

# Left Lateral Sectionectomy Performed Under Minimal Open Access after the Completion of Hand-Assisted Laparoscopic Mobilization

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## Abstract

**Purpose:** Left lateral sectionectomy is one of the best methods for laparoscopic anatomical liver resection. We have developed a three-port method for anatomical left lateral sectionectomy, in which the sectionectomy is performed via a minimal incision after hand-assisted laparoscopic mobilization.

**Methods:** Access for the open laparotomy was obtained by making an 8 cm incision for a hand port. The other ports were used as the camera port and working port. Liver immobilization was completed under pneumoperitoneum. Fingertip tape ligation is a very simple method for encircling the hepatoduodenal ligament and does not require any special equipment. The standard open technique was then employed for liver dissection through the mini-laparotomy. We compared the clinical and operative variables of the patients that underwent the open procedure (n = 6) with those of the patients that underwent the laparoscopic procedure (n = 5) at our institute between January 2005 through June 2008.

**Results:** We developed a three-port method for left lateral sectionectomy. No technical difficulties or major complications occurred. The laparoscopy group exhibited significantly less intraoperative bleeding and a significantly shorter period of hospitalization than the open procedure group.

**Conclusion:** The three-port method is suitable for hand-assisted left lateral sectionectomy and is easily repeatable by all liver surgeons, as it does not require any special skills.

**Keywords:** Hepatectomy; Laparoscopy; Pringle maneuver; Sectionectomy; Minimal access

## Introduction

Although hepatectomy has become safer, and the mortality rate of open laparotomy is decreasing [1], it is still higher than those of other gastrointestinal surgical procedures [2]. Standard hepatectomy requires a large skin incision to be made; i.e., a subcostal incision combined with midline extension, to ensure a good surgical field. However, large wounds can cause acute pain, resulting in decreased daily activity after surgery. Since 1991, laparoscopic hepatectomy has been developed to avoid excessive surgical stress after hepatectomy [3].

Left lateral sectionectomy is one of the best methods for laparoscopic anatomical liver resection [4,5]. However, as it requires a high level of surgical skill it is hard for some surgeons to perform. Recently, a hybrid method that can be applied to all types of hepatectomy was introduced [6], and a three-port method for laparoscopic liver resection was also proposed [7]. We have also developed a three-port method for anatomical left lateral sectionectomy, in which the sectionectomy is performed via a minimal incision after hand-assisted laparoscopic mobilization. Herein, we also present a simple manual procedure for the Pringle maneuver.

## Methods

We developed a three-port method for left lateral sectionectomy as a standard laparoscopic approach. First, a mini-laparotomy involving an 8 cm right subcostal incision or median incision was performed. A hand-assistance device (Gelexis™; Applied Medical, Rancho Santa Margarita, CA) was then inserted into the incision, which was used as the hand port. The other ports were used as the camera port and working port. The camera port was located between the left subcostal region and umbilicus, rather than at the umbilicus itself. This modification of the camera port location was very effective at maintaining a triangular

working space during pneumoperitoneum. The functions of the ports could be switched if necessary. The location of the hand port was decided based on preoperative virtual 3D imaging (Figure 1). In our cases, a right subcostal incision was used in four patients, and a median incision was used in one patient. The hand port was located on an extended straight line between the root of the left hepatic vein and the round ligament, which included the liver dissection plane. Basically, we attempted to ensure that the liver dissection plane ran in a straight line. A typical case is shown in Figure 1. In the latter case, when a midline incision was selected the planned liver dissection plane was angular (Figure 1a). On the other hand, it followed a straight line when a right subcostal incision was selected (Figure 1b). Although the liver could be moved a little manually and the window created by the mini-laparotomy could be moved by changing the traction of the retractors on the left or right side, the range of window movement was usually limited. The location of the hand port was very important as its correct placement allowed the surgeon to perform the open procedure without any stress.

