Application of microwave tissue coagulator in laparoscopic hepatectomy for the patients with liver cirrhosis

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Abstract

Laparoscopic hepatectomy has not been widely accepted, and has only been performed at special centers in 1990s, due to difficulties in technique and control of bleeding. In the last decade, multiple series have reported that laparoscopic hepatectomy is safe and efficacious. Moreover, recent experience has persuaded us that there are great potential benefits derived from laparoscopic hepatectomy, and we learned much regarding patient selection, the grade of surgical difficulty according to tumor location and the required instrumentation. To minimize blood loss, a precoagulation technique was applied in which the resection line is diathermically coagulated before liver parenchymal transection. In this technique, laparoscopic microwave tissue coagulator is useful for the precoagulation on superficial layer of liver, especially in cirrhotic patients. Laparoscopic liver resection appears to be a viable surgical alternative as less invasive surgery in selected cases with appropriate application of surgical instruments.

Key words: laparoscopic hepatectomy, precoagulation technique, microwave tissue coagulator

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Introduction

Multiple series have reported that laparoscopic hepatectomy is safe and efficacious for treatment of primary and metastatic malignant tumors in selected patients. Laparoscopic partial hepatectomy and left lateral sectionectomy is considered to be standard procedure, and more recently major hepatectomies. However, laparoscopic hepatectomy was not widely accepted and was performed at special centers, due to difficulties in technique and control of bleeding.

The careful patients selection and less blood loss are most important points for safe accomplishment of laparoscopic hepatectomy. To minimize blood loss, a precoagulation technique by a microwave tissue coagulator was applied in which the resection line is diathermically coagulated before liver parenchymal transection.

In this paper a general outline focused on the practical technique of liver parenchymal transection using the microwave tissue coagulator.

Materials and methods

We indicated our detailed surgical technique of laparoscopic hepatectomy using microwave tissue coagulator, and reviewed literatures using Pubmed cited English publications phased laparoscopy, hepatectomy or liver resection, and microwave.

1. Microwave coagulators (Fig. 1)

A microwave tissue coagulator (MTC) (Alfresa-Pharma Co, Inc., Osaka, Japan) generated a 2450 MHz microwave, which is transmitted to a hand piece with monopolar type of needle antenna, by way of a coaxial cable. Microwave emission is started after the liver tissue is punctured with the MTC antenna. Electric currents are induced in the tissue as a result of absorption of the microwave-produced heat which is used for coagulation of liver parenchyma.

2. Surgical technique

The technique of laparoscopic hepatectomy has been described elsewhere. Briefly, the patients are generally anesthetized according to the standard procedure. Each patient’s position and trocar placement are decided based upon the location of the tumor. Laparoscopic hepatectomies are generally performed with the four or five trocar techniques.

Laparoscopic flexible ultrasonography is indispensable for assessing the anatomic landmarks, such as vasculo-biliary connection, as well as the surgical margins. The line of the intended liver parenchymal transection is marked on the liver surface using diathermy.

Precoagulation is performed in the superficial layer, 2 cm beneath the surface of the liver, using a laparoscopic MTC prior to liver parenchymal transection. In order to avoid damage to the large vessels or biliary structures by the needle electrodes of the laparoscopic MTC, precoagulation in the deep layer is preferred using a monopolar sealer. The pressure of the pneumoperitoneum is maintained at 8mmHg or lower during the liver parenchymal transection to avoid the risk of carbon dioxide embolism.

The liver is punctured by the microwave antenna along
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the line of transection and it is irradiated with microwaves (Fig. 2). After precoagulation, the liver parenchyma is crushed with the clamp crushing method using laparoscopic forceps. Transection can be performed in the superficial layer with laparoscopic coagulating shears. Vessels and ducts larger than 2 mm in diameter are clipped or sealed using bipolar sealing devices. An endolinear stapler has been applied for transection of the main Glisson’s pedicles and hepatic veins.

The resected specimen is maneuvered into a plastic bag to avoid the possibility of tumor implantation, and extracted through the extended trocar incision or through an additional transverse suprapubic incision.

Results

Precoagulation technique with microwave for liver resection developed by Tabuse et al.11 have been followed by several groups12-14, and most recently by Satoi et al. who confirmed that microwave precoagulation was both safe and effective in terms of outcome of in patients undergoing nonanatomic and anatomic curative hepatectomies for hepatocellular carcinoma15. Christian et al. also suggested that the use of microwave precoagulation in open major liver resection is safe and can result in minimal blood loss with a low requirement for blood transfusion and low risk of postoperative bile leak. Moreover, the technique is easy and liver parenchymal transection can be performed rapidly16.

