

# Surgical technique

---

## Intrahepatic Glissonian approach for pedicle control during anatomic mesohepatectomy

Marcel Autran C. Machado, MD,<sup>a</sup> Paulo Herman, MD,<sup>b</sup> and Marcel C. C. Machado, MD, FACS,<sup>a</sup>  
São Paulo, Brazil

From the Department of Surgery, University of São Paulo, Brazil<sup>a</sup>; Department of Abdominal Surgery, Cancer Hospital, São Paulo<sup>b</sup>

CENTRALLY LOCATED LIVER TUMORS can be removed by either right or left trisectionectomies. These procedures are technically demanding and remove 60% to 85% of the liver parenchyma, much of which may not be involved with the neoplasm, and are often associated with severe complications, including hepatic failure.<sup>1</sup> To reduce the risk of liver failure after extended liver resection, it is possible to perform preoperative portal embolization to obtain hypertrophy of the future remnant liver.<sup>2,3</sup> Another option is to minimize the volume of normal liver resected by removing only the central hepatic segments (Couinaud's segments 4, 5, and 8).<sup>4</sup> This technique, called central hepatic resection or mesohepatectomy, was first described in 1972 by McBride and Wallace.<sup>5</sup> Mesohepatectomy, however, has not gained the popularity of extended hepatectomy probably due to the complexity of the procedure.

The development of segment-based resection using intrahepatic Glissonian<sup>6</sup> access made it possible to develop techniques to identify and isolate the right and left segmental Glissonian pedicles.<sup>7,8</sup> These techniques allow complete ischemic demarcation of the central liver segments that facilitate anatomic mesohepatectomies with sufficient residual liver.

Mesohepatectomy is mentioned rarely in the literature; only 5 papers were found dealing directly with this procedure:<sup>1,9-12</sup> two case reports,<sup>10,11</sup> two papers from the same group<sup>11,12</sup> (one of which was in German<sup>12</sup>), and only one with a detailed description of the technique.<sup>1</sup> We are aware that this procedure is performed frequently in many centers,<sup>13</sup> but there is a lack of technical description of this complex procedure in the literature. In this study, the authors report the results of their own technique of mesohepatectomy based on an intrahepatic Glissonian approach described previously.<sup>7,8</sup>

### PATIENTS AND METHODS

**Patients.** Eight patients with centrally located primary or secondary neoplasms were prospectively evaluated from July 2002 to December 2005. There were 3 men and 5 women with a mean age of 63 years (range, 48 to 79 years). Four patients had colorectal liver metastases, one had intrahepatic cholangiocarcinoma, two had hepatocellular carcinoma (one with cirrhosis), and one had benign liver neoplasm. The neoplasms were single in 5 patients and multiple in 3, with mean size of 5.5 cm (range, 3 to 8 cm). Preoperative investigation included liver and renal function tests, complete blood count, and coagulation profile. All patients underwent abdominal computed tomography (CT) and/or magnetic resonance imaging (MRI). Operative procedure, postoperative outcome, and outpatient follow-up were evaluated and the following data collected prospectively: duration of operation and hospital stay, perioperative blood transfusions, and postoperative complications. Patients were selected for mesohepatectomy when the lesion or lesions

Accepted for publication July 24, 2006.

