Journal of Surgical Oncology 2007;95:86–89

HOW I DO IT

Silkclasy: A Simple Way for Liver Transection During Anatomic Hepatectomies

PAULO HERMAN, MD, MARCEL AUTRAN C. MACHADO, MD,* AND MARCEL C.C. MACHADO, MD, FACS
Department of Gastroenterology, University of São Paulo, São Paulo, Brazil

Background: Parenchymal transection is the most important step of liver resection, and during this phase, blood loss may lead to morbidity and mortality. Liver parenchyma can be transected by different ways such as finger fracture, clamp crushing, or instrument-based techniques.
Methods: A simple and cost-efficient method has been developed for liver transection using a technique based on silk crushing of the liver substance.
Results: We have successfully employed this technique in 278 consecutive liver resections from July 2001 to March 2006. The average duration of hepatic transection varied according to the type of liver resection: 22 min (range 15–42), 19 min (range 11–37), and 12 min (range 7–21) for right hepatectomy, left hepatectomy, and bisegmentectomy 2-3, respectively. The mean transection speed was 6.9 ± 2.3 cm^2/min. Blood transfusions were necessary in 42 patients (15.1%), and there were three operative deaths (1.1%). Morbidity rate was 20.9% (58 patients).
Conclusions: This technique allows a safe and quick liver transection without the use of expensive hemostatic devices, and also precludes the use of inflow occlusion maneuvers. We recommend the use of this technique in centers with low economic resources.
J. Surg. Oncol. 2007;95:86–89. © 2006 Wiley-Liss, Inc.

KEY WORDS: **liver; anatomy, transection; technique; resection**

INTRODUCTION

Experience with liver resection has increased over the last few decades because of improvement in morbidity and mortality rates, and evidence that it may be the only chance of cure for numerous patients. The enhanced safety of liver surgery has been attributed to a number of factors, most notably the development of anesthetic and surgical techniques that reduce intraoperative blood loss [1–3]. These techniques include low central venous pressure anesthesia [4,5], and the use of vascular inflow occlusion [6,7]. However, despite of these advances, liver resection always carries a risk of intraoperative hemorrhage and postoperative hepatic failure. Parenchymal transection is the most important stage of liver resection, and during this phase, blood loss may lead to morbidity and mortality [2,3,8].

Liver parenchyma can be transected by different ways such as finger fracture, clamp crushing [9], or instrument-based techniques. The most popular devices that can facilitate liver transection include: ultrasonic dissector [10], water jet [11], radiofrequency devices [12], saline-linked cautery [13], bipolar cautery [3], and harmonic scalpel [14]. These devices are often expensive and therefore not available worldwide, especially in centers with low economic resources.

The authors describe herein a fast, simple, and cost-efficient way for liver transection using a technique based on silk crushing of the liver substance.

OPERATIVE TECHNIQUE

A bilateral subcostal incision extended superiorly in the midline to the xyphoid or a J-shaped incision is

*Correspondence to: Marcel Autran C. Machado, MD, Rua Evangelista Rodrigues 407-05463-000, São Paulo, Brazil. Fax: 55-11-3285-2640. E-mail: dr@drmarcel.com.br

Received 4 May 2006; Accepted 22 May 2006
DOI 10.1002/jso.20613
Published online in Wiley InterScience (www.interscience.wiley.com).

performed. The liver is mobilized by sectioning falciform, right or left triangular and coronary ligaments and routine intraoperative ultrasound is performed at the beginning of the operation to identify the course of the hepatic veins, especially when the tumor is located superiorly in the liver. Intrahepatic access for the glissonian pedicle is routinely performed as published elsewhere [15,16], and the pedicle is tied and divided. At this time, the limits of the liver segment(s) are clearly defined through an ischemic delineation, and the liver parenchyma is ready to be transected. A large right angle clamp (Mixter or Gray clamp) is introduced through the liver parenchyma following the ischemic lines encircling around 1.5–2.0 cm of extent and 1.0–1.5 cm of depth of liver tissue (Fig. 1A). It is important to introduce the clamp in a smooth way in order to avoid damage to large vascular structures. A 2-0 Silk or Mersilene® suture is then applied and the liver tissue is tied only at the side of the remnant liver (Fig. 1B). The liver is then sectioned with eletrocautery (Fig. 1C) leaving a knot on the remnant liver (Fig. 1D); any large vessels are suture ligated for reinforcement. Resection proceeds until liver parenchyma is completely transected. All these steps are performed without hilar dissection or clamping, and no fibrin sealant was applied to the raw liver surface. Round 19 F Blake drains (Ethicon, Inc., Somerville, NJ, USA) are routinely employed.

