

Central bisectionectomy for centrally located hepatocellular carcinoma

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Background: Central bisectionectomy, which involves the removal of the central hepatic segments (IVA, IVB, V, VIII) for hepatocellular carcinoma (HCC), is performed to reduce the volume of resected liver and to overcome the problem of insufficient future residual volume.

Methods: Twenty-seven patients with HCC underwent central bisectionectomy from January 1998 to April 2007 in one hospital. The surgical techniques, clinicopathological characteristics and outcomes were reviewed.

Results: The median operating time was 330 min. Twelve patients developed postoperative complications and two died. The most common complication, occurring in five patients, was bile duct injury leading to biloma or bile leakage. Median follow-up was 19.1 (range 1.4–102.2) months and eight patients developed a recurrence. Twenty-four patients were alive at the time of writing.

Conclusion: Although biliary complications occur somewhat frequently, central bisectionectomy in centrally located HCC can be performed safely to preserve liver volume.

Paper accepted 26 November 2007

Published online 23 June 2008 in Wiley InterScience (www.bjso.co.uk). DOI: 10.1002/bjs.6130

Introduction

There are several treatment methods for hepatocellular carcinoma (HCC), among which hepatic resection offers the best chance of cure¹. An extended hepatectomy or a non-anatomical resection can be performed for centrally located HCC, affecting Couinaud segments IV, V and VIII adjacent to the hilar plate. However, extensive hepatectomy may sacrifice a large amount of functioning liver and result in suboptimal residual liver volume, causing hepatic failure or death^{2,3}. Consequently, extensive hepatectomy such as trisectionectomy is not usually performed in patients with HCC, who have poor hepatic function frequently combined with cirrhosis, or in those in whom insufficient residual liver volume is expected following surgery.

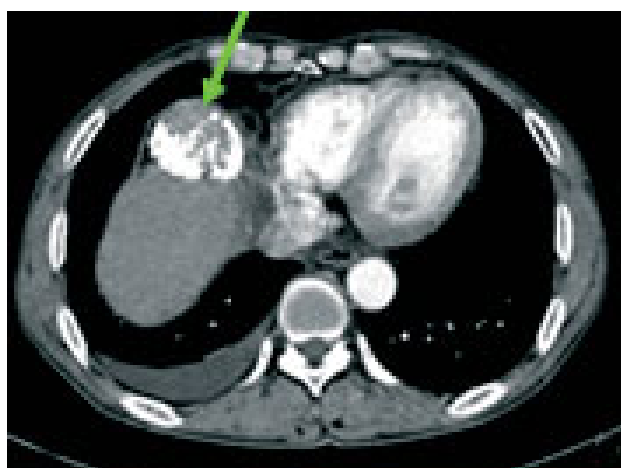
Central bisectionectomy, which involves the removal of the central hepatic segments (IVA, IVB, V, VIII) drained by the middle hepatic vein, was first performed for gallbladder cancer in 1972⁴. It has since been used to treat metastatic liver cancer, cholangiocarcinoma and HCC. It was introduced not only to reduce the resected liver volume and overcome the problem of insufficient future residual volume, especially in patients with underlying liver disease,

but also to increase the opportunity for repeat resection in case of recurrent malignancy⁵.

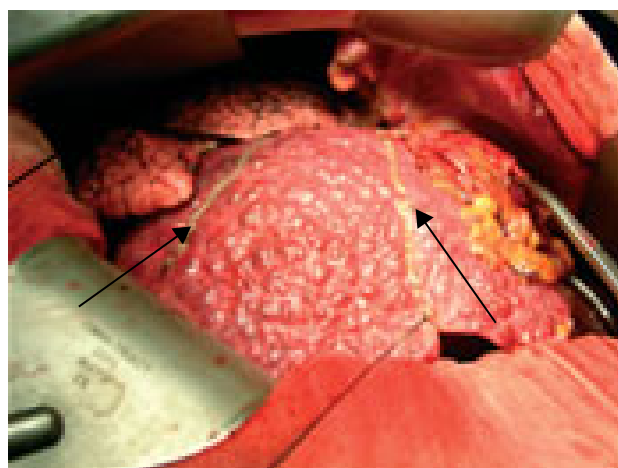
Central bisectionectomy has been reported to be a safe surgical technique in comparison with extended hepatectomy^{5–10}. Recently, it has been possible to take a more challenging and aggressive approach as a result of better understanding of hepatic segmental anatomy, improvements in surgical technique and equipment, better anaesthesiology and improved intensive support care. The aim of this study was to analyse the safety, feasibility and outcomes of central bisectionectomy for HCC, and to determine whether this procedure represents a valuable alternative to extensive hepatic resection by reviewing the literature.