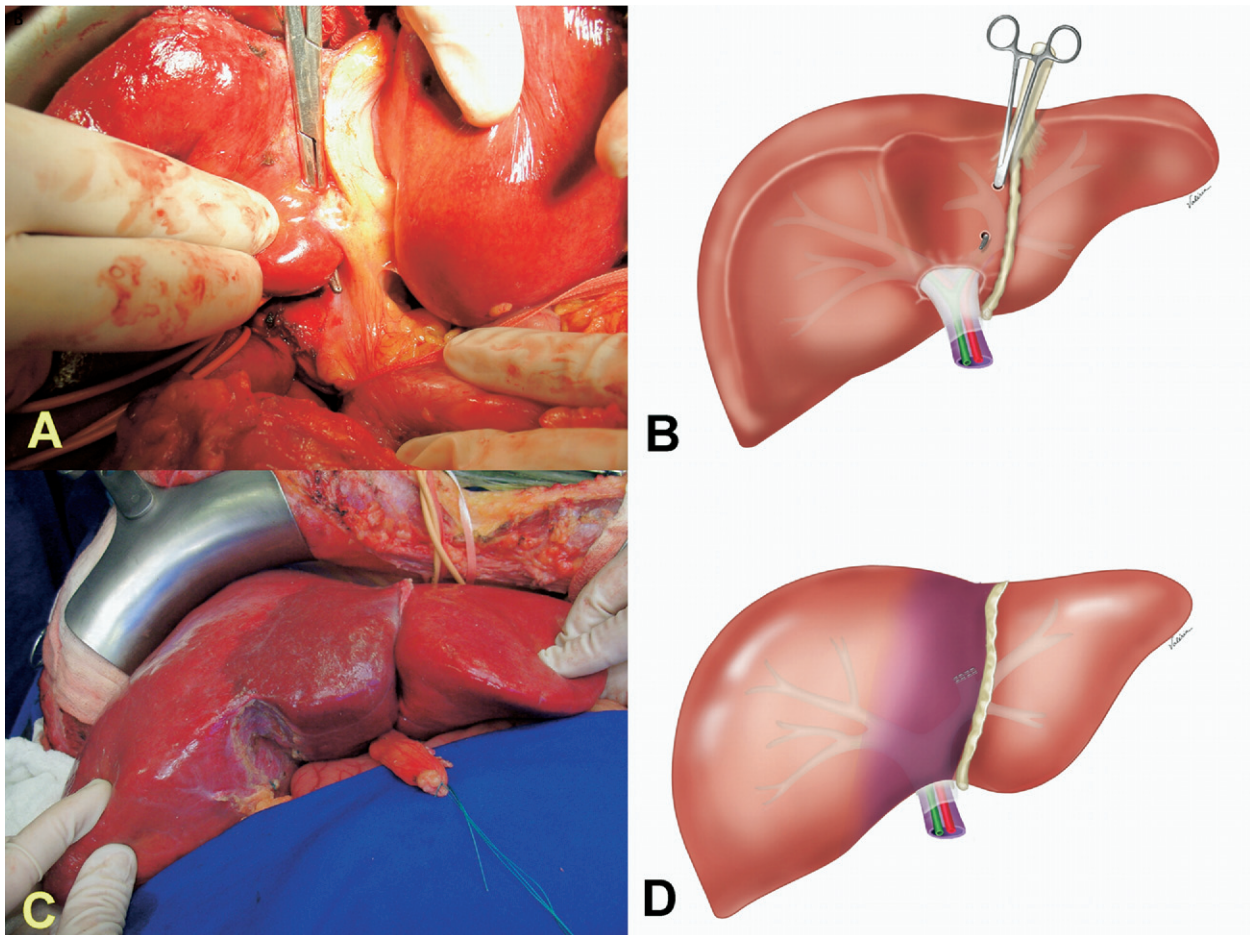
Reprint requests: Marcel Autran C. Machado, MD, Rua Evangelista Rodrigues 407 - 05463-000, São Paulo - Brazil. E-mail: dr@drmarcel.com.br.

Surgery 2007;141:533-7.

0039-6060/\$ - see front matter

© 2007 Mosby, Inc. All rights reserved.