Transection time, recorded in all patients, was defined as the time between the beginning of liver transection until the complete removal of surgical specimens. The transection speed, recorded in the last 30 liver resections, was calculated based on the transection area divided by transection time and expressed in cm^2/min using the formula described by Lesurtel et al. [2].

RESULTS

We have successfully employed this technique in 278 consecutive liver resections from July 2001 to March 2006. There were 160 men and 118 women with a mean age of 57.4 years (range 17–81 years). One hundred twelve patients had colorectal liver metastasis (40.3%), 61 hepatocellular carcinoma (21.9%), 25 cholangiocarcinoma (9%), 22 benign liver tumors (7.9%), 10 gallbladder cancer (3.6%), and 48 patients were operated for other causes. From the 61 patients treated for hepatocellular carcinoma, 43 had a cirrhotic liver. There were 137 (49.3%) major liver resections (removal of 3 or more liver segments).

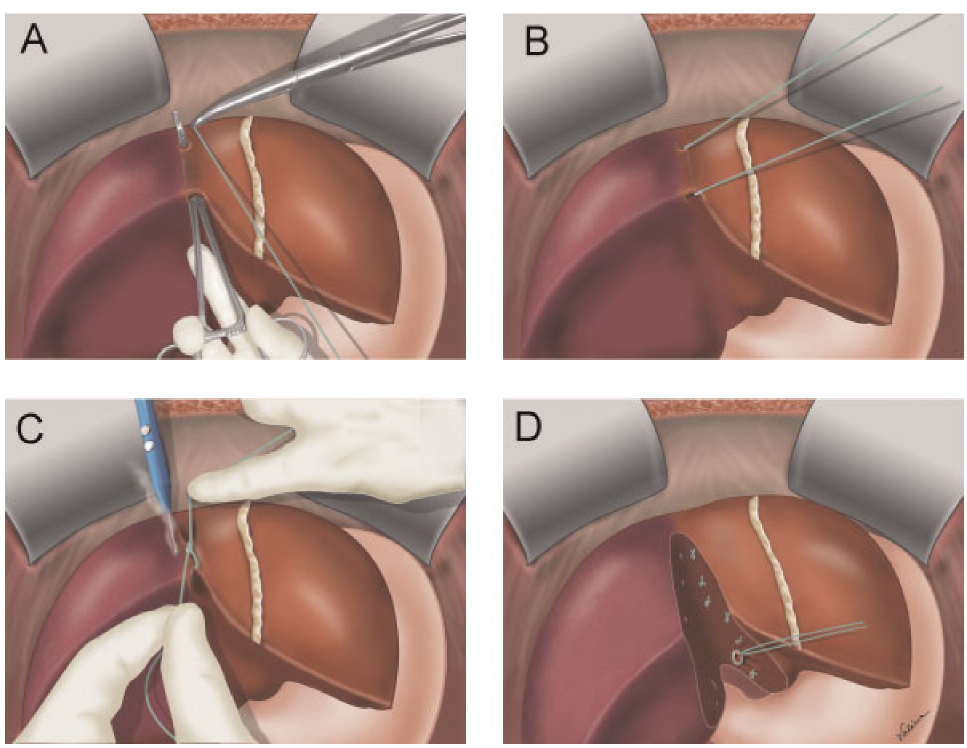

Fig. 1. Schematic view of silkclasy technique. **A**: A large right angle clamp is introduced creating a tunnel of 1.5–2 cm extension for 1–1.5 cm profundity. **B**: A 2-0 silk suture is applied around the liver tissue. **C**: The remnant liver parenchyma is tied and the ischemic liver is sectioned with electrocautery. **D**: View of the raw surface after partial liver transection. [Color figure can be viewed in the online issue, available at www.interscience.wiley.com.]

