Original Article

Experimental Laparoscopic Hepatectomy of Left Lateral Lobe in Pig Models

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Abstract

The application to laparoscopic hepatectomy has not been actively developed because of the technical and anatomical difficulties. In this article we describe our surgical technique and the materials used in the experimental model of pigs.

A laparoscopic left lateral lobectomy was performed in six pigs.

The left medial and lateral lobes of the liver were grasped after four trocars were introduced. An ultrasonic surgical system was used to dissect the parenchyma. The portal vein and hepatic vein were carefully dissected free from surrounding tissue. The vascular pedicles were secured with an Endo-clip and/or transfixing suture, cut with the scissors or Endo-cutter. The resected liver was placed in a nylon sack (Endo-pouch) and removed through a trocar site by extending the incision.

A left lateral lobectomy was performed safely in all six pigs. Surgery required 90 to 130 minutes and blood loss was less than 100 ml except one animal. All pigs were stable condition. No bile leakage or site of bleeding was observed at autopsy.

The laparoscopic hepatectomy, especially partial hepatectomy or left lateral segmentectomy, in select number of patients is considered to be a feasible operation from the result of our experience.

Keywords laparoscopy, hepatectomy, laparoscopic hepatectomy, left lateral lobectomy, ultrasonic surgical system

Introduction

The application to laparoscopic hepatectomy has not been actively developed because of the technical and anatomical difficulties in achieving hemostasis of the transected plane, controlling hemorrhage from large intrahepatic vessels, and exploration of deep regions. However, a variety of laparoscopic instruments and equipments developed in the past few years led us to attempt to perform a series of experimental laparoscopic hepatectomy. In this article we describe the materials used in the experimental model of

pigs and our surgical technique with reviewed and devised points for safe laparoscopic hepatectomy.

Methods

Animals and general procedure :

A total of 6 pigs weighing 20 to 30 kg supplied by commercial breeder were used in our experience. General endotracheal anesthesia was administered using halothane and air inhalation. Venous catheters were placed in all pigs for intravenous access, and the heart rate was monitored throughout the operation. A laparoscopic left lateral lobectomy was performed.

Fig. 1 An ultrasonic surgical system was used to dissect the parenchyma. (white arrow)

Fig. 2 The vascular pedicles are secured with an Endo-clip. (white arrow)

operation and autopsy were performed. The liver cutting surface was carefully examined for possible biliary leakage, haematoma or other intraabdominal finding.

Laparoscopic instruments, equipments and surgical procedure : —

Operative procedure were carried out from two monitors with the use of 3CCD camera. Disposable trocars (5mm, 12mm in diameter), endoscopic clip appliances, several kinds of grasping forceps (babcock forcep, lung clap and Glassman clamp), scissors, retractors and dissecting forceps containing electrocautery probes were used. The Endo-cutter (vascular

Fig. 3 The vascular pedicles are secured with transfixing suture. (white arrow)

cartridge) to divide portal and hepatic vein and the Endo-pouch to place resected liver were used. The ultrasonic surgical system (Olympus Inc., Ltd., Japan) was employed to dissect the hepatic parenchyma (1).

An incision was made at the umbilicus, and a trocar was introduced. Pneumoperitoneum was created by carbon dioxide insufflation at not higher than 10mmHg. Four trocars were needed for operative manipulation. The left medial and lateral lobes of the liver were grasped with either a babcock, Glassman or pulmonary forceps. An ultrasonic surgical system was used to dissect the parenchyma (Fig. 1). This system had a built-in power supply, allowing coagulation of smaller intraparenchymal vessels by the vibrating suction device. The portal vein and hepatic vein were carefully dissected free from surrounding tissue. Next, the vascular pedicles were secured with an Endo-clip (Fig. 2) and/or transfixing suture (Fig. 3), cut with the scissors or Endo-cutter (vascular cartridge) (Fig. 4a). Avitene powder along with compression and a fibrin starch were used to secure hemostasis at the cut edge of the liver. The resected liver was placed in a nylon sack (Endo-pouch) and removed through a trocar site by extending the incision.