doi:10.1016/j.surg.2006.07.023

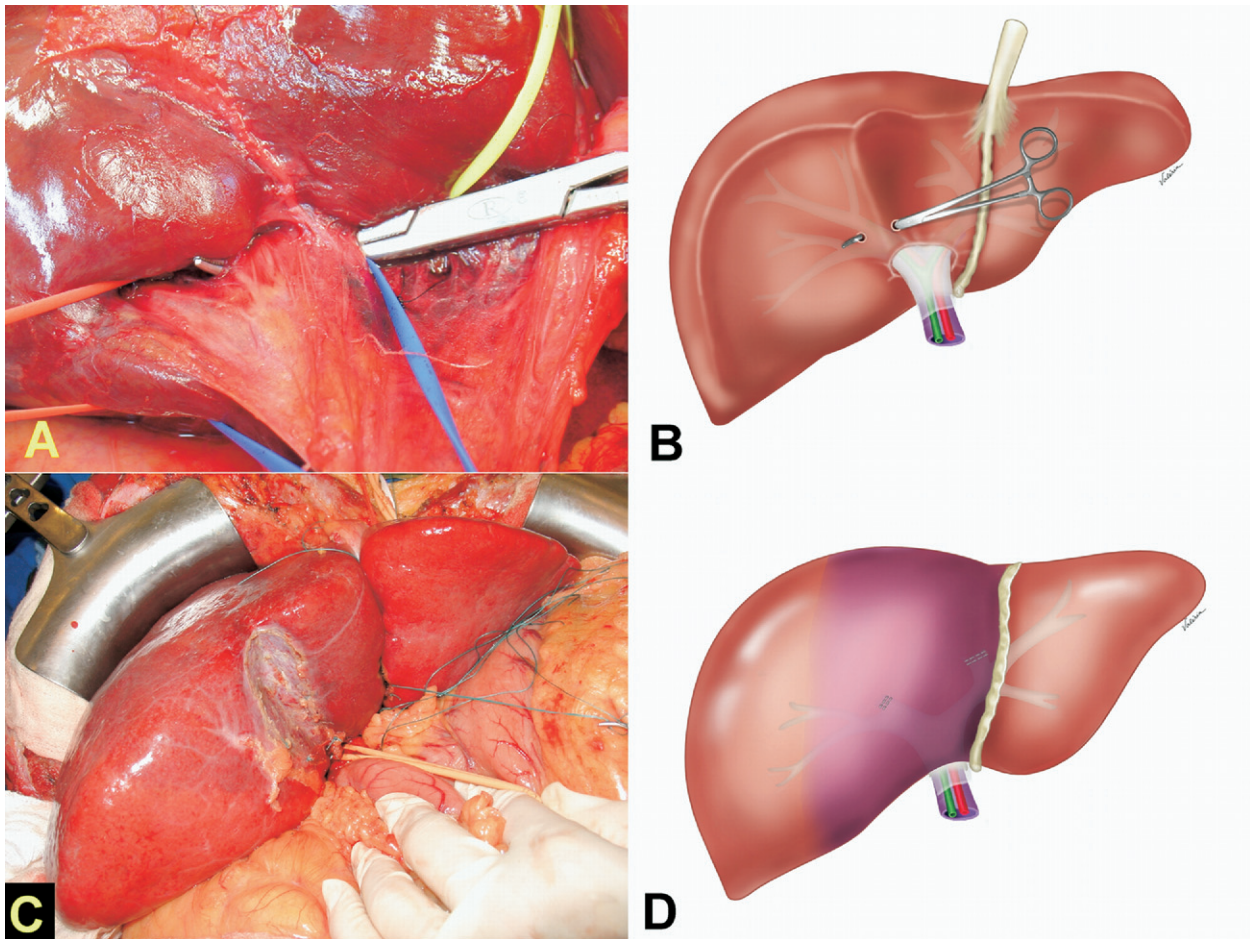


**Fig 1.** **A**, The Glissonian pedicle of segment 4 is encompassed by a large right angle clamp (intraoperative view). **B**, Schematic view of intrahepatic access of Glissonian pedicle of segment 4. **C**, Segment 4 Glissonian pedicle is clamped, resulting in ischemic delineation of segment 4 (intraoperative view). **D**, Schematic view of ischemic delineation of segment 4.

were located in the central segments 4, 5, and 8; there was no portal vein invasion; and an adequate margin (at least 1 cm) of nontumoral hepatic tissue could be obtained. The decision to perform a mesohepatectomy was confirmed after intraoperative ultrasonography showed the possibility to perform a free margin resection. Patients with mild or moderate steatosis or with cirrhosis were candidates for a liver-sparing surgery.

**Operative technique.** A bilateral subcostal incision extended along the midline up to the xyphoid or a J-shaped incision is performed. The right liver is mobilized by transecting falciform, right triangular, and coronary ligaments. A routine intraoperative ultrasonography is performed at the beginning of the operation to identify the course of the left and right hepatic veins, especially when the neoplasm is located in the upper portion of the liver. The round ligament then is retracted upward, ex-

posing the umbilical fissure between segments 3 and 4. Using the round ligament as a guide, one small incision is made at the base of the round ligament on its right side. Another small anterior incision is made 2 to 3 mm over the hilum at the left base of segment 4. With a right angle clamp (Mixer; Aesculap Inc., Center Valley, Pa) introduced through these two incisions, it is possible to isolate the Glissonian pedicle of segment 4 (Fig 1, A and B). Clamping of this pedicle results in ischemic demarcation of segment 4 (Fig 1, C and D). In some cases, the portal pedicles of subsegments 4A and 4B may arise separately; in those cases, the ischemia is confined to one of the subsegments, often the 4B. To reach the portal pedicle of the subsegment 4A (upper part of segment 4), the Mixer clamp is inserted deeper and behind the round ligament. A cholecystectomy is then performed.