Laparoscopic MTC has been used since the inception of laparoscopic hepatectomy17,18, and subsequent reports also suggest an utility of MTC as an important tool used in laparoscopic hepatectomy19-22, including the clinical series of the patients with HCC accompanied by liver cirrhosis20. MTC is also useful for tumor ablation therapy combined with hepatectomy using laparoscopic or thoracoscopic approach.

Discussion

In 1993, we initiated laparoscopic hepatectomy in cases of metastatic tumor or hepatocellular carcinoma9. The use of precoagulation technique with microwave combined with tissue transection by laparoscopic coagulating shears obtained satisfactory hemostasis during liver parenchymal transection. This technique was feasibly applied even for cirrhotic patients23.

Radiofrequency has been introduced as an instrument for control of bleeding in recent years, and has been described its effectiveness in terms of liver parenchymal transection during animal models24-26 and clinical applications27-29. It is often used for puncture and precoagulation of the transection line, similar to MTC. Additionally, a procedure to coagulate and occlude the segment feeding vessels in anatomical segmentectomy have been reported27.

However, currently there is no single equipment that is able to accomplish laparoscopic liver transection its own. Therefore, it is important to be familiar with the various surgical instruments and use them appropriately depending on the situations in the procedure.

Operative time in our recent series of patients performed laparoscopic hepatectomy has decreased, with less bleeding28. It is considered to be effect of learning curve. Furthermore, laparoscopic hepatectomy is less invasive than open hepatectomy on evaluation by the Estimation of Physiologic Ability and Surgical Stress (E-PASS) scoring system. Patients recovered more quickly after laparoscopic hepatectomy, which allowed shorter hospitalization. Both the 5-year survival rate for hepatocellular carcinoma and the survival rate without recurrence were nearly identical to those of open con-
ventional hepatectomy, although further analysis will be necessary to reach definitive conclusions. The Japanese Endoscopic Liver Surgery Study Group was established in 2007. They accumulated data of 16 domestic facilities in a questionnaire survey, and reported the current status of endoscopic liver surgery in Japan. The complications were occurred in 12.3% among 471 cases of laparoscopic hepatectomy. However, no serious hepatic failure or operative death was observed (Table 1) and laparoscopic hepatectomy was suggested to become a new treatment strategy.

An international consensus conference on laparoscopic hepatectomy was held in 2008. At that conference, the terms “pure laparoscopy”, “hand-assisted laparoscopy” and “the hybrid technique” were defined as procedures of laparoscopic hepatectomy. Moreover appropriate use of the surgical instruments is required with training of the surgical technique. As a result, laparoscopic hepatectomy was considered a safe and effective approach if performed by trained surgeons with experience in hepatobiliary and laparoscopic surgery. These conclusions were followed by systematic reviews from the members of this conference.

In 2010, laparoscopic partial resection and laparoscopic left lateral sectionectomy were listed as approved procedures for medical insurance system of Japanese ministry of health. Laparoscopic liver resection appears to be a viable surgical alternative as less invasive surgery in selected cases with appropriate application of surgical instruments, and is expected further developments in the procedure as new frontiers in the field of liver surgery.

### Table 1  Complications according to surgical procedure in 471 patients undergoing laparoscopic hepatectomy

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. of patients</th>
<th>Bile leakage</th>
<th>PE and ascites</th>
<th>SSI</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemihepatectomy</td>
<td>59</td>
<td>2 (3.4)</td>
<td>3 (5.1)</td>
<td>3 (5.1)</td>
<td>2 (3.4)</td>
<td>10 (16.9)</td>
</tr>
<tr>
<td>Sectionectomy</td>
<td>12</td>
<td>1 (8.3)</td>
<td>1 (8.3)</td>
<td>0</td>
<td>0</td>
<td>2 (16.7)</td>
</tr>
<tr>
<td>LLS</td>
<td>116</td>
<td>0</td>
<td>5 (4.3)</td>
<td>4 (3.4)</td>
<td>5 (4.3)</td>
<td>14 (12.1)</td>
</tr>
<tr>
<td>Segmentectomy</td>
<td>12</td>
<td>0</td>
<td>1 (8.3)</td>
<td>1 (8.3)</td>
<td>1 (8.3)</td>
<td>3 (25.0)</td>
</tr>
<tr>
<td>Partial resection</td>
<td>272</td>
<td>1 (0.4)</td>
<td>14 (5.1)</td>
<td>10 (3.7)</td>
<td>4 (1.5)</td>
<td>29 (10.7)</td>
</tr>
</tbody>
</table>

PE: pleural effusion, LLS: left lateral sectionectomy, SSI: surgical site infection

Sectionectomy other than LLS

### References

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