

• CLINICAL RESEARCH •

Ultrasonic aspiration hepatectomy for 136 patients with hepatocellular carcinoma

Wei Wu, Xin-Bao Lin, Jian-Min Qian, Zhen-Ling Ji, Zao Jiang

Wei Wu, Xin-Bao Lin, Institute of Acoustics, Ultrasonic Medical Electronics Research Group, State Key Laboratory of Modern Acoustics, Nanjing University, Nanjing 210093, Jiangsu Province, China

Jian-Min Qian, The first Affiliated Hospital of Nanjing Medical University, Nanjing 210029, Jiangsu Province, China

Zhen-Ling Ji, Zao Jiang, The Affiliated Zhongda Hospital of Southeast University, Nanjing 210009, Jiangsu Province, China

Correspondence to: Wei Wu, Institute of Acoustics, Ultrasonic Medical Electronics Research Group, State Key Laboratory of Modern Acoustics, Nanjing University, Nanjing 210093, Jiangsu Province, China. weiwu-cs@sohu.com

Telephone: +86-25-3272447

Received 2001-06-19 **Accepted** 2001-07-16

Abstract

AIM: To study the operative injury, post-operative complications, the hospitalization time, the post-operative survival rate of ultrasonic aspiration hepatectomy with a domestic new type of ultrasonic surgical device in comparison with that of conventional techniques of hepatectomy.

METHODS: A total 136 patients with hepatocellular carcinoma (HCC, including 12 patients in 1991 and 124 consecutive patients from July 1995 to December 2000) underwent ultrasonic aspiration in liver resection (group T) and 179 HCC patients received conventional hepatectomy during the corresponding period (group C). The results of the two groups were compared statistically.

RESULTS: There was no significant difference in the mean operation time between group T (152±11 min) and C (144±11 min). No operation or hospital death occurred in both groups. In group T, the mean volumes of bleeding (463±15 ml) and blood transfusion (381±12 ml) were markedly less than those in group C (557±20 ml, and 507±18 ml, respectively, $P < 0.05$). The mean hospitalization time of group T (8.9±0.6 d) was markedly shorter than that of group C (11.7±0.6 d) ($P < 0.05$). The incidence of complications in group T was markedly lower than in group C, post-operative jaundice occurred in 4/136 and 31/179, respectively ($P < 0.05$), liver failure in 0/136 and 2/179, cholorrhea in 0/136 and 6/179, hydrothorax in 21/136 and 39/179 ($P < 0.05$), ascites in 9/136 and 54/179, respectively ($P < 0.05$). There was no significant difference in the 1-year survival rate between the two groups ($P > 0.05$), while the 3-year survival rate of group T (64.2%) increased markedly as compared with that of group C (55.7%) ($P < 0.01$).

CONCLUSION: The ultrasonic aspiration hepatectomy with a domestic new type of ultrasonic surgical device could evidently reduce the operative injury and post-operative complications, shorten the hospitalization time and prolong the survivals of HCC patients.

Wu W, Lin XB, Qian JM, Ji ZL, Jiang Z. Ultrasonic aspiration hepatectomy for 136 patients with hepatocellular carcinoma. *World J Gastroenterol* 2002; 8 (4):763-765

INTRODUCTION

Hepatocellular carcinoma (HCC) is common in China^[1-10], and its treatment is not satisfactory so far^[11-17]. The first choice of treatment for HCC is hepatectomy, but the resectability is only about 4-20%^[18-25]. Therefore, it is important to improve the technique of liver resection and to increase the resectability. The invention of ultrasonic surgical device (also called ultrasound scalpel) is a breakthrough in medical field since the 1980s, it was also one of the developing hotspots in the surgery. The reason for its attention is that when compared with electric surgery unit, laser and microwave as well as other methods^[26-36], it has many advantages including less lesion for the tissue in or around the operating field, less bleeding (or no bleeding), clear operating field, less operating risk, high security and more convenient to operate^[37-40]. Since the 1990s, ultrasonic aspiration hepatectomy has been popularized in many European and American countries, and is now a standard technique of hepatosurgery^[41]. Our study on 136 ultrasonic aspiration hepatectomies indicated that ultrasonic aspiration hepatectomy could reduce operative injury and the incidence of the major operative complication markedly. In the meantime, it could shorten the duration of hospitalization, reduce the blood transfusion during the operation, and raise the survival rate.