Methods

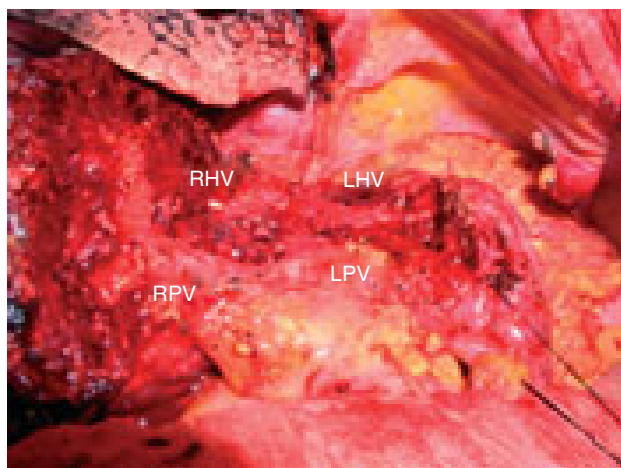
Of 436 patients with HCC operated on with curative intent from January 1998 to April 2007 in the Department of Surgery, Severance Hospital, Yonsei University College of Medicine, Seoul, 27 underwent central bisectionectomy. The resectability and vascular and ductal anatomy were



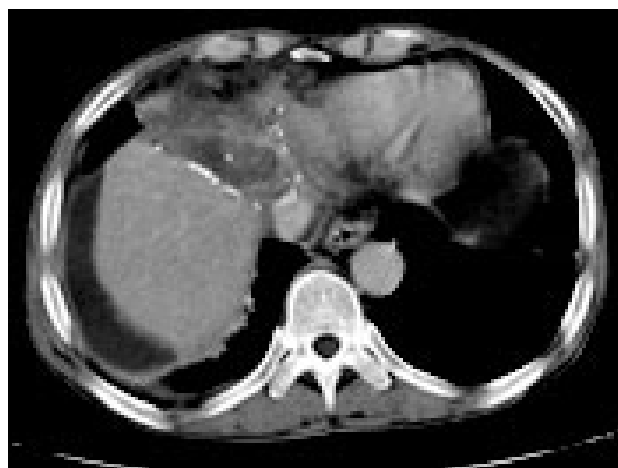
a Uptake of lipiodol



b Dissection planes



c Raw surfaces of residual liver



d Follow-up scan

Fig. 1 **a** Computed tomogram showing uptake of lipiodol into a hepatocellular carcinoma located in segment VIII (arrow). **b** Dissection planes, determined by intraoperative ultrasonography, marked along the medial side of the falciform ligament and right anterior fissure on the surface of the liver by electrocautery (arrows). **c** Raw surfaces of the residual liver following delivery of the specimen with exposed portal and hepatic veins. RHV, right hepatic vein; LHV, left hepatic vein; RPV, right portal vein; LPV, left portal vein. **d** Follow-up scan 7 days after surgery

evaluated by preoperative computed tomography. The functional reserve of the liver was estimated by blood biochemistry, indocyanine green retention rate at 15 min (ICG-R15) and prothrombin time. Patients with tumour located in the anterior and/or medial section, adjacent to the middle hepatic vein, were considered for central bisectionectomy (*Fig. 1*). Patients were also selected for central bisectionectomy if the anticipated remaining liver volume after conventional trisectionectomy was so small that hepatic failure would ensue, or if hepatic function was likely to deteriorate owing to cirrhosis regardless of the amount of residual liver. Central bisectionectomy

was preferred in such instances because the estimated future remnant liver volume was 40–60 per cent of the parenchyma, compared with 15–40 per cent after extended hepatectomy.