**Fig 2.** **A,** Using anatomic landmarks as guide, the Glissonian pedicle of right anterior sector is encircled by a right angle clamp (intraoperative view). **B,** Schematic view of intrahepatic access of right anterior pedicle (segments 5 and 8). **C,** The Glissonian pedicle of right anterior sector already is clamped along with segment 4 pedicle, resulting in ischemic delineation of the limits for an anatomic mesohepatectomy (segments 4, 5, and 8). **D,** Schematic view of ischemic delineation for mesohepatectomy.

To reach the right anterior pedicle, 2 incisions are necessary: (a) a small anterior incision is made 2 to 3 mm over the hilum at the right base of segment 4; (b) another small incision is performed on the right edge of the gallbladder bed. The Mixer clamp is inserted through the anterior incision in front of the hilum with a 60° angle reaching the second incision to allow access to the right anterior pedicle (Fig 2, A and B). The pedicle is then clamped and ischemic demarcation of segments 5 and 8 is obtained. At this time, the limits of the right anterior sector (segments 5 and 8) and segment 4 are defined clearly through an ischemic delineation (Fig 2, C and D). The pedicle is then tied and divided (a vascular stapler may be used as well). The liver parenchyma is then transected by a clamp-crushing technique following the ischemic lines (Fig 3, A and B). It is important to note that

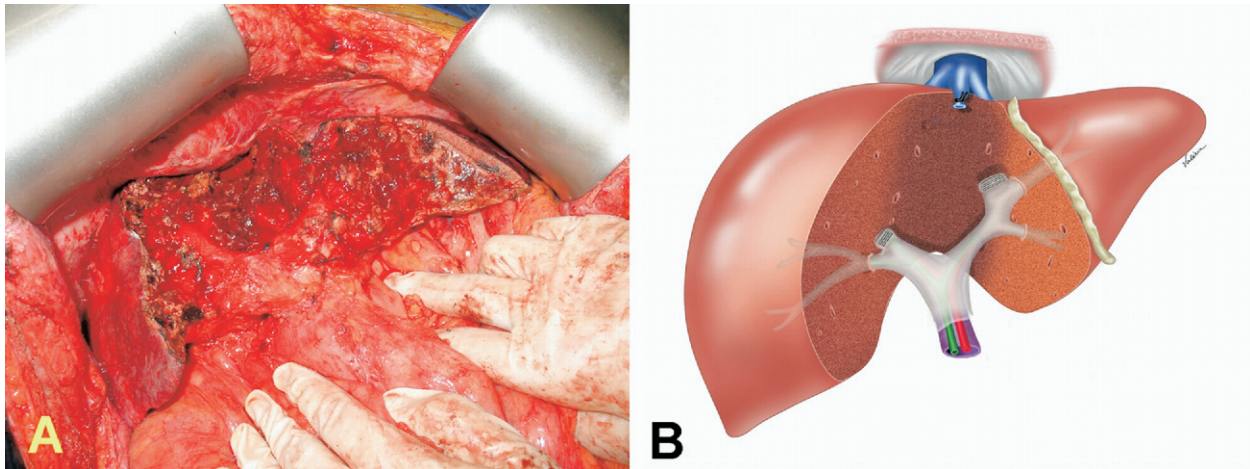
the Mixer clamp should be inserted inside the liver substance and not at the interface between the liver parenchyma and peritoneal cavity. This maneuver is safe once the thick Glissonian sheath inside the liver protects the portal triad (bile duct, hepatic artery, and portal vein branches) from damage.

All these steps are performed without hilar dissection or pedicle clamping. In one patient with a large neoplasm located superiorly, total vascular exclusion was necessary during part of the liver transection. Two round 19 F Blake abdominal drains (Ethicon, Inc, Cincinnati, Ohio) are left in place in all patients.

