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Resection of Large Hepatocellular Carcinoma Using the Combination of Liver Hanging Maneuver and Anterior Approach

Chih-Chi Wang · Kailash Jawade · Anthony Q. Yap · Allan M. Concejero · Chi-Yin Lin · Chao-Long Chen

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Abstract

Background Resection of a large hepatocellular carcinoma (HCC) is difficult and is associated with a poor outcome. Herein we describe our experience with the use of a liver hanging maneuver (LHM) in conjunction with the anterior approach (AA) in patients with large HCC (>10 cm) and compare the perioperative outcome with the conventional method (CM) for hepatic resection.

Methods Patients who underwent major hepatic resections for large HCC (>10 cm) were categorized as group 1 ($n = 14$), treated with LHM and AA, versus group 2 ($n = 11$), treated with CM. Variables including patient age, tumor size, operative time and transection time, blood loss, blood transfusion requirements, and postoperative ICU and hospital stay were used to compare the two groups.

Results There were 14 and 11 patients in groups 1 and 2, respectively. The variables in group 1 and 2 of median tumor size, median operative time, median transection time, median ICU stay, and median hospital stay were comparable. In contrast, the intraoperative blood loss and the blood transfusion requirements were significantly higher in group 2. Patients under LHM and AA and CM had a median blood loss of 375 ml (237.5–850) and 1,000 ml (500–1,200), requirement of blood transfusion of 3 (21.42%) and 8 (72.7%), respectively. Postoperative complications were comparable in the two groups. There were no deaths in the series.

Conclusions The liver hanging maneuver in conjunction with AA is a safe and highly feasible procedure, particularly in patients with sizable (>10 cm) tumors and tumors found to be adherent to the diaphragm and retroperitoneum. The use of the procedure eventuated in lower blood loss as well as fewer blood transfusion requirements when compared to the conventional method.

Introduction

Conventional hepatic resection for large hepatocellular carcinoma (HCC) is associated with various complications including excessive bleeding, tumor rupture, and spread of tumor cells, curtailing both the short-term and long-term survival outcome. To surmount these problems, Lai et al. [1] employed the anterior approach (AA) for major hepatic resections. Belghiti et al. [2], on the other hand, fashioned the liver hanging maneuver (LHM) technique and combined it with the anterior approach established by Lai. Suspending the liver with a tape enables control of bleeding at the deeper parenchymal plane and guides the direction of anatomic parenchymal transection. The presence of adhesions between liver and retroperitoneum or tumor infiltration into the retrohepatic region is described as a major limiting factor for the individual use of these procedures in large hepatocellular carcinoma [3–5]. Herein we describe our experience with the used of these techniques in patients with large hepatocellular carcinoma (>10 cm) and compare the perioperative outcome with the conventional method (CM) for hepatic resection.

C.-C. Wang (✉) · K. Jawade · A. Q. Yap · A. M. Concejero · C.-L. Chen
Division of General Surgery, Department of Surgery, Chang Gung Memorial Hospital-Kaohsiung Medical Center, Chang Gung University College of Medicine, 123 Ta-Pei Road, Niao-Sung, Kaohsiung 833, Taiwan
e-mail: ufel4996@ms26.hinet.net

C.-Y. Lin
Division of General Surgery, Department of Surgery, PingTung Christian Hospital, Ping Tung 900, Taiwan

Patients and Methods

We started using LHM in conjunction with AA in March 2006. Before that, all hepatic resections were performed employing the conventional approach. From March 2006 to June 2007, 14 major hepatic resections using LHM and AA ($\geq$3 Couinaud segments) were performed at the Chang Gung Memorial Hospital-Kaohsiung Medical Center. These were compared to 11 patients who had CM hepatic resections prior to March 2006. These patients were labeled as groups 1 and 2, respectively. Clinical records of these patients were reviewed for tumor location, number, size, operative time, and intraoperative blood loss, duration of ICU stay, length of postoperative hospital stay, complications, and postoperative mortality.

