Hemihepatic Ischemia for Laparoscopic Liver Resection

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Abstract: Laparoscopic hepatectomy has been recently proposed for the treatment of liver tumors. However, because of technical difficulties such as control of hemorrhage from the transection plane and large intrahepatic veins, laparoscopic hepatectomy has not been widely developed. The technique of hemihepatic ischemia has been used by the authors in conventional liver resection over the past 10 years with reduced splanchnic congestion and excellent hemostatic control. To minimize both intraoperative bleeding and circulatory and biochemical disturbances due to the interruption of blood flow to the liver, the authors describe a new technique combining hemihepatic ischemia and laparoscopic liver resection.

Key Words: liver, laparoscopy, technique, hemihepatic ischemia

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Refinements in instrument design and the development of new laparoscopic instruments such as the harmonic scalpel, endoscopic vascular staplers extended its application to the liver surgery.[1–4] The advantages of laparoscopy over open hepatectomy include smaller incisions, reduction in postoperative pain, patient convalescence, metabolic and immune responses, length of hospital stay, and morbidity.

Laparoscopic hepatectomy has been indicated for the treatment of benign liver conditions such as hepatic adenoma, hydatid cyst, and hemangioma. [1,5] However, because of technical difficulties such as control of hemorrhage from the transection plane and large intrahepatic veins, laparoscopic hepatectomy has not been widely developed.

To minimize both intraoperative bleeding and circulatory and biochemical disturbances due to the interruption of blood flow to the liver, Makuuchi et al[6] described in 1987 a technique for selective control of the hilar vessels to the liver called hemihepatic vascular occlusion. The aim of this paper is to describe a new technique combining hemihepatic ischemia and laparoscopic liver resection.

PATIENTS AND METHODS

The technique of hemihepatic ischemia has been used by the authors in conventional liver resection over the past 10 years with reduced splanchnic congestion and excellent hemostatic control. The initial cases of hemihepatic ischemia during laparoscopic liver resection are presented.

Case 1

A 59-year-old woman reported occasional right upper abdominal pain, and a diagnosis of gallstones had an incidentally discovered 3-cm liver tumor noted during a diagnostic ultrasound. Computed tomography (CT) revealed a 3-cm hypervascular liver tumor in segment VI. Further examinations were not consistent with any diagnosis. With a presumptive radiographic diagnosis of benign hepatocellular tumor, surgical resection was recommended.

Case 2

A 57-year-old woman with a history of colorectal cancer had a 1-cm liver mass discovered during a routine follow-up. CT and magnetic resonance imaging disclosed a 1-cm tumor in segment III. Further examinations failed to reach a diagnosis. The lesion was considered suspect for metastasis, and the patient was accepted for laparoscopic resection.

Surgical Technique

Patients were informed of the nature of the procedure and consent was obtained. The surgical approach and strategy for these 2 patients are similar. The patient is placed in a supine position and an orogastric tube is inserted and removed at the completion of the procedure. Using an open technique, a 10-mm trocar is placed in the supraumbilical position; through this port, a 10-mm 30-degree angled laparoscope is introduced. Pneumoperitoneum is established at 12 mm Hg. Additional ports are inserted in the same fashion as for laparoscopic cholecystectomy: 2 or 3 5-mm and 1 12-mm for right-sided resection and reverse image for left-sided resection (Fig. 1).

The liver is mobilized in a standard fashion with hepatic ligaments divided with harmonic scalpel (UltraCision, Ethicon Inc., Cincinnati, OH) and the gallbladder is excised. At this time, a 5-mm laparoscopic vascular clamp (REDA Instrumente GmbH, Tuttlingen, Germany) is introduced through a 5-mm trocar, and we obtain left or right hemihepatic inflow control by en masse occlusion of the glissonian sheath of the respective hemipedicle at the bifurcation in the hepatic hilum resulting in unilateral lobar delineation (Fig. 2). This maneuver is easy accomplished without prior portal dissection. The bifurcation of the portal triad generally occurs outside the liver substance in the projection of segment IVb midway between the basis of the round ligament and the gallbladder bed. The half-Pringle technique for open liver surgery is described elsewhere.[7] This maneuver results in a visible line of demarcation along the main fissure (Fig. 3).

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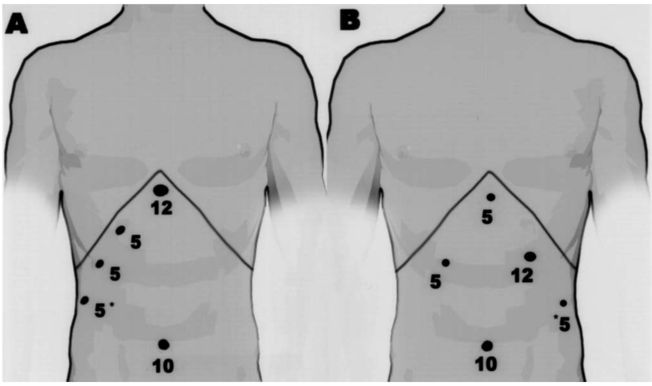

FIGURE 1. Diagrams of the trocar placement for laparoscopic liver resection. A, Right-sided liver resection. The surgeon is on the left side. B, Left-sided liver resection. The patient is in the supine position with lower limbs apart, and the surgeon is between the legs. *Trocar used for half-Pringle maneuver.