The clinical records, operative factors, pathological data and survival were reviewed retrospectively. The cause of cirrhosis, Child–Pugh classification, ICG-R15, α -fetoprotein level, and use of preoperative adjuvant therapy such as transarterial chemoembolization (TACE) or chemoinfusion (TACI) and radiation therapy were noted. Duration of operation, estimated blood loss and amount of blood transfused, tumour size and number,

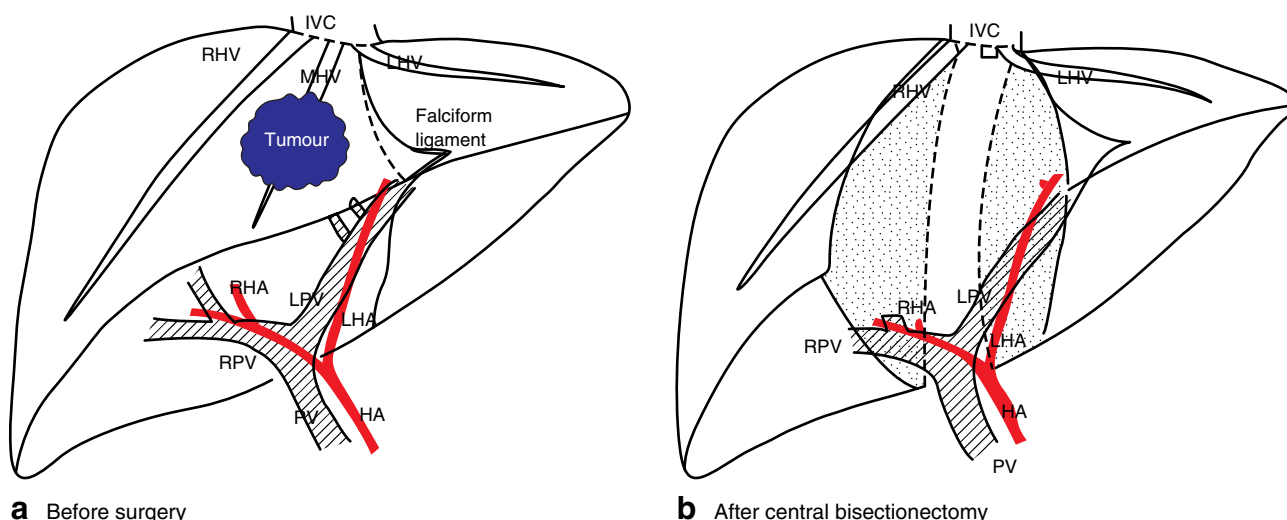


Fig. 2 Schematic diagrams showing central bisectionectomy. **a** The tumour is located at segments IV and V of the liver above the middle hepatic vein (MHV). The medial aspect of the falciform ligament is transected first, followed by right anterior section. **b** After delivery of the specimen, the MHV, right hepatic vein (RHV) and inferior vena cava (IVC) are exposed on the raw surface of the residual liver. LHV, left hepatic vein; RHA, right hepatic artery; LPV, left portal vein; LHA, left hepatic artery; RPV, right portal vein; PV, portal vein; HA, hepatic artery

margin status, and pathological stage according to the Japanese tumour node metastasis (TNM) classification system¹¹ were also recorded. Surgical outcomes and follow-up results, recurrence and survival were examined.

Surgical technique (Fig. 2)

After a thorough examination of the abdominal cavity, the right and left liver lobes were mobilized completely by dissecting the falciform, coronary and triangular ligaments, and resectability was confirmed. The suprahepatic vena cava and hepatic vein were exposed by sharp dissection. The hilum was dissected carefully following cholecystectomy to expose both hepatic arteries and portal veins. Intraoperative ultrasonography was performed routinely to trace the course of the hepatic veins and portal pedicles to determine the resection line. The left medial section was transected by ligation of the left medial branches of the portal triad along the medial side of the falciform ligament. The liver parenchyma was dissected with a Cavitron Ultrasonic Surgical Aspirator (CUSA®; Valleylab, Boulder, Colorado, USA). During parenchymal dissection, central venous pressure was usually maintained at less than 5 mmHg to reduce backflow from the hepatic vein. After the right anterior hepatic artery and portal vein had been ligated, the liver parenchyma was dissected. The dissection proceeded posteriorly as far as the trunk of the middle hepatic vein, which was also clamped and divided, and then the

specimen was delivered. Alternatively, if there was difficulty in dissecting the right Glisson's structure, the right anterior hepatic artery and portal vein were ligated following transection of the liver parenchyma. Bile leak was excluded by infusing water and air simultaneously via the cystic duct to test for leakage. The raw surfaces of the residual liver were covered with fibrin glue (TISSEEL; Baxter, Wien, Austria) and SURGICEL® (Johnson & Johnson Medical, Gargrave, UK). Two-armed closed drains were placed in the subhepatic space and raw surface of liver.