Preoperative Workup

Preoperative evaluation included determination of serum albumin, total bilirubin; aspartate aminotransaminase, alanine aminotransaminase, and indocyanine green assay (ICG) to assess liver function. Abdominal ultrasonography, plain and contrast-enhanced computed tomographies of liver and liver angiography and/or magnetic resonance imaging were performed to assess the tumor extent. Other biochemical tests were used to evaluate cardiac and renal function, Chest x-ray and electrocardiogram were carried out to assess the patient's functional status. The extent of hepatic resection was influenced by liver function tests results (Child's score and ICG).

Surgical Technique

Exposure of the abdominal cavity was carried out through a reversed L incision from the skin to the peritoneum in all patients. This was followed by an abdominal exploration to search for distant metastatic tumors.

Conventional Technique

The conventional technique was initiated by dissecting the hilum to isolate the major hepatic vessels (portal vein and hepatic artery) of the affected lobe followed by marking of the transection line. Mobilization of the liver was performed by dissecting the falciform ligament as well as the triangular and coronary ligaments of the affected lobe. Mobilization was further accomplished by freeing the affected lobe from its retrohepatic attachments. Intraoperative ultrasound was subsequently used to re-elucidate the tumors' extent. Hepatic transection was carried out by crushing the liver parenchyma with a Kelly clamp as well as with the used of a Cavitron Ultrasonic Surgical Aspirator (CUSA; Valleylab Inc., Boulder, CO) and bipolar diathermy. This was performed under a continuous selective or intermittent hepatic inflow occlusion. Small vascular and biliary structures were divided between ligatures using silk 4–0 sutures. Larger structures were sutured using prolene 6–0 in a continuous fashion. The removal of the specimen was followed by assiduous hemostasis and abdominal wound closure.

Combined Hanging Maneuver and Anterior Approach

Our technique was similar to the procedure originally described by Belghiti et al. Those authors dissected the space between the right and middle hepatic vein 2 cm downward, approaching the caudal region. This was followed by a dissection at the caudal end moving toward the level of the inferior part of the right hepatic vein [2]. We found this maneuver difficult to perform in our series because of the sizes of the tumors in our patients. This limited our capability of dissecting such length at the hepatic vein-vena caval region. Instead, we dissected the retrohepatic area at the caudal end, coursing in a cephalad fashion toward the space between the right and middle hepatic veins. This maneuver was carried out by gently lifting the caudate and ligating the small short retrohepatic veins, after which blunt dissection was carried out using a suction tip directed toward the suprahepatic space. An angled long aortic clamp was gently inserted and advanced in a cephalad direction at the 10–11 o'clock position toward the dissected space between the right and middle hepatic veins. When the tip of the clamp reached the space between the veins, a 13-mm Penrose tube tape was clenched in the tip of the clamp. The clamp was pulled down through the entire length of the retrohepatic IVC placing the tape in the retrohepatic space. The liver was suspended on the tape, after which hepatic parenchymal transection was accomplished. The parenchymal transection was similar to what was previously described.

Data Analysis

Fisher's exact test was used to evaluate the independent variables, and the Mann–Whitney test was used to analyze nonparametric variables. A P value of <0.05 was considered statistically significant.

Results

Table 1 summarizes the demographics of patients in group 1. Of the 14 patients, 10 had right lobe tumors, 3 had right lobe tumors extending to segment 4, and 1 had a tumor at the left lateral segment. The mean tumor size was 14.2 $\pm$ 6.7 cm. The smallest tumor measured 5 cm and was densely

Table 1 Patient demographics, clinical findings, and operative data

Case no.	Age	Sex	Tumor size, cm	Tumor location	Type of resection	Duration of surgery	Blood loss, ml	Blood transfusion, PRBC units
1	63	M	19	RL	ERH	357	400	–
2	55	M	13	RL	RH	362	250	–
3	73	M	10.5	RL	ERH	411	700	–
4	54	M	12	RL	RH	291	250	–
5	83	M	11	RL, S4	ERH	313	1,300	4
6	40	M	10	RL	RH	392	300	–
7	60	M	17	RL, S4	ERH	405	600	–
8	49	M	16	RL, S4	ERH	410	350	–
9	61	M	19	RL	RH	431	1,600	4
10	68	M	5	S7	RH	364	100	–
11	73	M	13	RL	RH	401	150	–
12	41	M	33	RL	RH	594	2,800	10
13	70	M	9	RL	RH	246	200	–
14	48	M	11	LLS	LH	506	400	–

