HOW I DO IT

Silkclasy: A Simple Way for Liver Transection During Anatomic Hepatectomies

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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 cm²/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.


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 performed. No preoperative vascular occlusion is needed. The following steps are performed sequentially: (1) mobilization of the liver, (2) exposure of the segmental pedicles, (3) control of the main hepatic artery, (4) transection of the hepatic vein, (5) transection of the hepatic artery, (6) transection of the veins, (7) transection of the bile ducts, (8) transection of the remaining vessels, (9) transection of the bile duct, and (10) closure of the incision. The technique is repeated for each segmental resection. The incision is closed in layers with absorbable sutures. The silk is removed at the end of the procedure.

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performed. The liver is mobilized by sectioning falci-
form, 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 electrocautery (Fig. 1C) leaving a knot on the remna-
tant liver (Fig. 1D); any large vessels are suture ligated for
reinforcement. Resection proceeds until liver parench-
yma is completely transected. All these steps are per-
formed 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.

**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
define the time between the beginning of liver transection
unclamping or clamping, and no fibrin

![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.]](image_url)
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 $6.9 \pm 2.3 \text{ cm}^2/\text{min}$. 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 ascites, 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 patients. 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 cm²/min (ultrasonic dissector) to 3.9 cm²/min (clamp-crushing technique). Takayama et al. [20], in a randomized study comparing two different transection techniques, reported mean transection speed of 1.1 cm²/min (ultrasonic dissector) and 1.0 cm²/min (clamp-crushing technique). The comparative values in this study was 6.9 cm²/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**


