



Totally Laparoscopic Associating Liver Tourniquet and Portal Ligation for Staged Hepatectomy via Anterior Approach for Cirrhotic Hepatocellular Carcinoma

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Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) can achieve rapid hypertrophy of the future liver remnant (FLR).¹⁻¹¹ However, because of liver splitting and postoperative severe adhesion of the first stage, the technique has a high morbidity rate^{1,5,6,8,12} (biliary fistulas, infected collections, necrosis of segment IV, high risk of posthepatectomy liver failure [PHLF]^{1,3,8}) and a mortality rate between 12% and 27%.^{1,6,8,12}

Laparoscopy may reduce adhesions. Machado and colleagues¹³ suggested that total or partial use of laparoscopy may be an easy solution for adhesions and difficulties that may be encountered during the second stage. Robles and associates¹⁴ introduced a new technique to avoid the risk of liver splitting in the first stage of ALPPS, associating liver tourniquet and portal ligation for staged hepatectomy (ALTPS), which could provide a less invasive modification of the ALPPS procedure. In their study, all patients underwent open ALTPS, and none suffered liver disease or cirrhosis (normal background liver). To our knowledge, there have been few reported cases to date using ALTPS in a patient with hepatitis B cirrhosis.

Aloia and Vauthey¹⁵ thought that the ALPPS was supposed to be an “all-touch” technique that would reduce the oncologic efficacy of treating liver malignancy.¹⁶ Recently, Cai and coworkers¹⁷ reported a patient who underwent laparoscopic ALPPS using round-the-liver

ligation to replace the parenchymal transection. In step 1 of Cai and colleagues’¹⁷ technique, the tourniquet was placed around the transection line via conventional approach after full mobilization of the right liver, rather than through the retrohepatic tunnel without mobilization of the right liver. Cai and associates’¹⁷ technique was also intended to be an “all-touch” technique.

Successful laparoscopic ALTPS with “non-touch” techniques in cirrhotic hepatocellular carcinoma has not been described, despite its oncologic superiority and reduced aggression. The “anterior approach” technique, avoiding manipulation of the right liver, is a “non-touch” technique.¹⁸ In this article, the first results of a modified “non-touch” ALPPS technique, “totally laparoscopic ALTPS using the anterior approach technique,” for staged hepatectomy in hepatocellular carcinoma (HCC) patients with hepatitis B cirrhosis are reported.

METHODS

Patient information

In September 2014, a 46-year-old man suffering from HCC with hepatitis B cirrhosis was admitted to the Sichuan Academy of Medical Sciences (Sichuan Provincial People’s Hospital). The standard liver volume (SLV) of the patient according to Huaxi’s Formula of Standard Liver Volume of Chinese¹⁹ was 1036.01 mL (body height and body weight were 168 cm and 61 kg, respectively).

Laboratory tests showed increases in hepatitis B virus (HBV)-DNA (HBV-DNA: 5.77×10^4 IU/mL), alanine aminotransferase (ALT), aspartate transaminase (AST), and prothrombin time (PT). Hemoglobin (HGB) and albumin (Alb) were decreased (Table 1). According to the Pugh-modified Child’s score scale, the score was 6 (Child classification: grade A). Computed tomography showed a tumor in the right liver measuring 7.7 cm \times 7.0 cm \times 6.1 cm, and no tumor thrombus in the portal vein (Fig. 1A). The tumor characteristics combined with a markedly elevated alpha-fetoprotein (AFP) level, increasing to

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Abbreviations and Acronyms

ALPPS	= associating liver partition and portal vein ligation for staged hepatectomy
ALTPS	= associating liver tourniquet and portal ligation for staged hepatectomy
FLR	= future liver remnant
HCC	= hepatocellular carcinoma
PHLF	= posthepatectomy liver failure

1,596.33 ng/L, with no evidence of splenomegaly or portal hypertension, were consistent with HCC. Computed tomography liver volumetry showed that the total liver volume (TLV) was 1,330.31 mL. Considering that Ultrasonic Transient Elastography (Fibroscan) showed the median value of stiffness was 26.3 kPa, a liver biopsy of segments 2/3 was performed, showing nodular cirrhosis (grade 4, stage 4). Computed tomography liver volumetry showed that if the required right hemihepatectomy were to be performed, the FLR (segments 2, 3 and 4 with volume of 301.48 mL) would likely be insufficient for postoperative recovery (FLR/total liver volume: 22.7%; FLR/standard liver volume: 29.1%; FLR/body weight: 0.49%) (Table 2), which indicated that it was inappropriate for the patient to receive radical resection of HCC.