M male; *RL* right lobe; *S4* segment 4; *S7* segment 7; *LLS* left lateral segment; *RH* right hepatectomy; *LH* left hepatectomy; ERH extended right lobectomy

adherent to the adrenal gland. The indications to proceed with the combined approach wereas follows: very large tumor with difficulty of mobilizing the liver in 7 cases (size >15 cm), adhesions to both the diaphragm and Gerota's fascia in 2 cases, adhesions to only Gerota's fascia in 2 cases, and adherence to caked omentum and colon in 1 case each. The technical feasibility of the combined technique was 100%.

Table 2 summarizes the comparison of variables between the two groups. There were 14 patients in group 1 and 11 patients in group 2. Groups 1 and 2 had a median age of 60 years (58.7–70.7) and 55 years (43–69), median tumor size of 12.5 cm (10.4–17.5) and 12 cm (11–16), median operative time of 396 min (346–416) and 405 min (299–490), median transection time of 104.5 min (96.2–125.7) and 86.5 min (77.5–141), medianICU stay of 5 days (4–6.2) and 4 days (2–7), and mean hospital stay of 15 days (10.7–19.7) and 16 days (13–19). These variables were comparable in the two groups. In contrast, the intraoperative blood loss as well as the blood transfusion requirement were significantly higher in group 2. Patients undergoing the combined technique had a median blood loss of 375 ml (237.5–850) whereas the patients in the other group had a median blood loss of 1,000 ml (500–1,200). Three patients (21.42%) in group 1 required blood transfusion, in contrast to 8 (72.7%) patients in group 2.

Postoperative ascites occurred in 6 patients in group 1 (42.85%) and in 5 (45.5%) patients in group 2. All patients responded well to albumin and diuretic treatment. Two patients in group 1 (14.28%) and 1 patient in group 2 (9%) had pneumonia, and 1 patient in each group required prolonged intubation (>20 days). All patients responded well with carbapenem treatment. A bile leak was noted in 1 patient in group 2. This was managed successfully with biliary stenting. Evidently, the effects of these negative events were not significantly different between the two groups. There was no postoperative mortality in either group.

Discussion

In conventional hepatic resections for liver tumors, complete mobilization of the liver is necessary prior to parenchymal transection. In large tumors liver mobilization is technically difficult and may result in bleeding and tumor rupture. Aggressive liver manipulation can cause tumor cell dissemination. The advances in perioperative and anesthesia care, coupled with improvements in patient selection and the inclusive understanding of the liver's anatomy have permitted hepatic surgeons to perform radical operations in patients with hepatocellular carcinoma. However, resections of large hepatic tumours remain intricate and often pose the risk of massive bleeding and postoperative hepatic failure. Further, mobilizing and removing such pathology often requires enlarging the operative field, which entails widening of the abdominal incisions and, at times, extending incisions to the chest region. Such factors have the potential to increase the risk of postoperative complications and can dismally affect patient survival.

The LHM procedure in conjunction with the anterior approach obviates the need for mobilizing the liver and potentially circumvents the above risks. It has several

Table 2 Comparison of variables in the two groups

	Group 1, $n = 14$	Group 2, $n = 11$	*P* Value
Age, years (median [IQR])	60 (58.7–70.7)	55 (43–69)	0.460
Tumor size, cm (median [IQR])	12.5 (10.4–17.5)	12 (11–16)	0.805
Operative time, min (median [IQR])	396 (346–416)	405 (299–490)	0.642
Transection time, min (median [IQR])	104.5 (96.2–125.7)	86.5 (77.5–141)	0.241
Blood loss, ml (median [IQR])	375 (237.5–850)	1000 (500–1,200)	0.028
ICU stay, days (median [IQR])	5 (4–6.2)	4 (2–7)	0.378
Hospital stay, days (median [IQR])	15 (10.7–19.7)	16 (13–19)	0.660
Blood transfusion requirement, %	3 (21.42%)	8 (72.7%)	0.017