MATERIALS AND METHODS

Materials

From April 1991 to December 2000, we observed randomly (completely random design) 136 primary liver carcinoma patients (group T) treated by ultrasonic aspiration hepatectomy and 179 primary liver carcinoma patients (group C) treated by conventional technique. The ages of patients in group T and C were 13-72 years (mean 57±15 years) and 19-74 years (mean 55±16 years), respectively. There were 14 and 21 patients with intrahepatic metastasis in the group T and C, respectively (Table 1). NTY-300 multifunctional ultrasonic surgical device (made in China) was used. The equipment was composed of main unit that could work in multi frequency, several kinds of hand-pieces and control keyboard. It had multifunction of ultrasonic cutting, aspiration, and liposuction. The basic principle was that the computer device of the mainframe could produce electric signal ranging from 19 to 35kHz of frequency, and the signal was amplified by power amplifier, then sent to the hand-piece after impedance conversion by the output isolating transformer, thus producing ultrasonic vibration. At the same time, the sampling circuit could feed back the working status of the hand-piece to the computer device judging whether it was falling in the best working frequency. And the computer could modulate it automatically to assure that the portable therapeutic head fell in suitable resonance frequency to give

the maximal ultrasound energy output. There are several simple control keys for manual operation on the control panel. And the corresponding parameters were displayed on the display monitor.

Table 1 Clinical data of patients included in this study

Main parameter	Common hepatectomy (n=179)	Ultrasonic aspiration hepatectomy (n=136)
Mean age (yrs)	55±16	57±15
M/F	166/13	128/8
T B/ (μ molL ⁻¹)	17.4±1.4	16.4±1.5
D B/ (μ molL ⁻¹)	3.1±0.3	3.0±0.3
ALB/ (gL ⁻¹)	40.0±7.0	42.4±7.4
ALT/ (nkatL ⁻¹)	667.0±49.8	538.1±51.2
AST/ (nkatL ⁻¹)	602.6±50.8	566.3±40.0
TT/ (gL ⁻¹)	78.62±7.85	73.32±8.26
Size of tumor		
T≤2cm	84	67
2cm≤T≤5cm	59	44
5cm≥T	36	25
Location		
Right	40	32
Tri-liver lobe	3	2
Left tri-liver lobe	8	5
VIII segment	19	16
Others	109	81
Number of tumor		
1	135	102
2	38	27
≥3	6	7

Methods

The bilateral subcostal approach, extended to the right as far as the midaxillary line, to the left as far as the lateral margin of the rectus muscle, and medially upwards the xiphoid process of the sternum (Mercedes incision) or a right subcostal incision extended along the median line (Invested-L incision) is the classic approach. JM- II retractor (made in China) was routinely used for opening the abdominal wall. In the first stage the ligaments around the lobe to be resected were dissected until the lobe was mobilized. The liver to be resected was demarcated by cautery, and stitched to block the local blood supply. The ultrasonic aspirator was utilized in hepatoparenchyma dissection. Liver cells were broken and emulsified, and aspirated out of body. The intrahepatic canaliculi were exposed and can be dissected and ligated. The oozing sites were controlled by conventional methods.

Statistical treatment

t-test and χ^2 test were used.

RESULTS

There was no significant difference in the mean operation time between groups T (152±11min) and C (144±11min). No operation or hospital death of patients occurred in both groups. In group T, the mean volumes of bleeding (463±15 ml) and blood transfusion (381±12 ml) were markedly less than those in group C (557±20 ml, and 507±18 ml, respectively, $P<0.05$). The mean hospitalization time of group T (8.9±0.6 d) was markedly shorter than that of group C (11.7±0.6 d), ($P<0.05$).

The incidence of complications in the group T was significantly lower than in group C. There was no significant difference in the 1-year survival rate between the two groups ($P>0.05$), while the 3-year survival rate of group T (64.2 %) increased markedly as compared with that of group C (55.7 %), (Table 2).