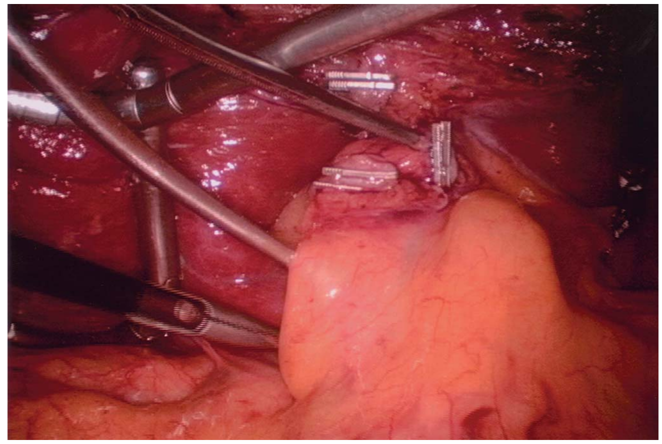

FIGURE 3. Intraoperative view. A 5-mm laparoscopic vascular clamp is being applied to the right hemipedicle at the bifurcation in the hepatic hilum.

The right glissonian sheath was occluded in the first patient (Figs. 3 and 4) and the left in the second patient. Once this is accomplished, we can proceed with the planned liver resection. The ischemic corresponding liver parenchyma is safely divided using combination of a harmonic scalpel, application of metallic clips, and an endoscopic linear stapler with minimal bleeding (Fig. 5). Careful dissection and low pneumoperitoneum are crucial preventive measures to avoid carbon dioxide embolism. The first patient underwent a laparoscopic liver resection of segment VI, and the second underwent partial resection of segment III. Once the liver specimen is completely resected, it is placed inside a plastic bag. This bag is brought through an accessory incision. The surgical field is irrigated using normal saline, and the transected liver surface is checked for bleeding or bile leakage. In the first patient, a drain was placed in the subphrenic space, and the second patient was not drained.

HOSPITAL COURSE/RESULTS

Case 1

Operative time was 120 minutes, including cholecystectomy. Hemihepatic ischemia time was 30 minutes. No intraoperative abdominal visceral stagnation or hemodynamic changes were noted during the laparoscopic half-Pringle maneuver. Estimated blood loss was 50 mL. The postoperative period was uneventful, and the patient was discharged on the second postoperative day. Pathology disclosed focal nodular hyperplasia and chronic cholecystitis. The drain was withdrawn on the 10th postoperative day. The patient is alive and without any surgical complication 10 months after the laparoscopic liver resection.

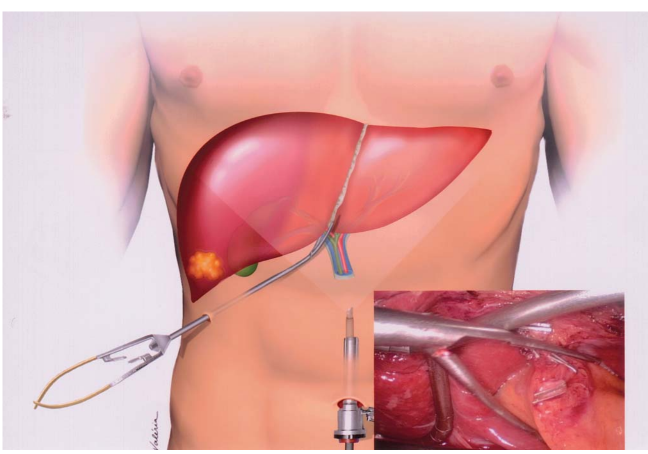

FIGURE 2. Schematic view shows en masse occlusion of right glissonian sheath at the bifurcation in the hepatic hilum using a 5-mm laparoscopic vascular clamp (REDA Instrumente GmbH, Tuttlingen, Germany), resulting in right liver ischemia. Inset: The clamp is inserted behind the hepatic hilum, and it is pointed toward the projection of segment IVb midway between the basis of the round ligament and the gallbladder bed.

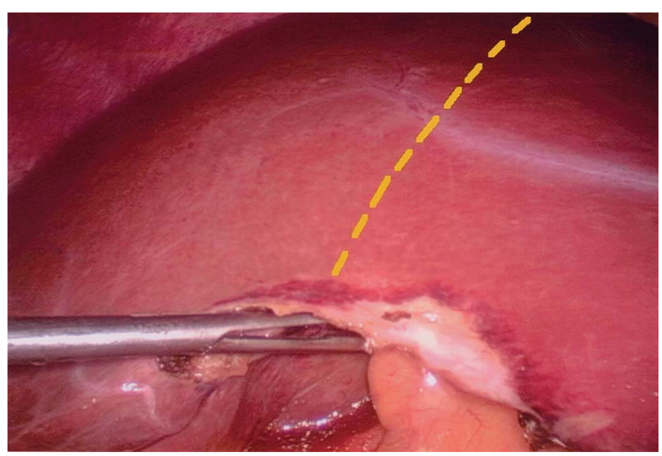

FIGURE 4. Intraoperative view of right liver ischemia. The dotted line shows the limits between the ischemic right and nonischemic left liver.

