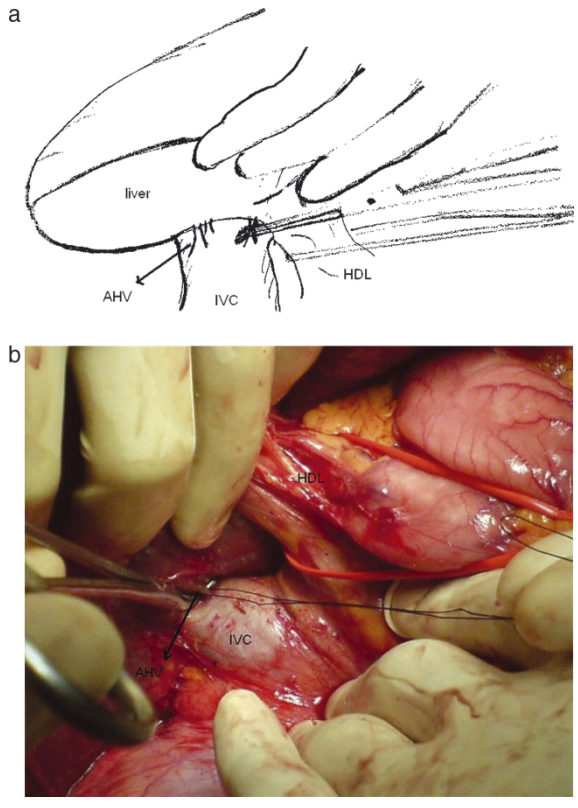

Figure 1. Dissection and division of the accessory hepatic veins (AHVs). HDL, hepatoduodenal ligament; IVC, inferior vena cava.

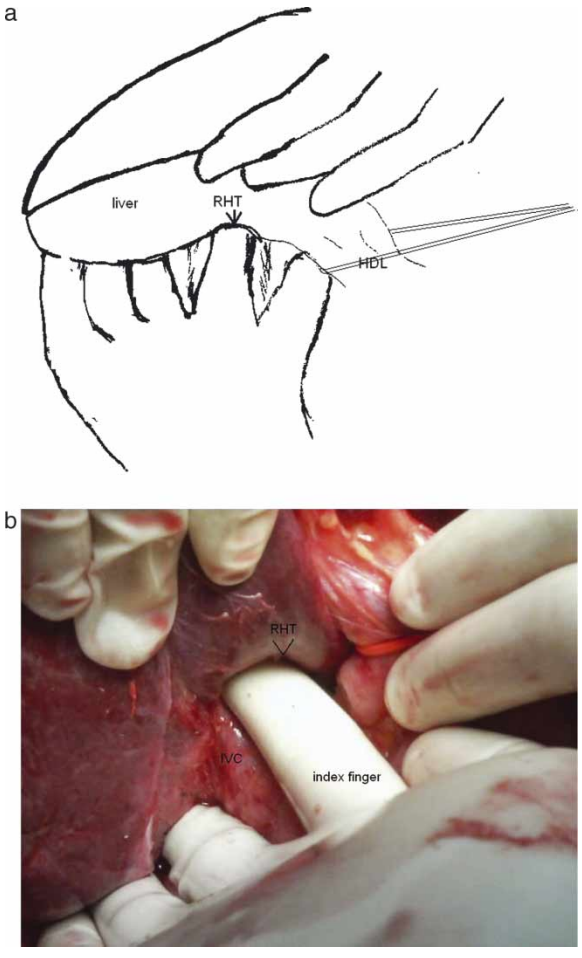

Figure 2. Dissection of the retrohepatic tunnel (RHT) with the index finger. HDL, hepatoduodenal ligament.

passed around the liver parenchyma (Figure 4a and b). After the BBLHM is completed, the penrose tape is grasped with clamps on both sides.

While simultaneously pushing the index fingers along the retrohepatic avascular tunnel, if any difficult movement is required instead of soft flexion–extension oscillation, this maneuver may be stopped. Another determinant for stopping the BBLHM is feeling AHVs with the distal phalanx of the index finger.