Table 2 Comparison of operation and treatment conditions between the two groups

Main parameter	Common hepatectomy (n=179)	Ultrasonic aspiration hepatectomy (n=136)
Operation time/min	144±11	152±11
Bleeding volume/ml	557±20	463±15 ^a
Transfusion volume/ml	507±18	381±12 ^a
Hospitalization day	11.7±0.6	8.9±0.6 ^a
Liver failure	2	0
Postoperative jaundice	31	4 ^a
Cholorrhea	6	0
Hydrothorax	39	21 ^a
Ascites	54	9 ^a
1-year survival rate	92.5%	94.8%
3-year survival rate	55.7%	64.2% ^b

^a $P<0.05$, ^b $P<0.01$, vs Common hepatectomy.

DISCUSSION

In the ultrasonic aspiration hepatectomy, semisolid liver tissue is broken and emulsified under the conjugated effects of ultrasonic shock acceleration and high-velocity liquid jet, and then is aspirated out by suction. Since most liver cancer patients (>90%) in China are complicated with liver cirrhosis [3-10], some researchers considered that it was difficult for the cirrhosis liver tissues containing plenty of connective tissue to be unbroken by ultrasonic knife. In fact, ultrasonic knife is just a common name, whose main function is not tissue-cut, but to expose intrahepatic canaliculi after breaking the cellular elements. For the intrahepatic fibrous tissue, the routine operative technique should be used [18-25].

Our data indicated that ultrasonic aspiration hepatectomy could significantly reduce the operative injury and the incidence of complication and shorten the mean hospitalization time by 3-4 days. Because of less blood transfusion required and tumor manipulation avoided in the operation, the 3-year survival rate of group T was higher than that of group C. The main technical advantages of this clinical application included (1) by the conventional operative procedure tissues are dissected with fingers, scissors or knife handle, and some fine canaliculi could not be exposed readily, so it is hard to avoid operative injury, which resulted in more bleeding during or after operation and higher incidence of cholorrhea. Ultrasonic knife can aspirate the liver tissues around the incision, the blood vessel and bile duct remained. The operators could ligate the vessel and bile duct perfectly, so cholorrhea and hematorrhea after operation may be avoided. (2) ultrasonic knife is actually a kind of ultrasonic aspirator. According to the principle that the highly hydrated tissues could be emulsified easily, ultrasonic knife could aspirate the cellular debris out of body, but it cannot replace the conventional operative technique. (3) since the main blood vessel and bile duct injuries can be avoided in the operation, the tumor near portahepatis can be cut off, thus it raises the resectability of liver cancer. Our first patient treated with this procedure was a 13 year old child with a tumor encroached on the first and second portahepatis. The pathologic diagnosis after operation was

hepatocellular carcinoma. The patient has been remained well and alive up to 10 years. In the 136 operations, there were 64 complicated operations, 32 right liver lobe resections, 16 VIII liver segment resections, 5 tri-liver lobe resections, and 2 left tri-liver lobe resections. (4)local block of blood flow could reduce bleeding in operation and assure the safety of hepatectomy^[2,8], which is important in saving blood resources and accelerating the rehabilitation of patient. (5)ultrasonic aspiration hepatectomy with no demand to block the portahepatis, is especially suitable for the patients with impairment of liver function so as to avoid further injuries to liver parenchyma.

