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How to Do It

Hepatic Resection Using the Harmonic Scalpel

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Abstract We describe herein our technique of performing extensive resection of the liver by blunt dissection in combination with excision using a harmonic scalpel. A ball coagulator was inserted at 3-cm intervals along the proposed cutting line in the liver, and the liver parenchyma between these holes was then cut using coagulation shears. Regardless of the condition of the liver, good coagulation and cutting were achieved using the harmonic scalpel without vascular occlusion when dividing the shallow layer of the liver, and no complications in association with the harmonic scalpel, such as postoperative bleeding, bile leakage, or abscess formation at the cut margins, occurred. In the deep layer below the main trunk of the hepatic vein, blunt dissection was used, since it was difficult to achieve sufficient control of bleeding from large vessels using the harmonic scalpel alone. Therefore, when used in combination with other techniques, the harmonic scalpel appears to be an effective device for liver surgery that minimizes bleeding and decreases the vascular clamping time.

Key words Liver resection · Harmonic scalpel · Hepatocellular carcinoma

Introduction

The harmonic scalpel, otherwise known as the ultrasonically activated scalpel (Johnson and Johnson Medical, Ethicon, Tokyo, Japan), is a new surgical instrument for coagulation and cutting that utilizes ultrasonic vibration.[1] Several previous studies on laparoscopic hepatectomy using a harmonic scalpel have been conducted, but its indications have until now been limited to performing resection of a small area of liver tissue.[2,3] No reports have been published on the efficacy of using this technique for performing extensive resection of the liver. We describe herein a technique for dividing the liver parenchyma using a harmonic scalpel in extensive resection of the liver.

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Technique

A laparotomy was performed under general anesthesia and a cholecystectomy was routinely carried out prior to hepatectomy in all patients. For a leakage test after resection of the liver, a tube was inserted into the cystic duct. If required, lymph node dissection was also performed prior to hepatectomy. The liver was mobilized using conventional methods for hepatectomy. When hepatic lobectomy was performed, dissection of the hepatic arteries, portal vein branches, and hepatic veins was carried out by the extrahepatic method before dividing the liver parenchyma,[4] and the resulting demarcation lines were used as the hepatic incision lines. When nonanatomical resections of the liver were performed, the incision line was determined by intraoperative ultrasonography.[5]

Two types of handpiece were employed for the harmonic scalpel, namely, a coagulation shear (CS) and a ball coagulator (BC) (Fig. 1).

Division of the Shallow Layer of the Liver Using the Harmonic Scalpel

A ball coagulator was placed vertically on the liver surface along the incision line planned for hepatectomy, then slowly inserted to a depth of about 3 cm while coagulating the contract surface. This procedure was repeated at intervals of approximately 3 cm along the entire resection line, excluding the root of the hepatic

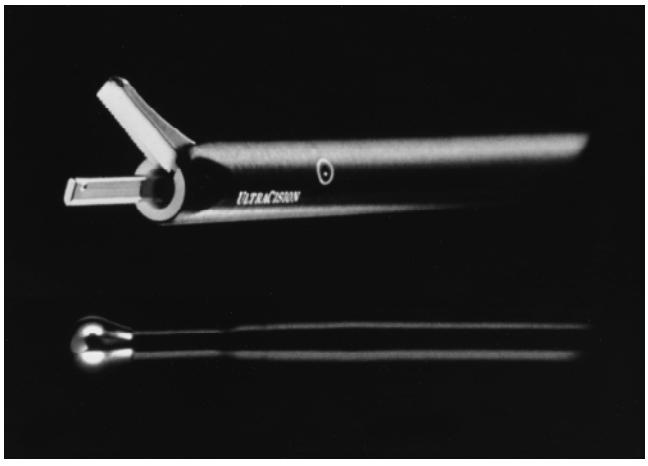

Fig. 1. Handpieces of the harmonic scalpel. *Upper*, the coagulating shears (tip shape, blunt mode); *lower*, the ball coagulator

vein and the area near the porta hepatis. The CS was then inserted between the holes coagulated by the BC, and the liver parenchyma between these holes was coagulated and cut with accurate hemostasis (Fig. 2). The blunt mode was selected as the CS blade used for incising the liver, and cutting was continued by repeating this procedure. The liver was divided using the CS immediately before exposure of the main trunk of the hepatic vein, or the ligating point of the Glissonean triad, on the cut surface of the liver under intraoperative ultrasonography guidance.

