Hepatectomy using a microwave tissue coagulator for 99 patients with HCC

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Abstract

This series of 99 consecutive hepatic resections for hepatocellular carcinoma (HCC) performed using microwave tissue coagulator (MTC) by one surgical team over a 10-year period shows results that compare with other reports in regard to blood loss, operation time, and clinical outcome. The mean blood loss was 838, 1948, 1765, 1325 and 6053ml for partial (HR0), subsegmental (HrS), segmental (Hr1), lobar (Hr2), and lobar or extended lobar resection (ext. Hr2) with tumor thrombus in main portal trunk or having huge tumor 1kg or bigger. The mean operation time was 3h 43m, 4h 21m, 4h 36m, 4h 53m, and 7h 15m for Hr0, HrS, Hr1, Hr2, and ext Hr2. In Hr1 group, the blood loss and operation time were most minimized in patients who underwent lateral segmentectomy, In Hr2 group, mean blood loss and operation time were most higher in central bi-segmentectomy. The safety of the method described herein is evident by the in-hospital mortality rate of 3% and a morbidity rate of 13.1%. The 5-year survival rate was 41%. 5-year survival of 55 resection margin positive patients (49.6%) was not different with that of 23 resection margin negative patients (54%). Recurrence near the resected margin was seen in only 9 patients (12%). We concluded hepatectomy using MTC is useful, safe, reproducible, and applicable in liver surgery.

Key words : hepatectomy, microwave tissue coagulator, HCC

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Introduction

Most of the patients with hepatocellular carcinoma (HCC) are associated with liver cirrhosis. This is a great problem in terms of liver functions in hepatic surgery. Recently, hepatectomy can be done safely and systematically under ultrasonically guidance in the treatment of HCC⁽¹⁾⁽²⁾. A one of major risk in hepatic surgery is large amount of blood loss. Thus, there are compelling reasons to minimize blood loss during hepatic resections by developing a safe and reproducible method. For this purpose, we have been using microwave tissue coagulator (MTC) in hepatic surgery.

Material and Methods

1. Patients (Table 1)

During the period from 1984 and 1994, 99 patients with initially treated HCC underwent hepatectomy using microwave tissue coagulator at the Chiba Cancer Center Hospital. The age of patients ranged from 20 to 77 years and average of 56.53 years. There were 79 males and 20 females. In patients with HCC, tumor size was 1 to 24cm in diameter with a mean of 5.53cm. 69 patients had solitary tumor, 30 patients had multiple tumors. Macroscopic portal thrombus was seen in 21 patients including 8 patients with tumor thrombus in main portal trunk.

This series of 99 consecutive hepatic resections were performed by one surgical team with 2 staff surgeons over a 10-year period. 28 patients underwent partial resection (Hr0), 25 patients underwent subsegmentectomy (HrS), 21 patients underwent segmental resection (Hr1), and 25 patients underwent lobar or extended lobectomy (Hr2, ext. Hr2). In partial resection group, 8 patients out of 28 patients underwent 2 or 3 lesion resection. In HrS group, resection of Couinaud's segment VIII was performed in 10 patients and the other subsegmental resections were

performed in 15 patients. In Hr1 group, lateral segmentectomy was performed in 5 patients, medial in 5, anterior in 6, and posterior in 5. In Hr2 and ext. Hr2 groups, left lobectomy was performed in 6 patients, right lobectomy in 10 patients, central bisegmentectomy in 3 patients, and extended right lobectomy in 6 patients. In the entire group, resected specimens weighted 10 to 4050g.

The survey was accomplished on December 1996.

2. Operative Procedure

Laparotomy is done by bilateral subcostal skin incision with a vertical midline extension. After the liver is exposed, the intraoperative ultrasonography is performed to detect tumor location and its relationship to portal and hepatic veins. Coagulation of the liver tissue by insertion of monopolar type needle electrode of MTC. The average output was 80 Wats and radiation lasted for 30 sec at one time. The insertion of monopolar-type needle electrode is repeated along the intended resection line where incision is anticipated. Our method consists of resection of tumor together with about 1cm of the margins. When segmentectomy or lobar hepatic resection are performed, the hilar structures are controlled by extrahepatic dissection of porta hepatis before hepatic dissection. When partial or subsegmental hepatic resections are performed, feeding vessels are ligated and divided intrahepatically.