REFERENCES

- 1 **Lin NF**, Tang J, Hoteyi SM. Study on environmental etiology of high incidence areas of liver cancer in China. *World J Gastroenterol* 2000; **6**: 572-576
- 2 **Gu GW**, Zhou HG. New concept in etiology of liver cancer. *Shijie Huaren Xiaohua Zazhi* 1998; **6**:185-187
- 3 **Yu SZ**, Dong CH. Risk identification, assessment and control of primary hepatocellular cancer. *Huaren Xiaohua Zazhi* 1998; **6**:1026-1029
- 4 **Jiang XL**, Pan BR, Ma JY, Ji ZH, Ma LS. Gastroenterologies in the beginning of new century---review and prospect. *Shijie Huaren Xiaohua Zazhi* 2000; **8**:1161-1176
- 5 **Tang ZY**. Hepatocellular carcinoma cause, treatment and metastasis. *World J Gastroenterol* 2001; **7**:445-454
- 6 **Wu MC**. Clinical research advances in primary liver cancer. *World J Gastroenterol* 1998; **4**:471-474
- 7 **Liu JP**, Peng WW, Li MD, Li QF. Clinical significance of serum and liver β -2 microglobulin in patients with various types of HBV infection. *Huaren Xiaohua Zazhi* 1998; **6** (Suppl 7):195-197
- 8 **Liao HY**, Lang ZW, Zhu RP, Cui BN, Li XM, Li Y, Weng L. The study of infection on hepatitis G virus in the tissue of hepatocellular carcinoma. *Shijie Huaren Xiaohua Zazhi* 1998; **6**(suppl 7):401
- 9 **Yuan FP**, Huang PS, Wang Y, Gong HS. Relationship between EBV infection in Fujian HCC and HBV and P53 protein expression. *Shijie Huaren Xiaohua Zazhi* 1999; **7**:491-493
- 10 **Deng ZL**, Ma Y, Yuan L, Teng PK. The importance of hepatitis C as a risk factor for hepatocellular carcinoma in Guangxi. *World J Gastroenterol* 2000; **6**(suppl 3):75
- 11 **Zhang BH**, Liu Y, Qian GX, Chen H, Wu MC. The prognostic significance of detection of AFPmRNA and AFP after HCC resected. *Huaren Xiaohua Zazhi* 1998; **6**(suppl 7):125-126
- 12 **Wu ZQ**, Fan J, Qiu SJ, Zhou J, Tang ZY. The value of post-operative hepatic regional chemotherapy in prevention of recurrence after radical resection of primary liver cancer. *World J Gastroenterol* 2000; **6**:131-133
- 13 **Ji W**, Ma KS, Dong JH, Huang XL, He ZP. The stage II hepatectomy on hepatic cancer after selective portal vein embolization. *Shijie Huaren Xiaohua Zazhi* 2001; **9**:1209-1210
- 14 **Yamanaka J**, Yumauaka N, Nakasho K, Tanaka T. Clinicopathologic analysis of stageII-III hepatocellular carcinoma showing early massive recurrence after liver resection. *J Gastroenterol Hepatol* 2000; **15**:1192-1198
- 15 **Dai YM**, Chen H, Wang NJ, Ni CR, Cong WM, Zhang SP. Clinicopathologic risk factors and prognostic evaluation in hepatocellular carcinoma recurrence after surgery. *Xin Xiaohuabingxue Zazhi* 1997; **5**:439-441
- 16 **Sun WB**. Further decrease the fatality rate in aged patients undergoing hepatobiliary surgery. *Huaren Xiaohua Zazhi* 1998; **6**:61-63
- 17 **Kobayashi T**, Kubota K, Takayama T, Makauchi M. Telomerase activity as a predictive marker for recurrence of hepatocellular carcinoma after hepatectomy. *Am J Surg* 2001; **181**:284-288
- 18 **Tang ZY**. Advances in clinical research of hepatocellular carcinoma in China. *Huaren Xiaohua Zazhi* 1998; **6**:1013-1016
- 19 **Zhang J**, Zhang JR. Surgical treatment of liver metastatic neoplasms. *Shijie Huaren Xiaohua Zazhi* 1999; **7**:414
- 20 **Vallet C**, Martinet O, Mosimann F. Surgical treatment of hepatic metastases. *Rev Med Suisse Romande* 2001; **121**:119-124
- 21 **Zhou XD**, Tang ZY, Yang BH, Lin ZY, Ma ZC, Ye SL, Wu ZQ, Fan J, Qin LX, Zheng BH. Experience of 1000 patients who underwent hepatectomy for small hepatocellular carcinoma. *Cancer* 2001; **91**:1479-1486
- 22 **Patiutko Iul**, Sagaidak IV, Kotelnikov AG, Badaliau KhV, Tumanian AO. Current approaches to surgical treatment of liver tumors. *Vopr Oukol* 1998; **44**:580-583