## RESULTS

We have used this technique successfully in all patients. Blood transfusion was required in one patient (3 units). Mean operative time was 300 minutes (range, 240 to 540 minutes). The median hospital





**Fig 3.** Mesohepatectomy. **A**, Intraoperative view of raw liver surface after resection of segments 4, 5, and 8. **B**, Schematic view of the remnant liver after removal of segment 4, 5, and 8.

stay was 6 days (range, 5 to 9 days). One patient developed bile leakage, which was managed conservatively with late removal of the drain. No patient had liver failure, and no postoperative mortality was observed. All 7 patients with malignant neoplasms had negative surgical margins of at least 1 cm. Three patients had moderate steatosis, two had mild steatosis, and another had hepatocarcinoma in a cirrhotic liver. Intraoperative liver ultrasonography confirmed the site and size of the lesions diagnosed by CT and/or MRI. In one patient with colorectal liver metastasis, another liver metastasis was observed within segment 6, and part of this segment was resected with the central segments.

The mean follow-up was 20 months. All patients are alive, but two have recurrent disease. One patient with cholangiocarcinoma developed an intrahepatic recurrence away from the cut surface 30 months after operation, and another patient developed pulmonary metastases 12 months after liver resection.

## DISCUSSION

Anatomic liver resection is defined as the removal of liver segments following anatomic limits. Respect of anatomic landmarks of liver segments during resection prevents impairment of the vascularization of the remaining parenchyma and excessive bleeding.

Anatomic mesohepatectomy is achieved by en bloc resection of Couinaud's segments 4, 5, and 8, preserving the right posterior and left lateral sectors and the caudate lobe (segments 6-7, 2-3, and 1). Mesohepatectomy involves resection of hepatic

tissue supplied by both right and left portal pedicles. This type of procedure was described initially to obtain free margins in cases of hilar cholangiocarcinoma and gallbladder cancer.<sup>4,11</sup> Recently, it has been used as an alternative to extended right- or left-liver resections because, with these resections, the volume of the removed liver accounts for 85% of the whole functioning liver.<sup>12,14</sup> With extended hepatic resection, the right or left liver and 2 additional segments on the opposite side of the liver are removed. This procedure may result in life-threatening postoperative liver failure, especially in patients with chronic liver disease and in those with injured liver (chemotherapy, major steatosis, cholestasis). Moreover, according to some authors, segment-oriented resection provides better short-term results than nonanatomic resection or extended resections.<sup>13</sup>

Despite the fact that mesohepatectomy is a liver parenchyma-sparing procedure, it is seldom used because it is technically demanding. The complexity of mesohepatectomy is based on dissection of 2 hepatic pedicles, doubled area of raw liver surface, proximity to the main hepatic veins, and necessity of preserving portal pedicles to the remaining liver segments. Mesohepatectomy is oncologically equivalent to extended resections, and the overall duration of the procedure can be the same as that in lobar extended resections, if classic techniques are employed.<sup>1</sup> This type of resection preserves a greater amount of liver parenchyma than that after extended hepatic resections. According to Scudamore et al,<sup>1</sup> mesohepatectomy is associated with lower rates of complications and shorter postoperative hospitalization. Indeed, in our experience,

there were no major complications, and the median hospital stay was 6 days.

Two techniques have been described for mesohepatectomy: (a) individual ligation and division of the vessels supplying the segments 4, 5, and 8 before the transection of the liver parenchyma, with transection of the liver parenchyma under temporary total hepatic inflow occlusion; and (b) ligation and division of the central pedicles of the liver segments during liver transection under a Pringle maneuver. The proposed technique is fast, easy to perform and avoids individual hilar dissection of artery, portal vein, and bile duct from segments 4, 5, and 8, and minimizes risks due to anatomic variations. Different from other intrahepatic Glissonian techniques,<sup>6,13,15</sup> this technique precludes extensive dissection around the hilar plate by using small incisions according to specific anatomic landmarks.

Total hepatic inflow occlusion, despite the possibility of postoperative liver failure, is usually applied during classic techniques. The intrahepatic Glissonian approach, as proposed, avoids total inflow occlusion because only the pedicles to segments 4, 5, and 8 are clamped. This approach may be of special importance in cirrhotic patients. Moreover, if bleeding occurs at one side during the parenchyma transection, hemihepatic inflow occlusion can still be applied. In case of major bleeding during parenchymal transection, a Pringle maneuver can be applied. However, if the bleeding comes from hepatic veins, total vascular exclusion is necessary until complete control of the bleeding site is obtained, which occurred in one of our patients.