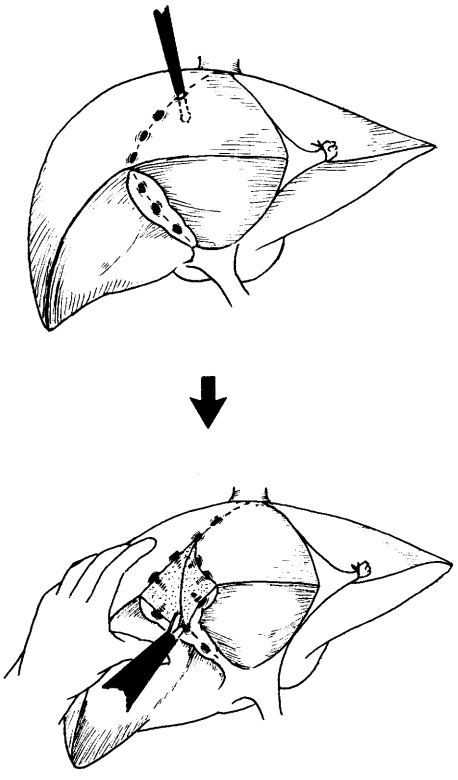

Fig. 2. Schematic representation of our technique of performing hepatic resection (in the form of left lobectomy). The ball coagulator was inserted slowly at approximately 3-cm intervals along the entire demarcation line (*upper*), and the liver parenchyma between the holes was coagulated and divided using the coagulating shears

Division of the Deep Layer of the Liver by Blunt Dissection

After dividing the shallow layer using the CS, the deep layer containing the large vessels was divided by blunt dissection until the hepatic resection was completed. The liver parenchyma was fractured using Kelly forceps, while the remaining hepatic vein branches and Glissonean triad were ligated and divided.[5] Occlusion of the hepatic inflow was continued for 15 min using Pringle's method, then discontinued for 5 min.[6] Clamping was repeated until the hepatic resection was completed.

Results

Between December 1997 and June 1999, 11 patients underwent extensive resection of the liver by this technique at the Department of Surgery, Koshigaya Municipal Hospital. Of the 11 patients, 7 were men and 4 women, ranging in age from 38 to 76 years, with a mean ± SD age of 61 ± 11 years. Their final diagnoses were: hepatocellular carcinoma in 2 patients, cholangiocellular carcinoma in 1, gallbladder carcinoma in 2, and metastatic liver cancer in 6. Moreover, 1 patient had liver cirrhosis and 1 had chronic hepatitis. Hepatic resection was performed as resection of the liver bed in 2 patients, subsegmentectomy in 2, monosegmentectomy in 2, lobectomy in 3, and extended lobectomy in 2. The average operation time and intraoperative blood loss were 341 ± 130 min (range 165–540 min), and 1443 ± 873 ml (range 430–2800 ml), respectively. All of the patients had an uneventful postoperative course, and there were no complications except for a slight postoperative bile leakage in one patient. The patient characteristics are summarized in Table 1.

Discussion

Minimizing operative blood loss in hepatectomy is important, especially for patients with liver cirrhosis. The intraoperative control of bleeding involves techniques of both vascular occlusion and division of the liver.

Table 1. Clinical characteristics of the 11 patients who underwent our new surgical technique for hepatectomy