Surgical procedures

Plans were made to use the laparoscopic anterior approach ALTPS procedure to induce rapid hypertrophy of the FLR. After appropriate preoperative preparation, the patient was taken to the operating room for stage I of the ALTPS. In the first stage, using a totally laparoscopic technique, a tourniquet was placed around the parenchymal transection line on the Cantlie's line via an anterior approach through the retrohepatic tunnel for a staged

right hepatectomy, and the right portal vein was ligated. The patient received general anesthesia and was placed in the left semidecubitus position with the right side elevated approximately 30 degrees. Generally, 5 ports were used. The first trocar (12 mm) was inserted at the upper umbilicus for placement of a 10-mm 30-degree laparoscope. Four other trocars were inserted at the subxiphoid position (5 mm), at 5 cm superior to the umbilicus on the midline (12 mm), at 5 cm below the costal margin on the right midclavicular line (12 mm), and 2 cm below the costal margin on the right axillary line (5 mm). After placing all trocars successfully (Fig. 2), the operating table was tilted slightly to the reverse Trendelenburg position. Laparoscopy showed apparent nodules in the liver surface (Fig. 3A). A cholecystectomy was performed first. Next, an 8F catheter was positioned as a tourniquet around Cantlie's line between the right and middle hepatic veins, using the hanging maneuver via an anterior approach through the retrohepatic tunnel (Figs. 3B and C). The right portal vein was ligated (Fig. 3D), and the right hepatic artery was dissected free (Fig. 3E). The tourniquet was then passed in front of the right portal pedicle using an extraglissonian approach to prevent occlusion of the right hepatic artery and right bile duct (Fig. 3F).

In the second stage, totally laparoscopic right hemihepatectomy was performed 10 days after the first-stage operation, which achieved sufficient hypertrophy of the FLR (Fig. 3G). The right hepatic pedicle, right hepatic vein, and inferior right hepatic vein were transected with a linear laparoscopic stapler (Echelon 60 ENDO-PATH Stapler, Ethicon Endo-Surgery, LLC). The parenchymal transection was performed at the level of the tourniquet using the ultrasonic dissector (Harmonic Scalpel; Ethicon Endo-Surgery) and vascular locks. The tumor was removed from a transverse incision (Pfannenstiel incision) 3 cm superior to the pubic symphysis after

Table 1. Perioperative Clinical Characteristics of Patients, and Follow-up

Time	AST, U/L	ALT, U/L	Alb, g/L	TBIL, $\mu\text{mol/L}$	DBIL, $\mu\text{mol/L}$	CR, $\mu\text{mol/L}$	PT, s	INR	HGB, g/L	WBC, $\times 10^9/\text{L}$	Neu, %	Drainage, mL
Before operation	78	50	28.8	6.7	3.3	68.3	12.8	1.1	117	7.09	61.4	—
POD 1 (stage 1)	875	731	26.5	13.3	8.6	64.8	11.6	1	118	10.69	84.1	200
POD 3 (stage 1)	307	517	31.9	34.3	24.7	55.0	11.5	1.12	115	11.38	84.8	200
POD 5 (stage 1)	83	148	32.9	21.2	10.8	47.3	11.6	1	121	7.96	74.7	100
POD 7 (stage 1)	78	89	31.8	18.7	10.1	44.8	11.1	1.1	117	8.78	70.5	50
POD 9 (stage 1)	57	67	31.3	19.3	11.1	46.7	11.6	1	116	8.18	69.7	50
POD 1 (stage 2)	190	131	20.9	28.3	13.3	50.9	16.1	1.36	110	27.91	92.3	400
POD 3 (stage 2)	124	109	31.4	20.5	13.7	44.7	15.9	1.35	93	17.94	87.3	200
POD 5 (stage 2)	78	75	31.9	18.5	11.7	40.6	14.9	1.27	94	9.24	72.1	—
POD 7 (stage 2)	47	74	30.4	18.3	10.7	44.0	12.3	1.16	98	9.19	69.4	—

Alb, albumin; ALT, alanine aminotransferase; AST, aspartate transaminase; Cr, creatinine; DBIL, serum direct bilirubin; HGB, hemoglobin; INR, international normalized ratio; Neu, neutrophil granulocyte; POD, postoperative day; PT, prothrombin time; TBIL, serum total bilirubin; WBC, white blood cell.

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