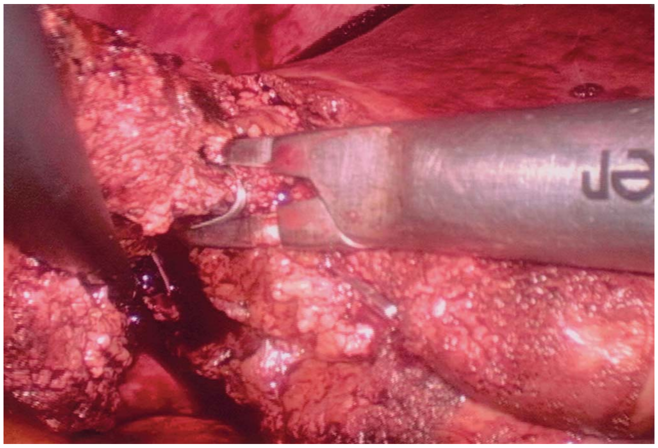

FIGURE 5. Intraoperative view. The ischemic liver is partially divided by meticulous dissection using a harmonic scalpel and application of metallic clips. An endoscopic linear stapler was already fired, and a metallic clip is being applied to a segmental hepatic vein.

Case 2

Operative time was 60 minutes. Hemihepatic ischemia time was 15 minutes. No intraoperative abdominal visceral stagnation or hemodynamic changes were noted during the laparoscopic half-Pringle maneuver. Estimated blood loss was 20 mL. Immediately after the procedure, the patient started a liquid diet with good tolerance and was discharged on the first postoperative day. Pathology showed an atypical hemangioma. No immediate or late surgical complications were recorded during follow-up. The patient is alive and without evidence of the disease 2 years after the laparoscopic liver resection.

DISCUSSION

Laparoscopic liver surgery was originally introduced for staging and limited resections have been initially reported in a number of small series.[3,5] The first laparoscopic anatomic liver resection was reported in 1996.[1]

Laparoscopic liver resections are difficult procedures and therefore require experience in liver surgery and advanced skills in laparoscopic techniques. Due its complexity, laparoscopic hepatectomy requires a program of experimental animal models for the development of new research in liver surgery and for training clinically applicable surgical techniques. Thus, it is appropriate for laparoscopic surgeons to learn this technique in large animals before clinical application. With this goal, an experimental study was carried out by the authors to promote familiarity with the instruments best suited to the techniques for performing laparoscopic hepatic resections in humans.[8] After initial experimental liver resection in animals, the authors introduced this technique in selected patients based on a prospective protocol of study.

The number and indications of laparoscopic liver resections are increasing worldwide.[2,4] However, there are still major drawbacks that must be resolved before wide application of this technique such as poor control of intraoperative bleeding. To minimize both intraoperative bleeding and circulatory and biochemical disturbances due to the total interruption of blood flow to the liver, we decided to use hemihepatic vascular occlusion, initially described for conventional liver resections.[6] This maneuver, also called half-Pringle by other authors,[7] has been used by the authors for the past 10 years without any complications related to the application of a metallic vascular clamp. This technique, used since 1987, reduces the intraoperative blood loss and the postoperative hyperbilirubinemia but does not produce larger postoperative change in transaminase serum levels when compared with similar resections without vascular control.[6] This technique eliminates splanchnic congestion and reduces warm ischemia of the remnant liver, while maintaining a comparable hemostatic effect.[9] The direct approach to the correspondent glissonian pedicle before the hepatectomy (Fig. 2), possible even without the need for intraoperative ultrasound or other auxiliary techniques, also permits the previous delineation of the liver, avoiding total hepatic ischemia reducing liver damage and intraoperative bleeding.[8,10,11]

Total portal triad clamping typically increases mean arterial pressure (+21%) and systemic vascular resistance (+48%) and decreases cardiac output (−17%).[12] Comparable hemodynamic changes occur at the start of pneumoperitoneum and are similar to those of chronic heart failure.[13] Although some authors has demonstrated that these hemodynamic changes could be well tolerated in patients with normal cardiac function,[4] laparoscopic liver resection with total portal triad clamping may result in both types of change, and therefore potentially serious hemodynamic changes may take place. Indeed, dramatic hemodynamic changes after total portal triad clamping have been reported in a pig model.[15] The present technique may minimize these adverse hemodynamic effects. Despite a small number of patients, we did not observe any significant hemodynamic changes or abdominal visceral venous stagnation.

The authors believe that the described technique is a feasible and safe alternative for vascular control during laparoscopic liver resection. It provides selective control of the hilar vessels to the liver without splanchnic congestion and reduces warm ischemia of the remnant liver.

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