Results

A left lateral lobectomy was performed safely in all six pigs. The heart rate remained stable intraoperatively except in one animal which experienced extensive hemorrhage. Surgery required 90 to 130 minutes and blood loss was less than 100 ml in 5 cases. Intraoperative complication occurred in 2 cases with one extensive hemorrhage and one pneumothorax on the left side. These complications were controlled intraoperatively with endoscopic technique. The weights of resected left lateral lobe of the liver were 65–100 g (**Table 1**). All pigs were stable condition. No bile leakage, site of bleeding or haematoma was observed. The cutting surface of the liver by an Endo-cutter shows a clear transection (**Fig. 4b**).

Fig. 4a The vascular pedicles are transected by an Endo-cutter.

Discussion

The rapid acceptance of abdominal therapeutic laparoscopy has resulted in its application not only for cholecystectomy and surgery of the digestive tract but also that of the parenchymatous organs, such as laparoscopic nephrectomy, splenectomy and adrenalectomy (2, 3, 4). Recently several papers of laparoscopic hepatic surgery for liver cyst deroofing have been published (5, 6) while resection of small pieces of the human livers have been rare and technique has not been safely accomplished (7).

However, several special instruments and equipments have greatly contributed to achieve safe operative method in open hepatic resection. This equipment included the ultrasonic

Fig. 4b The cutting surface of the liver by an Endo-cutter shows a clear transection. (white arrow)

Table 1. Summary of results

No.	Operative time	Blood loss	Intraoperative complication	Resected liver weight
1	130 min.	100 ml	none	73 g
2	120 min.	90 ml	pneumothorax	92 g
3	130 min.	370 ml	hemorrhage	100 g
4	95 min.	60 ml	none	65 g
5	92 min.	50 ml	none	88 g
6	90 min.	55 ml	none	95 g

dissector (8). It now has been feasible for laparoscopic use. In addition, continuing evolution of endosurgery has made laparoscopic exploration of hepatectomy the realistic application. Laparoscopic left lateral lobectomy in the liver with special equipments described above was performed safely on 6 cases of experimental pigs.

Ultrasonic dissection has been developed as alternative for liver transection with a view to reducing the incidence of bleeding. It has been accepted to be very effective. The characteristic of the ultrasonic surgical unit we used are built in power supply for diathermy. It is known to be useful to work not only ultrasonically with vibrating suction of the liver tissue but also provides coagulation of small vessels less than 2mm in diameter and fibrotic tissue. It could achieve sufficient hemostasis. However care must be taken that power supply of ultrasonic suction have to turn down near the main hepatic vein.

Although laparoscopic left lateral lobectomy in the pig liver with pneumoperitoneum was safely performed, it should be shifted to abdominal wall lift technique to avoid the formation of gas embolisms in clinical situation.

Dissection of portal and hepatic vein was a critical point. Endo-cutter (vascular cartridge) was used for transection of hepatic vein and it has been successfully and safely performed. Improvement of laparoscopic suturing technique was also contributed to ensure the secure ligation of large intrahepatic vessels during parenchymal dissection although double clipping might have been sufficient. If there is not enough space for use of Endo-cutter, utilization of transfixing sutures might be preferable.

Improvement of instrument are needed for safer laparoscopic hepatectomy. We used a babcock grasper, lung or glassman clamp but liver tissue was a fragile by these instruments especially with on ratcheted handle or was

slipped from these instruments with off ratcheted handle. In addition, consistence of the liver in human is different by underlying liver disease such as hard liver tissue in cirrhosis. Delicate handling is needed for indirect grasp of the liver.

It is certain that laparoscopic hepatectomy does not supplants open hepatectomy. However laparoscopic approach in selected patients is considered to be a feasible operation from the result of our experience. Currently the clinical operation of laparoscopic hepatectomy are underway.

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