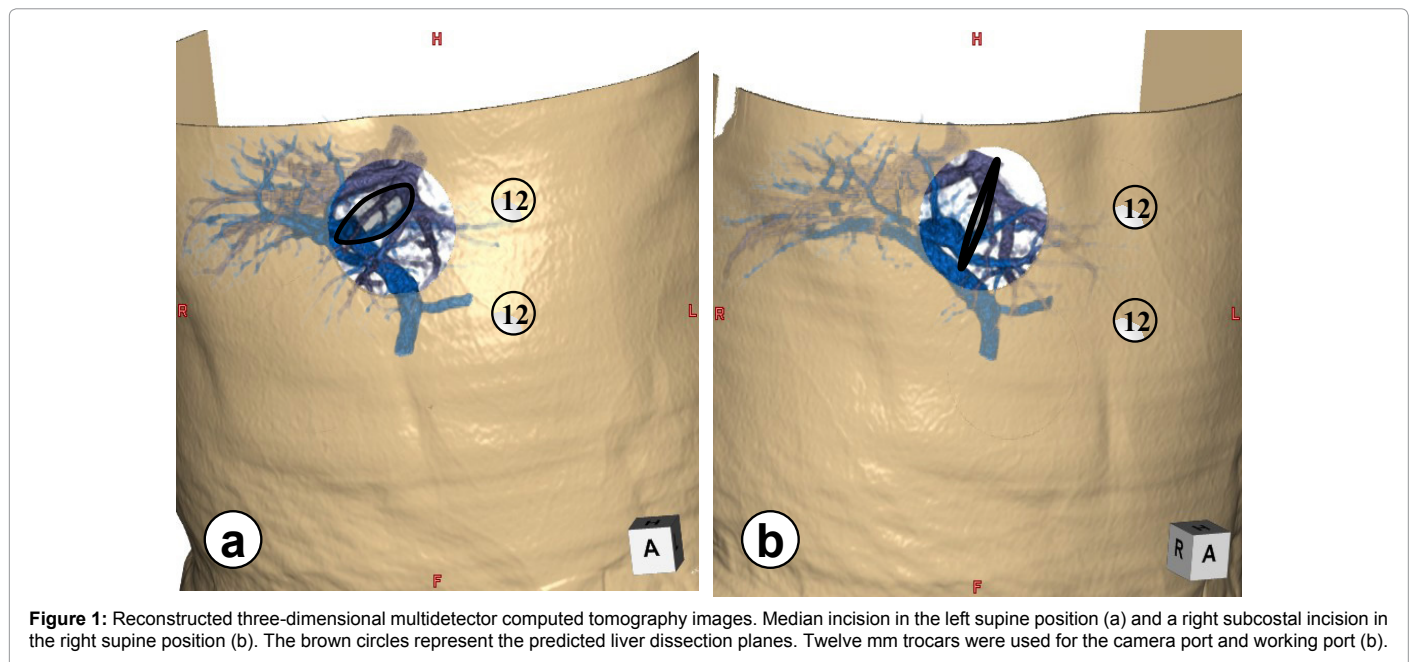
The taping of the hepatoduodenal ligament to perform the Pringle

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**Figure 1:** Reconstructed three-dimensional multidetector computed tomography images. Median incision in the left supine position (a) and a right subcostal incision in the right supine position (b). The brown circles represent the predicted liver dissection planes. Twelve mm trocars were used for the camera port and working port (b).

maneuver is usually considered to be one of the most difficult parts of the procedure. However, our technique, which involves fingertip tape ligation, is very easy and fast (Figures 2a-2d). Vascular tape was placed on the tip of the surgeon's left middle finger (Figure 2a). Then, the surgeon encircled the hepatoduodenal ligament with their finger (Figures 2b and 2c). This method is a very simple way of encircling the hepatoduodenal ligament without special equipment. The tape was then cut using endoscissors and pulled outwards with an endograsper (Figure 2d).

Immobilization of the liver was completed under low pressure pneumoperitoneum (Figure 3a). The standard open technique was employed after liver immobilization through the mini-laparotomy (Figure 3b). The liver dissection plane was lifted with hanging tape by pulling the round ligament. Any standard surgical device could be used to perform the liver parenchymal dissection (Figure 3c), although we preferred to use a Cavitron ultrasonic surgical aspirator (CUSA Sonopet UST-2000, M&M, Tokyo, Japan) and a saline-linked cauterizer (TissueLink, Dover, NH) for the (Figure 3c). Glisson's pedicles and the left hepatic vein were cut using a surgical stapler (Figure 3d and 3e). All incisions were sutured with absorbable monofilaments (4-0 PDS II; Ethicon Inc., Somerville, NJ), and a drain tube (Blake drain; Ethicon, Inc.) was placed on the surface of the liver transection plane for 2 days (Figure 3f). A typical example of the wound left after traditional open hepatectomy is shown in Figure 3g. The only technical difference between the laparoscopic approach and the open procedure was whether the liver immobilization was performed under laparoscopy or direct vision.