Results

Among 22 cases (10 male and 12 female; median age 54.5 years, range 42–64), the BBLHM was performed in 21 patients. In one case, this maneuver failed. In this patient, an AHV was felt while pushing the index finger. The hanging maneuver was not technically feasible because of the high risk of injury to this accessory vein with the finger maneuver during blind dissection. IOUS demonstrated that the short hepatic vein measured 3 mm in size. Right hepatectomy was achieved with a posterior approach. After hepatic resection, it was observed that this vein was located on the right hepatic vein, 1 cm below bifurcation. The procedure was performed successfully in all the other 21 (95%) patients. The indications for right hepatectomy included 11 primary hepatic tumors (52%), 8 metastatic right hepatic tumors (38%), and 2 hydatid cysts (9%). Minor bleeding (60 ml) was observed in only one patient (4%) because of failure in knotting of the inferior AHV. This AHV was repaired with continuous 6/0 prolen suture.

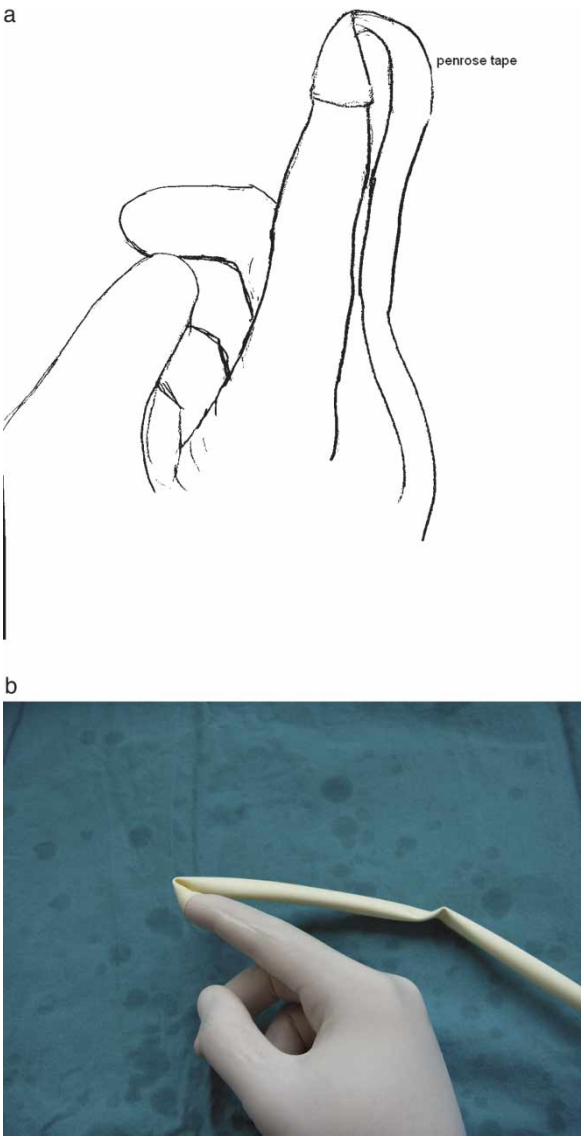

Figure 3. Index fingertip dressed with a Penrose tape.

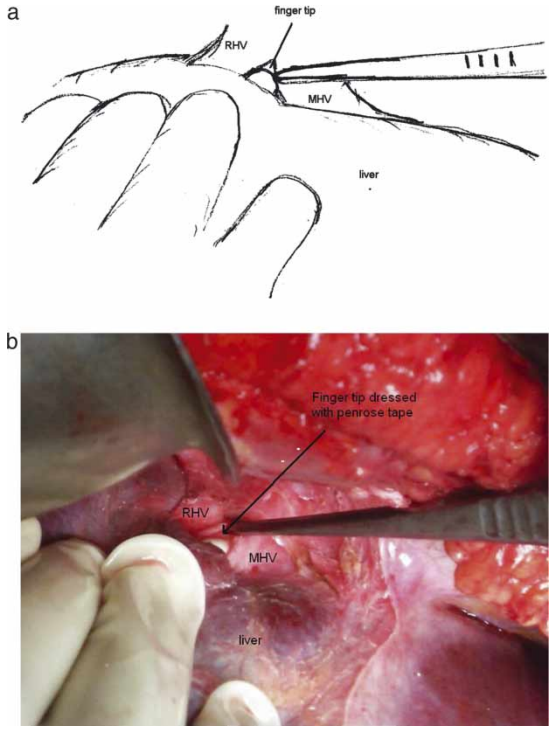

Figure 4. Picking up the Penrose tape from the fingertip.