Another advantage of the intrahepatic Glissonian access is to achieve quick pedicle control that results in ischemic demarcation of the area to be resected. The liver parenchyma can be transected by several ways, but we prefer the classic clamp crushing technique because it is more cost-efficient, as was confirmed recently.<sup>16</sup>

The technical difficulties of this procedure can be justified if morbidity of the alternative extended resections is considered. In fact, the risk of hepatic failure in patients with impaired liver function, such as moderate steatosis or cirrhosis, is higher after extended resections than after limited resections. The use of anatomic-based techniques, such as an intrahepatic Glissonian approach, may help identify the exact limits of the mesohepatectomy to avoid ischemic injury of the remnant liver. Therefore, centrally located neoplasms should not be a straightforward indication for extended hepatectomy for patients in whom a liver-sparing procedure, such as mesohepatectomy, can be used safely. In spite of its

technical complexity, mesohepatectomy may become the standard procedure for lesions located in the central part of the liver.

We thank Professor Felice Giuliani, Hepato-Biliary Surgery Unit, Catholic University, School of Medicine, Rome, Italy, for revising the manuscript. We also thank Valéria Fonseca for the drawings.

## REFERENCES

1. Scudamore CH, Buczkowski AK, Shayan H, Ho SG, Legiehn GM, Chung SW, et al. Mesohepatectomy. *Am J Surg* 2000; 179:356-60.
2. Hemming AW, Reed AI, Howard RJ, Fujita S, Hochwald SN, Caridi JG, et al. Preoperative portal vein embolization for extended hepatectomy. *Ann Surg* 2003;237:686-91.
3. Belghiti J. Arguments for a selective approach of preoperative portal vein embolization before major hepatic resection. *J Hepatobiliary Pancreat Surg* 2004;11:21-4.
4. Couinaud C. *Le foie: études anatomiques et chirurgicales*. New York: Masson Publishers; 1957.
5. McBride CM, Wallace S. Cancer of the right lobe of the liver: a variety of operative procedures. *Arch Surg* 1972; 105:289-96.
6. Launois B, Jamieson GG. The posterior intrahepatic approach for hepatectomy or removal of segments of the liver. *Surg Gynecol Obstet* 1992;174:155-8.
7. Machado MA, Herman P, Machado MC. A standardized technique for right segmental liver resections. *Arch Surg* 2003;138:918-20.
8. Machado MA, Herman P, Machado MC. Anatomical resection of left liver segments. *Arch Surg* 2004;139:1346-9.
9. Wu CC, Ho WL, Chen JT, Tang CS, Yeh DC, Liu TJ, et al. Mesohepatectomy for centrally located hepatocellular carcinoma: an appraisal of a rare procedure. *J Am Coll Surg* 1999;188:508-15.
10. Visokai V, Lipska L, Bergmann P, Levy M, Dutka J. Mesohepatectomy for colorectal liver metastasis. Case report. *Hepatogastroenterology* 2005;52:1563-6.
11. Lang H, Sotiropoulos GC, Malago M, Broelsch CE. Mesohepatectomy, caudate lobectomy and resection of hilar bifurcation with biliary reconstruction by 6 hepaticojunosotomies for Klatskin tumor. *Hepatogastroenterology* 2003; 50:1327-9.
12. Lang H, Sotiropoulos GC, Fruhauf NR, Radtke A, Malago M, Broelsch CE. Mesohepatectomy—an alternative to extended hepatectomy in the treatment of central liver tumors. *Chirurg* 2004;75:424-9.
13. Billingsley KG, Jarnagin WR, Fong Y, Blumgart LH. Segment-oriented hepatic resection in the management of malignant neoplasms of the liver. *J Am Coll Surg* 1998; 187:471-81.
14. Chouillard E, Cherqui D, Tayar C, Brunetti F, Fagniez PL. Anatomical bi- and trisegmentectomies as alternatives to extensive liver resections. *Ann Surg* 2003;238:29-34.
15. Takasaki K, Kobayashi S, Tanaka S, Saito A, Yamamoto M, Hanyu F. Highly anatomically systematized hepatic resection with Glissonian sheath code transection at the hepatic hilus. *Int Surg* 1990;75:73-7.
16. Lesurtel M, Selzner M, Petrowsky H, McCormack L, Clavien PA. How should transection of the liver be performed? A prospective randomized study in 100 consecutive patients: comparing four different transection strategies. *Ann Surg* 2005;242:814-22.