IQR interquartile range; *ICU* intensive care unit

advantages, including better control of bleeding, protection of the inferior vena cava, exposure during deeper parenchymal dissection, rapid transaction, and guidelines for the direction of transection. Initially it was used as complement to the anterior approach in primary HCC; later, it was used for metastatic liver tumors, benign liver tumors, recurrent right upper quadrant tumors, hydatid cyst resection, major left hepatectomies, orthotopic liver transplantation with inferior vena cava (IVC) preservation, and living donor hepatectomy [6–8]. Though some surgeons may consider it technically difficult and precarious because of the retrohepatic dissection, Belghiti et al. have shown that LHM is safe and highly feasible, particularly in patients with sizable tumors. Comparison of the tumor size, blood loss, and feasibility of techniques of the described reports in the literature [3, 4, 9–12] with our method combining AA and LHM is shown in Table 3. The procedure was technically feasible in all our patients. The used of this technique eventuated in less blood loss and fewer blood transfusion requirements in comparison to the conventional method.

Dissecting the retrohepatic space is considered as the most difficult part of the procedure. This often involves dissecting the section blindly. In the original description of the technique, Belghiti et al. illustrated a 1-cm-wide avascular space through which the dissection can be safely performed [2]. It is situated at the 10–11 o'clock position on the anterior surface of the retrohepatic IVC. The maneuver can be carried down 3–4 cm toward the caudal region by a punch-burn-cut method. This is followed by dissecting the caudal retrohepatic area from the inferior end, coursing superiorly toward the space created initially. The latter dissection is performed by gently lifting the caudate and ligating several small retrohepatic veins.

Unfortunately, we found the initial maneuver difficult to perform because of the largetumors in our patients. Therefore, we approached the retrohepatic area from the caudal end in a manner similar to the initial description, followed by a blunt dissection with a suction tip, starting from the level of the inferior part of the right hepatic vein and coursing toward the suprahepatic space. Such a maneuver was feasible in all our patients and with good perioperative results. Moreover, in contrast to previous studies that employed the technique in tumors as large as 10 cm, we found the procedure favorable in patients with larger tumors (11–33 cm). We similarly found it advantageous in tumors adherent to the diaphragm and retroperitoneum.

Although LHM is proven to be safe and is particularly advantageous in patients with sizable tumors and tumors densely adherent to the retroperitoneum, it is still limited by several factors. The technique is absolutely contraindicated in tumors infiltrating the IVC [7]. Further, in contrast to the conventional method, LHM necessitates the used of

Table 3 Comparison of previous experience with use of individual anterior approach or liver hanging maneuver with our method combining both

Author	Technique	Type of resection	Mean tumor size, cm	Mean blood loss, ml	Feasibility, %
Present study 2009	AA + LHM	MR	14.2	672.4	100
Hwang et al. 2008	LHM	LL	NA	NA	100
Ettorre et al. 2007	LHM	RL	NA	NA	96
Donadon et al. 2007	LHM	MR	10.5	800	NA
Cho et al. 2007	LHM		7.1	1,048	NA
Liu et al. 2006	AA	MR	10.5	800	NA

AA anterior approach; *LHM* liver hanging method; *MR* major resection; *LL* left lobectomy; *NA* not applicable; *RL* right lobectomy intraoperative ultrasound to attenuate bleeding while performing the retrohepatic dissection [13]. This instrument can elucidate the relationship of the tumor to the IVC and identify accessory and sizable inferior hepatic veins. Lastly, we believe that surgeons will require a certain level of experience in performing hepatic resections prior to employing this technique. Such experience is needed to gain extensive knowledge of the liver's anatomy, particularly the retrohepatic section.

Conclusions

The use of LHM in conjunction with AA is safe and highly feasible, particularly in patients with sizable (>10 cm) tumors and tumors adherent to the diaphragm and retroperitoneum. The use of the procedure eventuated in lesser blood loss as well as fewer blood transfusion requirements in comparison to the conventional method. However, the success of the technique necessitates the use of advanced imaging modalities (including intraoperative ultrasound), significant hepatic surgical experience, and proper selection of patients. Further, we believe that our modified procedure could be safely performed by liver surgeons and expanded to major hepatic resection.

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