Open Hepatic Transection Using Chang’s Needle

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2.1 Introduction

The techniques of hemostasis, inflow and outflow control, and reducing ischemia–reperfusion injuries and tumor cell floating during liver parenchymal transection are the major issues of hepatic resection for benign and malignant liver diseases. Although surgical techniques, sophisticated instruments, and postoperative care are improving, simple, inexpensive, less insult-inducing, less technique- and training-demanding instruments and maneuvers are fundamental for global use. In 1911, a German surgeon, Professor Walther Wendel [1], published a paper about such a preliminary technique. Coincidently, about 100 years later (1996) in Asia, a Taiwanese surgeon [2–4] began innovative techniques by using a similar instrument without knowing about the existence of this pioneer.

2.2 Device Description

Chang’s needle consists of a straight, inner needle with a hook near its top to catch the thread, and an 18-gauge stainless-steel external sheath (Fig. 2.1a) to prevent tissue and vascular injuries caused by the hook during the procedure.

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Currently, we have inner needles of three sizes (19.5, 16.5, and 11.5 cm) to be used for livers of varying sizes and thicknesses (Fig. 2.1b). A curved needle is being developed as well in an effort to control every individual intrahepatic vessel in laparotomy and laparoscopy models.

2.3  **Technique Description: Right Hepatic Lobectomy**

A right or bilateral subcostal incision with or without extension to the xyphoid is used to open the abdomen. The right side of the liver is first thoroughly mobilized and routinely examined by palpation, and intraoperative ultrasonography is used to confirm the lesion and to determine a suitable division line. Doppler ultrasonography can be used to locate the inflow and outflow vessels if needed. Next, Chang’s needle is applied repeatedly along both sides of the division line. The needle penetrates the entire depth of the liver parenchyma from the liver surface and catches one end of no. 1 silk thread from below (Figs. 2.2 and 2.3), then penetrates again, 3–5 cm away from the previous point of insertion, to catch the
other end of the thread. A secure tie can subsequently be made to block all vascular flows within this area (Fig. 2.3).

Ultimately, two rows of interlocking mattress sutures are formed (Fig. 2.4a–c). Doppler ultrasonography may alternatively be used to verify whether the vessels are securely blocked before the hepatic transection. Subsequently, without using
Pringle’s maneuver or any other procedures to block the hepatic inflow and backflow, the liver parenchyma is divided at these two rows of interlocking sutures using scissors (most frequently used), forceps with the division and clamping method, or electrocautery. With increasing experience, this operation can be completed with only one row (the remnant side) of interlocking sutures, and the second row can be omitted.

Although some interlocking mattress sutures may be cut during the parenchymal transection, this will not affect the operation significantly; however, additional sutures with Chang’s or conventional needle may be required in this situation.

Any tubular structure of significant size encountered may be ligated with 3-0 silk thread, and any major Glisson sheath can be suture-ligated with 2-0 silk thread for reinforcement (Fig. 2.5).

Sometimes a congestive condition of the liver may occur and cause unnecessary bleeding if the inflow is not completely tied while the backflow is blocked. The inflow may be incompletely tied due to high arterial pressure or thick liver parenchyma; the backflow, on the other hand, can be easily tied because of low pressure in the hepatic vein. In such situation, the ligature of the outflow should be released or severed, and immediately replaced with an untied suture. After dividing the main Glissonian pedicle of the inflow, the untied suture of the backflow is then secured.

Fig. 2.4 Interlocking mattress sutures or right hepatic lobectomy: a finishing the first row and starting the second row puncture; b, c completion of two rows, but now only one row is necessary.
2.4 Typical Indications of the Straight Chang’s Needle

Current indications for using the straight Chang’s needle in hepatic resections are right lobectomy, S6 + 7 + 8 trisegmentectomy, left lateral segmentectomy, S7 + 8 or S5 + 6 bisegmentectomy, S2 or 3 segmentectomy of Couinaud classification, or nonanatomic resections shown in Fig. 2.6. Figure 2.7 shows our 102 hepatic resections, including a case with hepatorrhaphy.

The resections can be designed freely if the biliary drainage and hepatic inflow of the remnant liver can be properly preserved. Oblique puncture may also be used for lesions where vertical puncture is impossible [e.g., above the inferior vena cava (IVC)] using the straight needle. Currently, a curved needle is being developed to overcome such problems as well as to secure the inflow and outflow before laparoscopic liver resection. Severe liver laceration may also be easily suture-compressed using this needle.

A contraindication for the straight needle is tumors near or over the IVC.