Postoperative complications were defined and classified according to the modified Clavien classification system [8]. Briefly, grade I complications were defined as any deviation from the normal postoperative course that did not require special treatment. Grade II complications were defined as those that required pharmacological treatment. Grade III complications were defined as those that required surgical or radiological intervention with (IIIb) or without (IIIa) general anesthesia. Grade IV complications were defined as life-threatening complications involving single (IVa) or multiple (IVb)

organ dysfunction. Grade V complications were defined as those that resulted in the death of the patient.

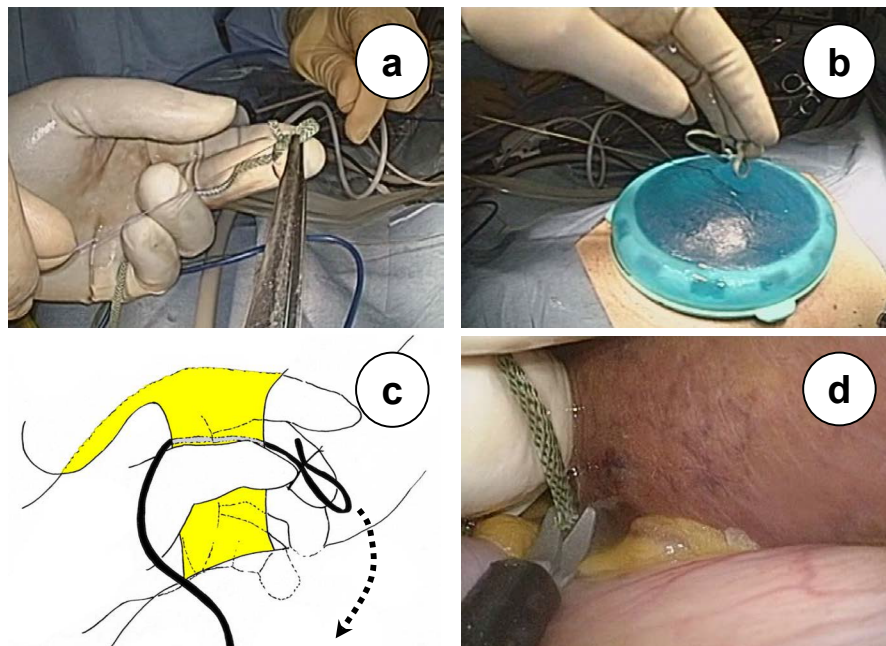
## Results

We employed laparoscopic left lateral sectionectomy with the abovementioned three-port method in five patients from January 2005 through June 2008. We then compared the clinical and operative variables of the patients that underwent the open procedure ( $n = 6$ ) with those of the patients that underwent the laparoscopic procedure ( $n = 5$ ). Basically, left lateral sectionectomy was conducted using the three-port technique unless the patient had a history of upper-abdominal surgery. Therefore, all of the patients in the open procedure group had previously undergone surgery and exhibited upper abdominal adhesion.