Table 1. Background of the patients

Age	56.5 years (20-77)
Sex male/female	79/20
HBsAg (-) / (+)	82/17
Child class A/B/C	75/21/3
AFP (ng/ml)	10053 (1-405042)
Tumor size (mm)	55.3 (240-10)
Tumor number	
solitary/multiple	69/30
Vp (-) / (+)	78/21

Vp : portal tumor thrombus

ly at final stage of hepatic dissection. Coagulated liver tissue dissection can be performed without causing hemorrhage without inflow vascular occlusion technique (Pringle maneuver) at hilar portion. Liver parenchyma is divided using Pean forceps to crush coagulated liver tissue. Exposed blood vessels of more than 3mm in diameter are encountered, they must be suture ligated.

Results

1. Blood loss (Table 2)

The blood loss in 28 patients who received Hr0 ranged from 90ml to 2970ml with the mean of 838ml. In Hr0 group, the mean blood loss in patients with one lesion resection (710ml) and multi-lesion resection (1,206ml) were not significantly different. In 25

patients who underwent HrS, blood loss ranged from 420ml to 4500ml with mean of 1948ml. In 21 patients who underwent Hr1, blood loss ranged from 237ml to 4000ml with mean of 1765ml. In 12 patients without tumor thrombus in main portal trunk who underwent Hr2, blood loss ranged from 980ml to 5170ml with mean of 1325ml. In 13 patients with portal thrombus in main portal trunk or having huge tumor 1kg or bigger who underwent ext Hr2, blood loss ranged from 400ml to 30000ml with mean of 6053ml. Marked blood loss were recognized in patients having huge tumor 1kg or bigger or portal thrombus in main portal trunk.

2. The operation time (Table 3)

The Hr0 lasted 1 hour (h) 40 minutes (m) to 5h39m

Table 2. Mean blood loss and operating time by operative procedure

operative procedure	No. of patients	mean blood loss (ml)	mean operation. time
HrO	28	838	3h 43m
one portion resection	20	710	3h 33m
multi-portion resection	8	1206	4h 7m
HrS	25	1948	4h 21m
Hr1	21	1765	4h 36m
Hr2 (Vpo-2)	12	1325	4h 53m
HR2 or ext. HR2 (with Vp3 or huge tumor)	13	6053	7h 15m

Table 3. Mean blood loss and operating time in patients who underwent subsegmentectomy, segmentectomy, or lobectomy (excluding patients with huge tumor 1kg or bigger or Vp3)

operative procedure	No. of patients	mean blood loss (ml)	mean operation. time
S VIII subsegmentectomy	10	2132 (1,200-3,700)	4h 37 (3h 50-6h 15)
other subsegmentectomy	15	1093 (90-1,700)	3h 52 (1h 35-6h 15)
lateral segmentectomy	5	523 (235-897)	3h 18 (1h 45-5h)
medical segmentectomy	5	2211 (330-4,817)	4h 19 (1h 45-6h 05)
anterior segmentectomy	6	1689 (632-2,800)	5h 25 (3h 35-5h)
posterior segmentectomy	5	1187 (420-2,600)	4h 30 (3h 20-6h 20)
central bisegmentectomy	3	3971 (3,245-5,170)	8h 56 (7h 43-9h 55)
left lobectomy	3	833 (340-1,300)	3h 42 (3h 15-4h 26)
right lobectomy	6	1215 (987-2,300)	4h 35 (3h 50-6h 20)
total	58		

with mean of 3h43m. 1 lesion resection lasted 3h33m and multi-lesion resection lasted 4h7m. There were not significantly difference in both groups. The mean operation time ranged from 4h21m to 4h53m in HrS, Hr1, and Hr2 group. The surgery lasted more than 7 hours in ext.Hr2 group.

3. Mean blood loss and operation time in patients who underwent HrS, Hr1, and HR2 (excluding patients with huge tumor 1kg or bigger or Vp3) (Table 3).

In HrS group, mean blood loss in patients who underwent S VIII subsegmentectomy (2132ml) were significantly more than that in patients who underwent the other subsegmentectomy (1093ml). The operation time

in patients who underwent S VIII subsegmentectomy (4h37m) were significantly longer than that in patients who underwent the other subsegmentectomy (3h52m).