The average duration of hepatic transection varied according to the type of liver resection: 22 min (range 15–42), 19 min (range 11–37), and 12 min (range 7–21) for right hepatectomy, left hepatectomy, and bisegmentectomy 2-3, respectively. The mean transection speed was 6.9 ± 2.3 cm^2/min. No other form of liver transection was necessary. Pringle maneuver was necessary in cases of severe bleeding and was employed for a short period of time in 13 patients (4.7%).

Blood transfusion was necessary in 42 patients (15.1%), and there were three operative deaths (1.1%). Morbidity rate was 20.9% (58 patients). Two patients (0.7%) needed reoperation for postoperative bleeding, 16 patients (5.8%) developed postoperative biliary fistulas, 12 had postoperative ascitis, 9 subphrenic abscess, 8 wound infection, 5 pulmonary infection, 2 patients had transitory liver failure, and 4 other complications.

DISCUSSION

Parenchymal transection is the most important step of liver resection. The majority of intraoperative complications that will affect patient outcome usually occur during transection of liver substance. Many efforts have been done for achieving safe liver transection by delineating the transection plane and developing techniques that enables liver parenchymal splitting in a bloodless surgical field. Proper transection plane means that malignancies will be resected with clear margins while protecting vascular and biliary structures from inadvertent injuries. Surgical experience, intraoperative ultrasonography along with portal pedicle control allow accurate and reliable determination of the transection plane [8,15,16].

Safe and efficient way for liver transection is dependent on the ability to simultaneously perform parenchymal division and hemostasis [1]. None of the instruments developed for transection is completely adequate for division and hemostasis, and most liver transections are performed using a combination of instruments and techniques [9–14,17,18].

The most employed technique is the clamp crushing transection which, although simple and fast, usually needs inflow occlusion and can be associated with significant blood loss. There are situations where inflow occlusion is not advisable, such as when only a small volume of liver will remain or when hepatic reserve is compromised by preoperative prolonged chemotherapy, underlying liver disease, jaundice, or advanced age [3]. Intraoperative ischemia following inflow occlusion may add another risk factor for postoperative liver failure. Therefore any technique that avoids the routine use of inflow occlusion is recommended in these not uncommon circumstances; this has led to the development of several devices for liver transection that precludes inflow occlusion [10–14]. However, these instruments are expensive and not always available, especially in centers with low economic resources.

The present technique is very simple and does not need any special instrument, only a right angle clamp and silk sutures. Its principle is very similar to that of Chang et al. [19] who used a straight needle to apply an interlocking mattress sutures along the division line. However, their technique is not feasible in every liver transection and also leaves a great amount of devitalized liver behind. In the present technique the amount of liver encompassed by the right angle clamp is variable and larger amounts can be achieved in order to increase the speed of liver transection. It is important to localize, during intraoperative ultrasonographic evaluation, every major hepatic vein branches in order to perform suture ligation for reinforcement.

Different from other techniques, silkclasy seems to be very efficient in cirrhotic livers. The tunnel created with the right angle should be smaller because sometimes it is difficult to differentiate fibrous septa from intrahepatic vascular structures. A slight movement upwards and downwards with the wrists during the application of the right angle clamp may overcome this difficulty and, with greater experience, we are now able to encircle larger amounts of liver even in cirrhotic patients.