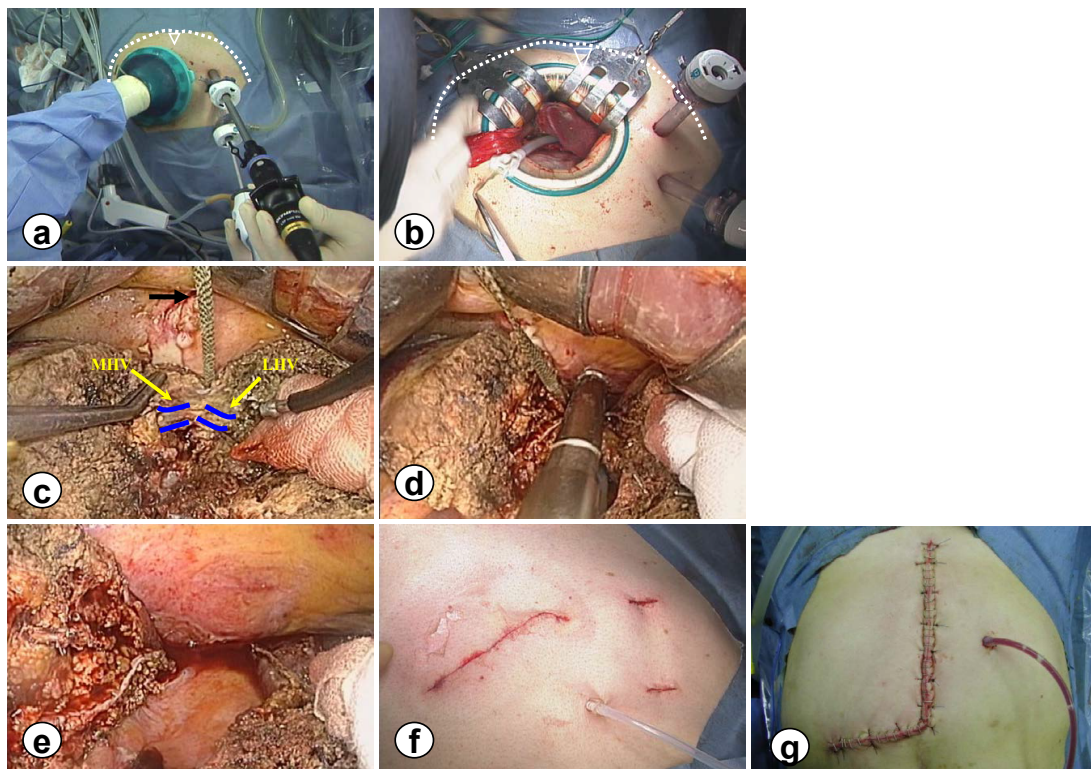
No significant differences in the sex ratio; disease etiology; age; white blood cell count; hemoglobin concentration; platelet count; serum levels of albumin, total bilirubin, aspartate transaminase, or alanine transaminase; prothrombin time; tumor size; operation time; or the frequency of blood transfusions were detected between the groups (Table 1). However, less bleeding occurred during the laparoscopic procedure than during the open procedure ( $129.0 \pm 139.3$  ml vs.  $483.3 \pm 207.9$  ml;  $P=0.017$ ). Furthermore, the patients in the laparoscopic procedure group had shorter hospital stays than those in the open procedure group ( $8.8 \pm 1.1$  days vs.  $13.0 \pm 1.1$  days;  $P=0.006$ ). No major complications or technical conversions occurred. In the open procedure, a grade IIIa wound infection was observed in one patient.

## Discussion

The laparoscopic approach for liver resection requires a high level of skill for both the laparoscopic and hepatobiliary surgical techniques. However, efforts have been made to explore the feasibility of performing all types of hepatectomy with the aid of laparoscopy [9]. As it is a developing technique, there is no standard method for laparoscopic liver resection. Our technique for left lateral sectionectomy is easy for all surgeons to perform, as it does not require any special skills. Therefore, it can be used as a standard method for left lateral sectionectomy.



**Figure 2:** Tape ligation method for the Pringle maneuver. Vascular tape was placed on the tip of the surgeon's left middle finger (a). A Gelexis™ HALS device was inserted into the right subcostal incision (b). The surgeon encircled the hepatoduodenal ligament with their finger, and the tape was then pulled outwards with an endograsper (c). The dotted line shows the direction in which the tape was pulled. The tape was then cut using endoscissors and pulled outwards with an endograsper (d).



**Figure 3:** Intraoperative overview during liver immobilization under pneumoperitoneum (a). A wound retractor was installed for the minimally open approach, and the round ligament was pulled to lift the liver itself (b). The dotted white lines indicate the subcostal margins, and the triangles show the xiphoid process. The liver dissection plane was lifted using vascular tape (arrow), and the liver parenchymal dissection was carried out using the same technique as was employed in the open procedure (c). The parenchymal dissection extended to the bifurcation of the middle hepatic vein (MHV) and left hepatic vein (LHV), as shown by the blue lines. The left hepatic vein was cut with a stapler (Endocutter; Ethicon Inc.) containing a white cartridge (d). The liver dissection plane just after the left hepatic vein had been cut (e). Overview after skin closure and drain placement (f). Typical wound left after traditional open hepatectomy (g).