In Hr1 group, mean blood loss was 523, 2211, 689, 1187ml for lateral, medial, anterior, and posterior segmentectomies respectively. The mean operation time was 3h18m, 4h19m, 5h25m, and 4h30m for lateral, medial, anterior, and posterior segmentectomies respectively. The blood loss and operation time were not minimized in patients who underwent lateral segmentectomy.

In Hr2 group, mean blood loss was 833, 1215, and 3971ml for left, right, and central bisegmentectomies. The mean operation time was 3h42m, 4h35m, and 8h56m for left, right, and central bisegmentectomies.

Table 4. Complications

morbidity	13 (13.1%)
bile leakage	9 (9%)
(treated with re-drainage	4)
post operative hemorrhage	1 (1%)
hepatic failure	3 (3%)
in-hospital mortality	3 (3%)
due to hepatic failure	2
due to cancer regrowth	1

4. Complications (Table 4)

Postoperative complications were occurred in 13 patients and morbidity rate was 13.1%. Bile leakage occurred in 9 patients (9%). 5 patients resolved spontaneously within 50 days without any surgical treatment. Remaining 4 patients occurred perihepatic

Fig.1 Survival by tumor size

abscess and these were treated by ultrasonically guided puncture. Postoperative hemorrhage from hepato-duodenal ligament was observed in one patients but no postoperative bleeding from the resected liver stump was experienced. No patient died within a month. Three patients suffered from postoperative hepatic failure and two patient died 43 and 53 postoperative days respectively. One patient associated with portal tumor thrombus died within 2 months due to regrowth of cancer. Finally hospital death were observed in 3 patients and in-hospital mortality was 3%.

5. Survival after resection (Fig. 1)

The 5-year survival rate was 41% and 5-year disease free survival rate was 24.4%. The 5-year survival rate in patients with HCC 30mm or smaller and 31 to 50mm in size were 53.4% and 54.7% respectively. In the other hand, 5-year survival rate of patients with HCC 51mm or larger in size (23.3%) was significantly worth than that of patients with HCC 50mm or smaller.

6. Survival by resection margin positive and negative in patients with HCC without portal tumor thrombus (Fig.2)

5-year survival rate of 55 resection margin positive patients (49.6%) was not different with that of 23 resection margin negative patients (54%).

7. Survival by with or without portal tumor thrombus

5-year survival rate of 78 patients without portal tumor thrombus (50.9%) was significantly better than that of 21 patients with portal tumor thrombus (11.9%).

8. Recurrence style

Recurrence occurred 75% of patients. Among of them, hepatic recurrence was observed in 91.7% and extra-hepatic recurrence was seen in 11% of patients. Recurrence near the resected margin was seen in 9 patients (12%).

Discussion

In 1981, Tabuse³⁾ first used MTC in the treatment of HCC. Tabuse⁴⁾ performed hepatectomy using MTC in

Fig.2 Survival of resection margin positive and negative group

21 patients with HCC and mean blood loss was 1173 ml. Tabuse³⁴⁾ reported that hepatectomy using MTC is great valuable in hemostatic performance. This series of 99 consecutive hepatic resections performed using MTC by one surgical team with 2 staff surgeons over a 10-year period shows results that compare with other reports in regard to blood loss, operation time, and clinical outcome.

Few reports correlate blood loss with type of resection. Holm⁵⁾ reported mean blood loss of 1658, 3216, 4070, and 5133ml for wedge, segmental, lobar, and combined resections, respectively in a study of 36 hepatic resections for colorectal cancer. Cunningham⁶⁾ reported that median blood loss was 450, 700, 1000, 1100, and 1500ml for segmental, nonanatomic, lobar, extended right and extended left resections respectively includes resections for 52 colorectal metastasis, 17HCCs, 6 hemangiomas, 8 bileducts tumors, and others using Pringle maneuver. Lee⁷⁾ performed partial hepatectomy under hepatic clamping over the medial site of the right lobe of the liver on cirrhosis liver and average amount of blood transfused during resection was 1552ml. They concluded clamping method is a simple, rapid technique without any side effect. But they reported 4 out of 21 patients caused hypotension. Clamping should be applied in selected patients. Matsumata⁸⁾ compared the patients who underwent limited resection from 1981 to 1985 (n=58) and those operated on from 1985 to 1988 (n=105). In later period they use MTC in 54.3% of patients and ultrasonic dissector in 74.3% of patients. The mean blood loss (2500ml versus 1300ml) were significantly less than in earlier period but the mean operation time was significantly longer (174 minutes versus 313 minutes) than in earlier period. They concluded the use of new tools could be reduced intraoperative blood loss.

