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A laparoscopic technique of partial hepatectomy in the rat

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ABSTRACT

Background: Laparoscopic partial hepatectomy is an increasingly applied technique in the treatment of liver tumors and in living donor transplantation. There is a need for establishing an animal model that would facilitate experimental research on the technique. The aim of the present study was to describe a safe and efficient laparoscopic technique of 70% partial hepatectomy in the rat.

Materials and methods: Twenty-four male Wistar rats underwent either laparoscopic (group LAP-HEP) or open resection of the median and left lateral hepatic lobes (group HEP). In group LAP-HEP, a 5-mm Hg pneumoperitoneum was established. Three 5-mm trocars were introduced in the abdominal cavity. A self-made pretied ligature loop was used to ligate *en bloc* the pedicles of the hepatic lobes to be resected. A self-made sterile elastic specimen retrieval bag facilitated extraction of the resected liver tissue. In group HEP, the same liver lobes were resected by ligation of their pedicles after midline laparotomy.

Results: The percentage of resected liver parenchyma did not differ between groups. All animals returned to normal feeding activity by 48 h postoperation and had no complications.

Conclusions: A simple, cost-effective, safe, and efficient laparoscopic technique for 70% partial hepatectomy in the rat was described.

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Introduction

Partial hepatectomy is a method applied primarily for the treatment of hepatic neoplasms, both benign and malignant, and in living donor transplantation. Laparoscopic partial hepatectomy (LPH) is a minimally invasive technique that offers advantages compared to open partial hepatectomy, such as less trauma, less postoperative pain, shorter recovery period, and a better cosmetic result. LPH, although a technically demanding procedure with hidden risks, including uncontrollable hemorrhage, gas embolism or port site metastases, has become an increasingly popular option for surgeons during the past decade, owing to advances in liver resection safety and laparoscopic equipment.[1] Still, more research is needed to evaluate the efficacy and safety of the technique. To this end, the establishment of an animal model of LPH would be invaluable.

To date, numerous animal studies on liver regeneration have used the 70% hepatectomy rat model, initially described by Higgins and Anderson; this involves the excision of the median and left lateral hepatic lobes after ligation of their lobe pedicles.[2] Therefore, a rat model of LPH in which these lobes

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were resected with the same process would offer direct comparison of results with those of the existing relevant literature.

The main problem encountered in an LPH rat model is the small abdominal cavity that makes laparoscopic manipulations difficult. This has driven researchers to establishing pneumoperitoneum before open liver resection when studying the effects of pneumoperitoneum on liver regeneration induced by partial hepatectomy.[3,4] However, the validity of this protocol has been questioned.[5] In previously described LPH techniques in the rat, liver parenchyma was resected using either a electrocauterizing wire loop suitable for endoscopic polypectomy[6] or a commercially available pretied ligature loop (Endoloop/Johnson and Johnson/Spreitenbach, Switzerland).[7] The aim of the present study was (a) to describe a simple and cost-effective technique of LPH in the rat and (b) to evaluate its efficacy and safety.

Materials and methods

Animals

Twenty-four male Wistar rats, 8 mo of age, weighing 450-500 g provided from our laboratory's inbred rat colony were studied. They were housed in polycarbonate cages, three rats per cage pre-operatively and one rat per cage postoperatively at 20-22°C room temperature, on a 12:12 light/dark cycle and were provided with a commercial pelleted diet and tap water ad libitum.

Experimental design

Rats were divided into two groups of 12 animals each and were subjected to either laparoscopic excision of the median and left lateral hepatic lobes (group LAP-HEP) or excision of the same lobes after midline laparotomy (group HEP). The resected liver (ResL) tissue was weighed. At 1 h after operation, six rats per group were euthanized by CO_2 inhalation, and the remnant liver (RemL) tissue was excised and weighed. The percentage of the ResL weight to total liver (TotL) weight was calculated according to the following equation:

$$\text{ResL weight \%} = [\text{ResL weight}/\text{TotL weight}] \times 100$$

where, TotL weight = ResL weight + RemL weight.

The postoperative (feeding activity) course was evaluated in the rest of rats which were euthanized at 48 h to inspect the abdominal cavity for abscesses, hemorrhage, bile leakage, or adhesions. The experimental protocol was approved by the Animal Care and Use Committee of the local veterinary service because it complied with Directive 2010/63/EU on the protection of animals used for scientific purposes.

Additionally, a cost analysis was performed on the consumables required for the laparoscopic procedure comparing the present technique with those already described in the literature for LPH in the rat.

Animal preparation

Rats were anesthetized by administration of the inhaled anesthetic sevoflurane (2%-3% in oxygen) provided by a face mask. They were secured in a supine position on a heated-surface operation table. Their abdomen was clipped and disinfected with 10% povidone iodine solution.

Laparoscopic partial hepatectomy

Specimen retrieval bag preparation

A common sterile condom was used to prepare a self-made specimen retrieval bag. The unwrapped condom was ligated and cut approximately at 3 cm from its opening. A purse-string suture was applied around the opening of the condom to facilitate closure of the bag during the specimen collection process.

Pretied ligature loop preparation

A pretied ligature loop was prepared using a No 4 braided polyamide suture (Polycon/Tonzos 95/Yambol, Bulgaria). A modified Meltzer slip knot was used as previously described[8] (Fig. 1).

Instruments—equipment

Trocars: Three 5 × 90 mm SILS port cannulae (Covidien/Norwalk, Connecticut).

Laparoscopic instruments: Two 5 × 310 mm duck-jaw laparoscopic forceps (Endo Grasp 5 mm/Auto Suture/Covidien), one 5 × 310 mm laparoscopic scissors (Endo Shears/Auto Suture/Covidien), and one 5 × 330 mm laparoscopic knot pusher (Tonglu Yida Medical Devices/Zhejiang, China).

Laparoscope: 4 × 150 mm 30° telescope (A7595 A/Olympus/USA).

Laparoscopic tower (LemkeVision, World of Medicine A.G./Ludwigsstadt, Germany).

Pneumoperitoneum installation

A 21G intravenous catheter was inserted intra-abdominally through the umbilicus and connected to a insufflation tube to introduce CO_2 up to a intra-abdominal pressure of 5-mm Hg.

Laparoscopic operation

Three 5-mm trocars were introduced transdermally in the abdominal cavity after having performed stamp incisions with a No 11 blade at the insertion sites. The first trocar (midline trocar) with an insufflation side port was introduced in the midline, 2 cm below the umbilicus. The insufflation tube was then connected to the insufflation side port, whereas the intravenous catheter used for pneumoperitoneum installation was left in place to facilitate relief of gas and equilibration of intra-abdominal pressure. The second trocar (right trocar—operator's right side) was introduced in the left lower quadrant of the abdomen at the level of the first trocar, after having intra-abdominally inserted a specimen retrieval bag through the insertion site incision. Care was taken to leave the free ends of the purse-string suture of the retrieval bag extracorporeally. The third trocar (left trocar—operator's left side) was introduced in the right lower quadrant of the abdomen at the level of the first trocar (Fig. 2).

The laparoscope was introduced intra-abdominally through the midline trocar to inspect the peritoneal cavity and identify the liver. The latter was mobilized by division of

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