With the use of this technique, liver transection was safe and fast but a comparative study with other techniques was not performed. However, our results compare favorably with reports in which transection time and transection speed was recorded. For instance, Chang et al. [19] recently reported an average transection time of 63.5 min for right hepatectomy in contrast with 22 min in our study. Lesurtel et al. [2], in a randomized study comparing four different transection strategies, reported mean transection speed from 2.3 cm^2/min (ultrasonic dissector) to 3.9 cm^2/min (clamp-crushing technique). Takayama et al. [20], in a randomized study comparing two different transection techniques, reported mean transection speed of 1.1 cm^2/min (ultrasonic dissector) and 1.0 cm^2/min (clamp-crushing technique). The comparative value in this study was 6.9 cm^2/min. This present series of liver resections demonstrates that the silkclasy technique is a simple and cost-efficient way for liver transection. This technique allows a safe and quick liver transection without the use of expensive hemostatic devices, and also precludes the use of inflow occlusion maneuvers. We recommend the use of this technique in centers with low economic resources.

REFERENCES

1. Aloia TA, Zorzi D, Abdalla EK, et al.: Two-surgeon technique for hepatic parenchymal transection of the noncirrhotic liver using saline-linked cautery and ultrasonic dissection. Ann Surg 2005; 242:172–177.

2. Lesurtel M, Selzner M, Petrowsky H, et al.: How should transection of the liver be performed? A prospective randomized study in 100 consecutive patients: Comparing four different transection strategies. Ann Surg 2005;242:814–822.
3. Strasberg SM, Drebin JA, Linehan D: Use of a bipolar vessel-sealing device for parenchymal transection during liver surgery. J Gastrointest Surg 2002;6:569–574.
4. Melendez JA, Arslan V, Fischer ME, et al.: Perioperative outcomes of major hepatic resections under low central venous pressure anesthesia: Blood loss, blood transfusion, and the risk of postoperative renal dysfunction. J Am Coll Surg 1998;187:620–625.
5. Jones RM, Moulton CE, Hardy KJ: Central venous pressure and its effect on blood loss during liver resection. Br J Surg 1998;85:1058–1060.
6. Huguet C, Gavelli A, Chieco PA, et al.: Liver ischemia for hepatic resection: Where is the limit? Surgery 1992;111:251–259.
7. Abdalla EK, Noun R, Belghiti J: Hepatic vascular occlusion: Which technique? Surg Clin North Am 2004;84:563–585.
8. Smyrniotis V, Arkadopoulos N, Kostopanagiotou G, et al.: Sharp liver transection versus clamp crushing technique in liver resections: A prospective study. Surgery 2005;137:306–311.
9. Lin TY: A simplified technique for hepatic resection: The crush method. Ann Surg 1974;180:285–290.
10. Andrus CH, Kaminski DL: Segmental hepatic resection utilizing the ultrasonic dissector. Arch Surg 1986;121:515–521.
11. Papachristou DN, Barters R: Resection of the liver with a water jet. Br J Surg 1982;69:93–94.
12. Stella M, Percivale A, Pasqualini M, et al.: Radiofrequency-assisted liver resection. J Gastrointest Surg 2003;7:797–801.
13. Poon RT, Fan ST, Wong J: Liver resection using a saline-linked radiofrequency dissecting sealer for transection of the liver. J Am Coll Surg 2005;200:308–313.
14. Sugo H, Mikami Y, Matsumoto F, et al.: Hepatic resection using the harmonic scalpel. Surg Today 2000;30:959–962.
15. Machado MA, Herman P, Machado MC: A standardized technique for right segmental liver resections. Arch Surg 2003;138:918–920.
16. Machado MA, Herman P, Machado MC: Anatomical resection of left liver segments. Arch Surg 2004;139:1346–1349.
17. Nagano Y, Matsuo K, Kunisaki C, et al.: Practical usefulness of ultrasonic surgical aspirator with argon beam coagulation for hepatic parenchymal transection. World J Surg 2005;29:899–902.
18. Yamamoto Y, Ikai I, Kume M, et al.: New simple technique for hepatic parenchymal resection using a Cavitron Ultrasonic Surgical Aspirator and bipolar cautery equipped with a channel for water dripping. World J Surg 1999;23:1032–1037.
19. Chang YC, Nagasue N, Lin XZ, et al.: Easier hepatic resections with a straight needle. Am J Surg 2001;182:260–264.
20. Takayama T, Makuuchi M, Kubota K, et al.: Randomized comparison of ultrasonic vs clamp transection of the liver. Arch Surg 2001;136:922–928.