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REVIEW ARTICLE

Laparoscopic Habib™ 4X: a bipolar radiofrequency device for bloodless laparoscopic liver resection

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Abstract

Background. In recent years the progress of laparoscopic procedures and the development of new and dedicated technologies have made laproscopic hepatic surgery feasible and safe. In spite of this laparoscopic liver resection remains a surgical procedure of great challenge because of the risk of massive bleeding during liver transection and the complicated biliary and vascular anatomy in the liver. A new laparoscopic device is reported here to assist liver resection laparoscopically. *Methods.* The laparoscopic Habib™ 4X is a bipolar radiofrequency device consisting of a 2x2 array of needles arranged in a rectangle. It is introduced perpendicularly into the liver, along the intended transection line. It produces coagulative necrosis of the liver parenchyma sealing biliary radicals and blood vessels and enables bloodless transection of the liver parenchyma. *Results.* Twenty-four Laparoscopic liver resections were performed with LH4X out of a total of 28 attempted resections over 12 months. Pringle manoeuvre was not used in any of the patients. None of the patients required intraoperative transfusion of red cells or blood products. *Conclusion.* Laparoscopic liver resection can be safely performed with laparoscopic Habib™ 4X with a significantly low risk of intraoperative bleeding or postoperative complications.

Key Words: *laparoscopic liver resection, liver resection technique, radiofrequency, Habib 4X*

Introduction

Since the advent of laparoscopic cholecystectomy, laparoscopic surgery has become a popular surgical technique [1] and has been applied to solid organs such as the spleen [2,3], kidney [4,5], pancreas [6] and adrenal gland [7,8]. Initial laparoscopic liver procedures included biopsies [9], tumour staging [10], and the fenestration of nonparasitic liver cysts [11].

The improvement in surgical techniques has allowed the development of the laparoscopic liver resection, which is gaining popularity among surgeons and patients due to both clinical and social benefits of a shorter hospital stay, quicker recovery and better cosmetic results. However, among intra and post-operative complications, bleeding represents one of the most serious problems for the surgeon during laparoscopic liver surgery. Various devices have been designed and developed to minimise the blood loss during transection of the liver parenchyma laparoscopically in the last decade. In spite of this, bleeding during the procedure remains the main cause of conversion to a laparotomy in order to control the haemorrhage and achieve the liver resection [12–14]. Following good results in open liver surgery with Habib™ 4X [15] and successful use of radiofrequency (RF) in laparoscopic liver resection [16] a new device, laproscopic Habib™ 4X (LH4X) has been developed and used clinically for laparoscopic liver resection.

Device description

The laparoscopic Habib™ 4X (LH4X, Rita, USA), consisting of a 2×2 array of needles arranged in a rectangle, uses bipolar RF energy (Figure 1). The LH4X measures 45 cm in length with a protected

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Figure 1. Laparoscopic Habib™ 4X.

insulated area to allow 5 cm in length for RF. The device can be introduced via a 10–12 mm laparoscopic port and is connected to a 500-kHz generator (Model 1500X Rita Medical Systems, Inc. California, USA) which produces up to 250 W of RF power. It allows measurement of the generator output, tissue impedance, temperature, and time. The system also consists of a pneumatic foot pedal used to turn the RF energy on and off. The generator can be run in manual or automatic mode. On connecting the device and switching on the generator, the RF power setting defaults to 125 W and this can be modified according to user experience and the thermal requirement of the individual tissue types.

Operative technique

Under general anaesthesia, for resections of segments II through V, patient is placed in the supine position. For lesions in segment VI, the patient is placed in the left lateral decubitus position, to expose the lateral and posterior aspect of the right lobe. The open technique for creation of pneumoperitoueum was used to avoid possible damage to intraabdominal organs as a result of adhesion from previous abdominal operation. Pneumoperitoneum was maintained throughout the procedure on a high flow rate with CO_2 at a pressure of 12 mmHg. The operation was performed via three 12 mm and one 5 mm ports placed along the subcostal margin depending on the site of liver tumour (Figure 2). In general, two 12 mm were inserted to one side and, one 12 and 5 mm respectively to the other. Any perihepatic and peritoneal adhesions related to the previous laparotomy were divided to allow examination of the entire peritoneal cavity for either local recurrence at the site of previous colorectal resection or for peritoneal deposits. Laparoscopic intraoperative ultrasound (LIOUS, Aloka Co., Ltd, Tokyo, Japan) was applied in all patients to obtain further information on the extent of disease and the anatomical relationship between the portal pedicles, hepatic venous branches and the tumour.

The technique of laparoscopic liver resection assisted with LH4X is similar to previously described using this for open approach. In brief, LH4X was used to produce coagulative necrosis along the line of intended parenchymal transection without vascular clamping of either portal triads or major vessels. In contrast to the open approach in which the whole resection line was coagulated before cutting, the liver parenchyma was progressively transected with a pair of scissors after each RF application in laparoscopic approach. Following routine LIOUS examination of liver prior to starting LH4X assisted liver resection; the intended transection plane was marked on the surface of liver with diathermy. Then, LH4X was inserted first to the most difficult part of the intended plane of transection in the deepest and farthest areas from the surface of liver under the guidance of