2.5 Clinical Results

There were 66 HCCs, 5 cholangiocarcinomas (CCC), 10 colon metastases, 1 angiomyolipoma, 4 hemangiomas, 1 liver trauma, and 15 intrahepatic duct (IHD) stones. Thirty-five patients had mild to severe degrees of liver cirrhosis, and six patients had chronic active hepatitis. The remaining 61 patients had a normal liver.
However, in two of the four patients with CCC, one liver showed marked cholestasis, while the other showed signs of sepsis before the operation. Chang’s needle was used for hepatic resections in 13 right lobectomies, 3 trisegmentectomies, 25 bisegmentectomies, 17 segmentectomies, 20 subsegmentectomies, 5 wedge hepatectomies, 18 left lateral segmentectomies, and 1 heptorrhaphy (Fig. 2.7). There was no procedure-related mortality. One patient had severe multiple injuries from a motor vehicle accident and died of multiorgan failure.
Despite successful hemostasis for her liver laceration. Another died from severe nosocomial pneumonia [methicillin-resistant Staphylococcus aureus (MRSA)]. Minor bile leakage occurred in one case (1%), but healed spontaneously. Three had hemorrhages; one minor hemorrhage stopped spontaneously, but the other two needed re-intervention, one of which was not attributable to the use of Chang’s needle. Several patients with IHD stones experienced minor wound infections as a result of contamination from pus discharged from the bile duct. In most cases, only minimal hemorrhage was encountered during hepatic transection. The average durations of hepatic transections (Table 2.1), including the time required for
placement of interlocking mattress sutures, were 62, 40, 45, 19, and 25 min for right lobectomy, trisegmentectomy, bisegmentectomy, segmentectomy, and left lateral segmentectomy, respectively. It took only 5 min for hemostasis of liver laceration bleeding using compression sutures.

### Table 2.1 102 hepatic resections using Chang’s needle

<table>
<thead>
<tr>
<th>Operation</th>
<th>Case number</th>
<th>Blood loss (ml)</th>
<th>Transection time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right lobectomy</td>
<td>13</td>
<td>612 (0–2,100)</td>
<td>62 (10–120)</td>
</tr>
<tr>
<td>Complete placement</td>
<td>8</td>
<td>663 (0–2,100)</td>
<td>63 (10–120)</td>
</tr>
<tr>
<td>Partial placement</td>
<td>5</td>
<td>430 (0–1,500)</td>
<td>60 (40–80)</td>
</tr>
<tr>
<td>Trisegmentectomy</td>
<td>3</td>
<td>333 (0–700)</td>
<td>40 (15–60)</td>
</tr>
<tr>
<td>Bisegmentectomy</td>
<td>25</td>
<td>299 (0–1,950)</td>
<td>45 (10–90)</td>
</tr>
<tr>
<td>Segmentectomy</td>
<td>17</td>
<td>71 (0–300)</td>
<td>19 (3–40)</td>
</tr>
<tr>
<td>Subsegmentectomy</td>
<td>20</td>
<td>291 (0–350)</td>
<td>20 (5–40)</td>
</tr>
<tr>
<td>Wedge hepatectomy</td>
<td>5</td>
<td>7 (0–35)</td>
<td>16 (10–20)</td>
</tr>
<tr>
<td>Left lateral segmentectomy</td>
<td>18</td>
<td>110 (0–1,000)</td>
<td>25 (15–60)</td>
</tr>
<tr>
<td>Hepatorrhaphy</td>
<td>1</td>
<td>Minimal</td>
<td>5</td>
</tr>
</tbody>
</table>

a S6 + 7 + 8  
b DIC patient

**Fig. 2.8** Partial placement of interlocking mattress sutures according to the location of tumor interference

Occasionally, tumors located near the IVC or the entrance of the right hepatic vein (Fig. 2.8, left), or near the bifurcation of the right portal vein (Fig. 2.8, right) will disturb complete placement of the interlocking mattress sutures. In the former case, partial placement can be done first, followed by conventional transection without using Pringle’s maneuver [5]. In the latter case, hilar ligation of the vessels
and bile duct and conventional transection can be done before partial placement of the interlocking mattress sutures.

### 2.7 Chang’s Maneuver: Selective, Temporary, or Permanent Blocking of Intrahepatic Inflow and Backflow

Intraoperative ultrasound (with or without Doppler function) is used to locate the respective inflow and backflow vessels, and then Chang’s maneuver is used on these vessels (Fig. 2.9) before starting the hepatic resection. After the resection, the inflow and backflow blocks may be released.

### 2.8 Advantages of the Current Technique

The advantages of this maneuver can be summarized as follows: (1) inexpensive, simple, and reusable instruments are used; (2) Pringle’s maneuver is unnecessary; (3) shortened operation time; (4) fewer or no blood transfusions needed in most cases; (5) fibrin glue is unnecessary; (6) fewer ischemic and reperfusion injuries of
the remnant liver, which leads to simpler postoperative care; (7) a lower level of stress for the surgeon during parenchyma transection due to the lack of bleeding; (8) less demand for technique and training for surgeons; (9) less sophisticated and expensive equipment is required; (10) contributes to reduced medical costs; and (11) an easier maneuver that allows more surgeons to perform hepatic resections, especially in developing countries.

Acknowledgments  The undernoted illustrations appear in this chapter by kind permission of the sources listed below: Figs. 2.1, 2.6, and 2.7 are from Wolters Kluwer Health, Ann Surg 2006;243(2):169–172. Figs. 2.2 and 2.9 are from Wiley, HPB 2008;10:244–248.

References