- 23 **Liu CL**, Fan ST, Lo CM, Tung PR, Wong J. Anterior approach for major right hepatic resection for large hepatocellular carcinoma. *Ann Surg* 2000; **232**:25-31
- 24 **Wu MC**, Shen F. Progress in research of liver surgery in China. *World J Gastroenterol* 2000; **6**:773-776
- 25 **Wu ZQ**, Fan J, Qiu SJ, Zhou J, Ma ZC, Zhou XD, Tang ZH. An approach for difficult hepatectomy-retrograde hepatectomy in 29 patients with liver malignant tumor. *Hepato-Gastroenterol* 1999; **46**:1140-1144
- 26 **Savvier E**, Castaing D. Use of a water-jet dissector during hepatectomy. *Ann Chir* 2000; **125**:370-375
- 27 **Asahara T**, Dohi K, Nakahara H, Katayama K, Itamoto T, Sugino K, Moriwaki K, Shiroyama K, Azuma K, Ito K, Shimamoto F. Laparoscopy-assisted hepatectomy for a large tumor of the liver. *Hiroshima J Med Sci* 1998; **47**:163-166
- 28 **Chen HY**, Ker CG, Juan CC, Lo HW. Laparoscopic subsegmentectomy for hepatocellular carcinoma with cirrhosis: a case report. *Kaohsiung J Med Sci* 2000; **16**:582-586
- 29 **Gertsch P**, Pelloni A, Guerra A, Krpo A. Initial experience with the harmonic scalpel in liver surgery. *Hepatogastroenterology* 2000; **47**:733-736
- 30 **Yamashita Y**, Sakai T, Maekawa T, Watanabe K, Iwasaki A, Shirakusa T. Thoracoscopic trasdiaphragmatic microwave coagulation therapy for a liver tumor. *Surg Endosc* 1998; **12**:1254-1258
- 31 **Jia YC**, Tian JM, Wang ZT, Chen D, Ye H, Liu Q, Yang JJ, Sun F, Lin L, Lu JP, Wang F, Cheng HY. A retrospective review on interventional treatment of 10000 cases of liver cancer. *Huaren Xiaohua Zazhi* 1998; **6**:2-3
- 32 **Tu SP**, Wu DM, Yuan YZ, Wu YL, Jiang SH, Wu YX. Treatment of hepatocellular carcinoma by transcatheter arterial chemoembolization with hydroxycamptothecin. *Shijie Huaren Xiaohua Zazhi* 1999; **7**:158-160
- 33 **Cheng SZ**, Zhang JH, Cheng YJ. Relative analization in the effects of percutaneous injecting several agents into hepatic neoplasmo. *Shijie Huaren Xiaohua Zazhi* 2000; **8** (suppl 8):88
- 34 **Fan J**, Ten GJ, He SC, Guo JH, Yang DP, Weng GY. Arterial chemoembolization for hepatocellular carcinoma. *World J Gastroenterol* 1998; **4**:33-37
- 35 **Huang DZ**, Wu YD, Song XQ, Hu XH, Kang P. United treatment with iodine-125 oil embolism and local radioactive therapy on hepatic carcinoma. *Shijie Huaren Xiaohua Zazhi* 2001; **9**:1198-1201 (in Chinese)
- 36 **Fan J**, Wu ZQ, Tang ZY, Zhou J, Qiu ST, Ma ZC, Zhou XD, Ye SL. Multimodality treatment in hepatocellular carcinoma patients with tumor in portal vein. *World J Gastroenterol* 2001; **7**:28-32
- 37 **Yamamoto Y**, Ikai I, Kume M, Sakai Y, Yamauchi A, Shinohara H, Morimoto T, Shimahara Y, Yamamoto M, Yamaoka Y. New simple technique for hepatic parenchymal resection using a Cavitron Ultrasonic Surgical Aspirator and bipolar cautery equipped with a channel for water dripping. *World J Surg* 1999; **23**: 1032-1037
- 38 **Trupka A**, Hallfeldt K, Kalteis T, Schmidbauer S, Schweiberer L. Open and laparoscopic liver resection with a new ultrasound scalpel. *Chirurg* 1998; **69**: 1352-1356
- 39 **Kokudo N**, Kimura H, Yamamoto H, Seki M, Ohta H, Matsubara T, Takahashi T. Hepatic parenchymal transection using ultrasonic coagulating shears: a preliminary report. *J Hepatobiliary Pancreat Surg* 2000; **7**: 295-298
- 40 **Ouchi K**, Mikuni J, Sugawara T, Ono H, Fujiya T, Matsuyama Y, Kakugawa Y, Yamanami H, Nakagawa K. Hepatectomy using an ultrasonically activated scalpel for hepatocellular carcinoma. *Dig Surg* 2000; **17**: 138-142
- 41 **Fan ST**, Lai ECS, Lo CM, Chu KM, Liu CL, Wong J. Hepatectomy with an ultrasonic dissector for hepatocellular carcinoma. *Br J Surg* 1996; **83**:117-120

Edited by Ma JY