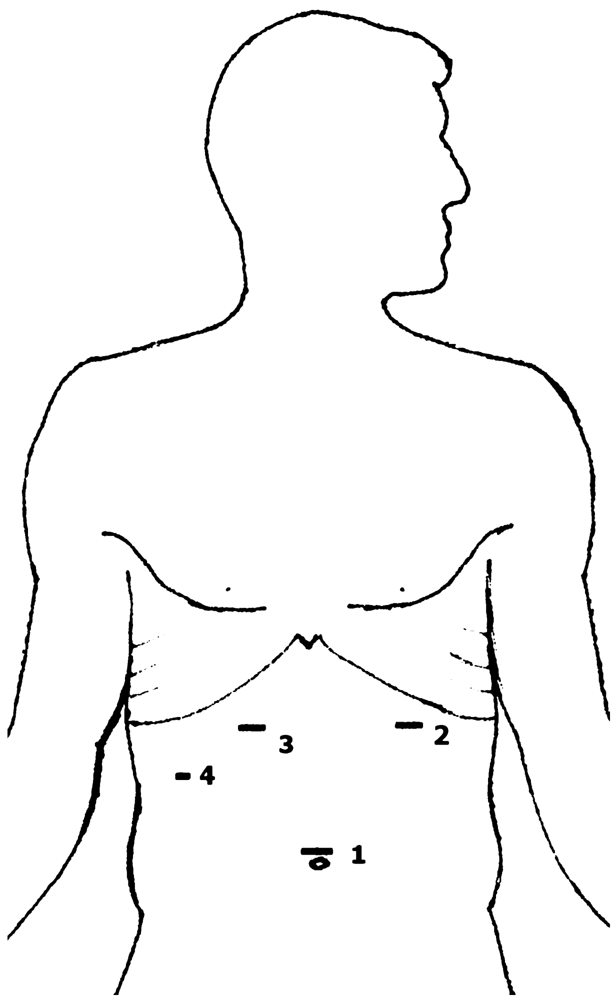

Figure 2. Port positions: 1, 2 & 3 are 12 mm ports and 4 a 5 mm port.

LIOUS to ensure a correct position of the probe in order to avoid any inadvertent damage to any vascular or vital structures and at the same time to allow an adequate resection margin. This was done prior to starting RF to prevent interference of ultrasonic images from RF. To complete the transection of liver parenchyma along the ablated plane, a pair of laparoscopic dissection scissors was used. Finally, the specimen was extracted whenever possible with an endobag (Endocatch, Autosuture, United States Surgical Cooperation, Norwalk, CT) by enlarging a port-site incision. For a large specimen, incision was made between two adjacent ports to retrieve the tissue through this open incision. A 20 FG drain (Smiths Medical International Ltd., Hythe, Kent, UK) was routinely placed close to the resection margin.

Results

Twenty-four Laparoscopic liver resections were performed with LH4X out of a total of 28 attempted resections over 12 months. Of the patients 50% ($n =$ 12) had single or multiple tumourectomies while three (12.5%) patients had resection of one segment and nine (37.5%) patients had bisegmentectomies. Pringle manoeuvre was not used in any of the patients. None of the patients required intraoperative transfusion of red cells or blood products. The average blood loss was less than 50 ml. All patients made good recovery from the procedure and there was no postoperative mortality.

Discussion

Major bleeding causes severe problems in laparoscopic liver surgery. In these cases immediate compression by a laparoscopic instrument or control by surgeons hand is not feasible. Therefore bleeding complications in laparoscopic liver resection requires special equipment which can control bleeding during parenchymal transection. By using this laparoscopic device, there was very little intraoperative bleeding encountered during transection of liver parenchyma making laparoscopic liver resection easier and quicker, and few postoperative complication rate.

A careful staging and selection of patients remains a key to success in laparoscopic surgery for cancer [17]. Although major liver resection has been reported to be performed laparoscopically [14,18], laparoscopic technique should ideally be considered for resection of small tumours located peripherally in lower or lateral segments of liver.

The benefits of the laparoscopic approach over open surgery are a quicker improvement in serum transaminase levels, a reduced postoperative analgesic requirement, a shorter delay to oral intake, and a reduced hospital stay [19]. Problems related to laparoscopic liver resection include difficulty in liver mobilisation, retraction and identifying tumour margins [12,14,20]. When using LH4X during laparoscopic liver resection, a less degree of mobilisation of the liver is required compared to open procedure for tumours in lower or lateral segments.

Most of the indications for liver resections are malignant lesions, including metastatic disease, mostly of colorectal origin, and Hepatocellular carcinoma (HCC). There is a debate about the specific risks of tumour seeding during laparoscopic surgery. The potential mechanisms for tumour seeding include direct contamination by technical errors during laparoscopic resection, cell exfoliation or cytokine activation secondary to pressure effects from pneumoperitoneum [21]. A potential complication of laparoscopic liver resection is gas embolism which is caused by pnuemoperitoneum during resection of liver parenchyma [22,23]. There was no clinical evidence of air embolism in our sereis. This potential complication seems to be rare and not reported in the largest studies of laparoscopic liver tumour resection [24–27].

A wider assessment of clinical data suggest similar tumour recurrence rates after laparoscopic and conventional surgery and lesser suppression of immune function due to lesser surgical insult in laparoscopic surgery, compared to open operations [28–30]. Moreover, in a prospective, randomised study Lacy et al. [31] reported that survival was better after laparoscopic colonic resection for cancer than with the traditional open resection.

Since our first description of RF ablation for unresectable liver cancer, the role of RF in liver surgery has been extended from mere ablation to actual liver resection by our group [32–34]. This technique has now been applied for liver resection laparoscopically by the development of this new device to assist laparoscopic liver resection. This is a safe and feasible device to assist laparoscopic liver resection when performed by surgeons with dual expertise in both laparoscopic and open liver surgery.

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