Patient no.	Age (years)	Sex	Diagnosis	ICG R_{15} (%)	Associated liver disease	Location of tumor[a]	Procedures	Blood loss (ml)	Operation time (min)	Postoperative complications
1	58	M	HCC	15.5	CH	S8	Extended right lobectomy of liver; left hepaticojejunostomy	2500	540	Bile leakage
2	46	F	Metastatic	6.5	None	S4	Left lobectomy of liver	600	365	None
3	76	M	CCC	8.5	None	S4	Left lobectomy of liver	800	372	None
4	64	M	HCC	5.0	LC	S8	Subsegmentectomy of liver; splenectomy	950	165	None
5	72	F	GBCa	7.5	None	—	Resection of liver bed (partial resection of liver)	430	210	None
6	59	M	Metastatic	9.5	None	S8, S6	Subsegmentectomy and partial resection of liver; gastrojejunostomy	2800	410	None
7	57	M	Metastatic	3.5	None	S6, S7	Segmentectomy of liver	2600	252	None
8	70	F	Metastatic	6.5	None	S5	Right lobectomy of liver; sigmoidectomy; partial resection of lung	2000	510	None
9	73	M	Metastatic	7.0	None	S6, S2	Segmentectomy and partial resection of liver	1300	227	None
10	59	M	GBCa	4.0	None	—	Resection of liver bed (partial resection of liver)	700	240	None
11	38	F	Metastatic	7.0	None	S8	Extended right lobectomy of liver	1200	470	None

HCC, hepatocellular carcinoma; metastatic, metastatic liver cancer; CCC, cholangiocellular carcinoma; GBCa, gallbladder carcinoma; ICG R_{15}, indocyanine green retention rate at 15 min; CH, chronic hepatitis; LC, liver cirrhosis

[a] Location was based on Couinaud's classification[7]

Various techniques have been reported for division of the liver, such as blunt dissection,[5] the use of an ultrasonic surgical aspirator (CUSA) or water-jet scalpel,[8] and the microwave tissue coagulator method.[9] The CUSA and water-jet scalpel can divide the liver by fracture aspiration of the liver parenchyma, but they cannot be used for coagulation or cutting. Unlike these instruments, the harmonic scalpel can be used for both coagulation and cutting, thereby reducing the time needed to divide the liver. Moreover, the adjustment of the vibration setting, depending on the liver state, is of critical importance using the CUSA and water-jet scalpel. Une et al. demonstrated that cutting cirrhotic liver using the water-jet scalpel took much longer than cutting noncirrhotic liver parenchyma.[10] Our technique using a harmonic scalpel enables successful resection to be performed regardless of the condition of the liver, even when chronic hepatitis or cirrhotic liver exists. Thus, we believe that our technique using the harmonic scalpel is a simpler method that does not depend as much on the operator's skill and experience as other techniques. No bleeding or bile leakage was observed following division of the shallow layer using a harmonic scalpel, and the procedure could also be performed in a field of less blood loss without vascular occlusion.

It has been reported that the microwave tissue coagulator method can induce bile leakage or infection due to necrosis detachment of the cut margin of the residual liver.[9] Since the coagulation temperature with a harmonic scalpel is less than 100°C, being lower than that of the electro- and laser surgical techniques, tissue damage is minimal.[11] Indeed, the necrotic changes at the cut margin of the residual liver following surgery with our technique were minimal and no complications in association with the harmonic scalpel, such as postoperative bleeding, bile leakage, and abscess formation at the cut margins, were observed.

Nevertheless, we divided the deep layer below the main trunk of the hepatic vein by blunt dissection, since it is difficult to control bleeding using a harmonic scalpel alone. When the deep areas of the liver are divided, the tip of the CS blade creates a blind spot, and there is a risk of massive bleeding when the lateral wall of the large vessels is cut. Moreover, the harmonic scalpel is not appropriate for delicate procedures, such as systematic resection, when the hepatic veins are exposed on the resected surface. Indeed, adequate control of bleeding from the large Glissonean triad near the porta hepatis was sometimes difficult to achieve using the harmonic scalpel alone. Thus, division of the deep layer appears to require other techniques, such as blunt dissection or CUSA.

In the present series, 11 patients underwent hepatectomy by this method. Since there were differences in the surgical procedures, making direct comparisons of the blood loss and operation times between this technique and others was difficult. However, the postoperative courses of the patients were good, and there were no complications apart from a slight bile leakage from the divided surface of the deep layer in one patient, which was successfully treated by an extended right lobectomy, when a leakage test could not be performed.

In conclusion, while further studies on a greater number of patients are necessary to master the use of the harmonic scalpel and clarify the extent of its capabilities, in combination with other techniques for dividing layers, the harmonic scalpel appears to be an effective device for liver surgery that minimizes blood loss and decreases the vascular clamping time.

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