	Open procedure (n = 6)	Laparoscopy (n = 5)	P value
Sex (M:F)	3:3	1:4	NS
Etiology (HCC:metastasis)	2:4	1:4	NS
Age (years)	62.2 ± 7.8	61.8 ± 16.6	NS
WBC (/mL)	5720 ± 1371	5883 ± 1139	NS
Hemoglobin (g/dL)	18.7 ± 8.1	19.6 ± 6.5	NS
Platelet count (X10 <sup>9</sup> /dL)	23.6 ± 6.9	25.0 ± 7.7	NS
Albumin (g/dL)	4.0 ± 0.3	4.2 ± 0.4	NS
Total bilirubin (mg/dL)	0.62 ± 0.11	0.87 ± 0.26	NS
AST (U/L)	23.6 ± 6.9	25.0 ± 7.7	NS
ALT (U/L)	22.4 ± 7.8	23.2 ± 13.8	NS
Prothrombin time (%)	95.3 ± 11.9	104.2 ± 8.9	NS
Tumor size (cm)	4.5 ± 1.2	4.1 ± 1.1	NS
Operation time (min)	284.8 ± 65.4	282.0 ± 115.1	NS
Bleeding (ml)	483.3 ± 207.9	129.0 ± 139.3	0.017
Blood transfusion (units)	0	0	NS
Hospital stay (days)	13.0 ± 1.1	8.8 ± 1.1	0.006
Complications (Y:N)	1:5	0:5	NS

Data are shown as mean ± standard deviation values. The chi-square test was used for categorical variables, and the Mann-Whitney U-test was used for continuous variables. Complications only occurred in one patient (a Grade IIIa wound infection according to the Clavien classification), who underwent the open procedure. P values of < 0.05 were considered to be statistically significant.

WBC: White blood cell count, AST: aspartate transaminase, ALT: Alanine transaminase, NS: Not significant

**Table 1:** Comparison of the clinical and surgical parameters of the two groups.

The laparoscopic approach for liver resection has been compared to the conventional open method in various studies [5,10,11]. In such studies, it has been suggested that the laparoscopic approach contributes to a shorter hospital stay [5] and reduced bleeding [10] although it requires a longer operative time than the open approach [11]. Our preliminary results showed our procedure also resulted in a shorter hospital stay and less bleeding. The shorter hospital stay could be due to the patient experiencing less severe postoperative pain, as most patients who do not experience severe pain would prefer to be discharged from hospital, although we did not assess our patients' pain on a pain scale. Oncological factors such as survival after surgery do not differ significantly between the laparoscopic and open approaches [5,11,12]. Thus, the only obstacle to applying the laparoscopic approach to surgery for liver tumors is the technical difficulty of the procedure. Therefore, once a standard approach has been established the laparoscopic approach can become a major surgical strategy, as is the case for laparoscopic cholecystectomy, which has gained acceptance all over the world.

Surgical procedures for liver tumors involving various numbers of ports have been reported, including three-port [6,7], four-port [13,14], and five-port procedures [15,16], depending on whether a pure laparoscopic approach, hand-assisted approach, or hybrid approach is employed. A pure laparoscopic approach would be ideal, as it would be minimally invasive. In fact, the first left lateral sectionectomy was done using a five-port method [15], and subsequent reports described similar approaches. However, this demands a high level of skill, and therefore, cannot be performed by all surgeons. Furthermore, we are unsure about the benefits of the pure laparoscopic approach because the abdominal wall must eventually be opened to remove the resected liver. As far as the location of the incision is concerned, subcostal incisions are avoided by some surgeons due to a fear of postoperative complications [10]. However, no reports have demonstrated any difference in the incidence of complications between different types of incision. Furthermore, the port sites should be distributed in a triangular manner to ensure a good scope field and working space. Relocation of the umbilical port is sometimes necessary in order to maintain the ideal triangular formation. In the present study, we found

that preoperative 3D reconstructed images including of the abdominal wall (Figure 1) were useful for planning the port site locations. We would like to emphasize that performing parenchymal dissection using the abovementioned three-port method under minimal open access after the completion of hand-assisted mobilization is a suitable approach to left lateral sectionectomy and is easily repeatable by all liver surgeons, as it does not require any special skills.

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