IOUS demonstrated the normal anatomic configuration type of the hepatic veins, i.e. right and middle hepatic veins have different openings to the IVC without any relation. In addition, eight right AHVs, five left AHVs and one middle AHV ranging in size from 3 to 6 mm were detected. During dissection, nine right and four left AHVs $\leq$2 mm in diameter were also revealed. All AHVs except two right AHVs and one left AHV were ligated and divided because they were $\leq$4 mm in size.

Discussion

Hepatic resection has been performed with a low rate of intraoperative complications for the past 10 years. This is particularly attributed to liver mobilization [5]. Right hepatectomy, which has been accepted as a routine surgical procedure, requires a complete mobilization of the right lobe. Complete hepatic mobilization for right hepatectomy by the conventional method is the first step for parenchymal transection. In case of a large hepatic tumor, the conventional approach has the potential risks of disseminating

tumor cells, rupture of the tumor, and excessive bleeding due to forceful retraction [3]. However, when the tumor invades the diaphragm, liver mobilization may be difficult or even impossible. Lai et al. in 1996 [2] and Liu and colleagues in 2000 [6] described an anterior approach with a parenchymal transection from the anterior surface down to the IVC. Although this approach has some advantages, it is not without risk of complications. Nevertheless, there is still a danger of difficult homeostasis when bleeding occurs from the deeper transection plane, if the posterior surface of the liver has not been mobilized previously. Hanging of the liver away from the IVC presents more advantages, including less manipulation of the remnant liver as well as less tumor dissemination, and also homeostatic facilities to control bleeding of the deeper plane [1]. In addition, Belghiti's technique helps the surgeon to obtain a uniform cut edge following the marked plane. Belghiti et al. reported that there was a 1 cm wide avascular space located in the midline of the anterior surface of the retrohepatic IVC [1]. All hepatic veins draining the right lobe of the liver, including the proper right hepatic vein and accessory right hepatic veins, had their point of entry on the right side of the IVC. The retrohepatic tunnel was shown to be only relatively avascular. However, Meng and colleagues observed that the veins located in the caudal half of the tunnel, which drain the caudate process of segment I, could be easily controlled under direct vision from the infrahepatic region [3]. Ettorre et al. developed this technique, reducing the length of the blind dissection [7]. To achieve this, they ligated the right inferior hepatic veins and AHVs in their modified liver hanging maneuver.

The laparoscope or IOUS may be used to overcome the problem of blind dissection. In video-assisted or ultrasound-assisted dissection of this region, the entire course of the blind dissection between the anterior surface of IVC and the liver can be visualized in real time [3,4]. In addition, bleeding from an injured short hepatic vein is the most important complication of this procedure, with a reported incidence of 4–6% [1,7].

Despite all the facilities (videoscopy, US, etc.) for avoiding any injury to IVC or hepatic veins, determination of all movements and the angle of the forceps are difficult. Moreover, the retrohepatic avascular space is usually narrower than the width of the forceps. Therefore, the surgeon hesitates during dissection of the retrohepatic tunnel. Because control of the handle of the forceps is particularly difficult in obese patients, it can be really troublesome.

In the present study, the liver hanging maneuver was performed without any instruments such as forceps or clamp, but with the fingers. The BBLHM seems to have advantages for surgeons with long, thin fingers. The cornerstones of the maneuver include: (i) analysis of the anatomic distribution of the hepatic veins and accessory veins by IOUS, (ii) careful dissection of the suprahepatic IVC between the right and middle hepatic veins, and (iii) the most important step is the demonstration of the infrahepatic IVC and AHVs. Although the anatomic and experimental studies performed by Hirai et al. [8] and by Sato et al. [9] described an avascular plane between the right IHV and the thickest caudate vein, the risk of tear in some hepatic veins is still present. The AHVs are particularly located both on the left and right side of the infrahepatic IVC. Our findings suggest that, regardless of which liver hanging maneuver is used, during demonstration of the infrahepatic IVC, these veins can successfully be managed as encountered. After ligating and dividing the veins $\leq$4mm in size, the length of the avascular space for blind dissection is reduced. This makes it easier to use the right index finger during the preparation of a retrohepatic tunnel. In this step, the criterion to stop this technique is feeling an AHV with a finger, as occurred in our study. In one patient, an AHV was felt during finger dissection of the tunnel and thus the BBLHM was stopped. In case of failure of BBLHM, the other alternative methods of liver hanging maneuvers may be performed or it may be completely cancelled.

In conclusion, according to our recent study, in patients undergoing right hepatectomy, the BBLHM, instead of any instrument, makes it possible to achieve hepatic parenchymal resection in a safe way.

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