In our experience for HCC, mean blood loss was 868, 1704, 1625, 1325 ml for Hr0, HrS, Hr1, Hr2. Mean

blood loss of partial hepatic resection was not difference between our experience and Cunningham's experience⁶⁾.

Segment VIII of the liver, as described by Couinaud⁹⁾, is located at the anterosuperior part of the right hepatic lobe. It is situated between the right and middle hepatic veins. These relationship render the resection of segment VIII a difficult operation. Franco¹⁰⁾ reported 2 patients underwent segment VIII resection with duration of operation were 6 hours and 4 hours 20 minutes respectively and received 7U and 4U packed red cell transfusion. In our experience, mean blood loss and operation time of segment VIII resection (2132ml and 4 hours 37 minutes) were significantly more than that of other subsegmental resection (1093ml and 3 hours 52 minutes).

Lui¹¹⁾ performed segmentectomy according to anatomic classification of Healy to perform curative resection for patients with HCC without tumor thrombus in main or first trunk of portal vein. His technique is as follows. Hilar dissection is performed to ligate and divide the portal pedicle of the involved segment. Hepatic transection is carried out by crashing the liver parenchyma with a kelly clamp under intermittent Pringle maneuver. He reported that mean blood loss was 1550, 2775, 2841, 3559ml for lateral, medial, anterior and posterior segmentectomy respectively. Mean operation time was 244, 367, 421, and 350 minutes for lateral, medial, anterior and posterior segmentectomy respectively. They also reported that four operative death occurred and deaths were caused by mainly technical problems. In our Hr1 series, mean blood loss was 523, 2211, 1689, and 1187ml and operation time was 198, 259, 325, 270 minutes for lateral, medial, anterior and posterior segmentectomies respectively. We think anterior segmentectomy is perhaps the most difficult to perform because the two large planes must be opened.

In our Hr2 series, mean blood loss of central biseg-

mentectomy was significantly more than those of left or right lobectomy (3971ml versus 833ml and 1215ml). And operation time of central bisegmentectomy were significantly longer than those of left or right lobectomy (8 hours 56 minutes versus 3 hours 42 minutes and 4 hours 35 minutes).

These results of compare with several reports suggested that hepatectomy using MTC can be performed with minimized blood loss same rather than hepatectomy under Pringle maneuver or hepatic method.

Another characteristics feature of MTC obtained that risk of tumor recurrence in the resected liver stump is negligible in patients with lesser than 1 cm of resected margin. Saitsu¹²⁾ performed coagulation therapy using MTC for HCC in 21 patients with nodules less than 5 cm in diameter and reported that there was no local recurrence at the treatment tumors. Sato¹³⁾ also treated HCC by microwave coagulation in 21 patients. They reported microwave coagulation therapy is a safe and potential curable treatment modality for HCC¹²⁾¹³⁾. In our series, 5-year survival was not differ between the patients with resection margin positive group and resection margin negative group. And recurrence near the resected margin was observed in only 12%. These results suggested that microscopic residual in resected margin were thought to be coagulated by MTC.

In 1990, the liver cancer study group of Japan reported 5-year survival rate after resection in 2478 patients was 28.5%¹⁴⁾. The 5-year survival rate in our patients was 41%. We have been aggressively treated HCC with portal tumor thrombus. 5-year survival of 78 patients without portal tumor thrombus (50.9%) was significantly better than that of 21 patients with portal tumor thrombus (11.9%).

Our results suggested that hepatectomy using microwave tissue coagulator used in acceptable blood loss, complication, and survival in patients with HCC.

We concluded this techniques is useful, safe, reproducible, and applicable for wide spread use.

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