Results

Clinicopathological characteristics

There were 22 men and five women, of median age 55 (range 28–67) years. The clinicopathological characteristics are summarized in *Table 1*. All patients had Child–Pugh class A disease and the median preoperative ICG-R15 was 9.7 (range 3.5–25.0) per cent. The degree of fibrosis in the non-tumorous liver was periportal in six patients and septal in 13; the remaining eight patients had cirrhosis. Preoperative TACE and/or TACI were performed in 16 patients; four patients underwent TACE/TACI more than twice. Two patients received radiation therapy and one patient was treated with radiofrequency ablation before surgery.

The median duration of operation was 330 (range 215–669) min. The median estimated blood loss during

Table 1 Clinicopathological characteristics

	No. of patients
Sex ratio (M : F)	22 : 5
Age (years)*	55 (28–67)
Hepatitis	
HBV	20
HCV	3
Unknown	4
ICG–R15 (%)*	9.7 (3.5–25.0)
α -Fetoprotein (units/ml)*	12.0 (1.4–29 700.4)
Clinical stage (Japanese TNM)	
I	2
II	21
III	4
Preoperative treatment	
TACE/TACI	14
TACE/TACI + radiation therapy	2
Operating time (min)*	330 (215–669)
Intraoperative blood loss (ml)*	1400 (550–7000)
Transfusion (ml)*	345 (0–3200)
Weight of specimen (g)*	300 (147–483)
Size of tumour (cm)*	4.3 (2.0–9.0)
Resection margin (cm)*	1.5 (0.1–4.0)
Pathological stage (Japanese TNM)	
I	1
II	13
III	8
IV	5

*Values are median (range). HBV, hepatitis B virus; HCV, hepatitis C virus; ICG–R15, indocyanine green retention rate at 15 min; TNM, tumour node metastasis; TACE, transarterial chemoembolization; TACI, transarterial chemoinfusion.

Table 2 Postoperative complications

	No. of patients
Hepatic necrosis	1
Biloma	5
Ascites	2
Pleural effusion	5
Wound evisceration	1
Acute renal failure	1
Stroke	1

operation was 1400 (range 550–7000) ml and the volume of red blood cells (RBCs) transfused was 345 (range 0–3200) ml. The median weight of resected liver was 300 (range 147–483) g and tumour size was 4.3 (range 2.0–9.0) cm. The resection margin was not involved by tumour in any patient; the median width was 1.5 (range 0.1–4.0) cm. According to the Japanese TNM classification, there was one pathological stage I tumour, 13 stage II, eight stage III and five stage IV.



Fig. 3 Three-dimensional reconstruction of a computed tomogram showing the relationship between a tumour located in segment IV and the portal pedicle and vascular anatomy

Complications and outcome

Postoperative complications developed in 12 patients (*Table 2*). The most common complication was bile duct injury (five patients) leading to biloma or bile leakage. Three of five biliary complications resolved following percutaneous drainage, and the other two resolved spontaneously without drainage. Other complications included pleural effusion (five) and severe ascites (two). Two patients died after surgery, one on postoperative day 70 from necrosis of the residual liver that caused hepatic failure, suggesting injury to the right posterior hepatic artery. The second patient died 33 days after operation from the sequelae of postoperative bleeding, acute renal failure and hepatic failure.

Median follow-up was 19.1 (range 1.4–102.2) months. Eight patients developed recurrent disease, of whom one died from recurrence 1 year after operation. Twenty-four patients were alive at the time of writing.

Discussion

In this study central bisectionectomy was used safely to preserve liver volume in patients with centrally located HCC, although biliary complications were common.

Central bisectionectomy, defined according to the Brisbane 2000 system¹², is also referred to as middle hepatic lobectomy, central hepatectomy and mesohepatectomy in the literature^{13–16}. This procedure was used in 6.2 per cent of patients in the present study, compared with a reported rate of approximately 2–10 per cent^{7–10, 13–16}. The procedure is difficult as it is based on two resectional planes with exposure of two cut surfaces, with the need to preserve the portal pedicles to the remaining hepatic segments. Knowledge of the vascular and ductal anatomy,

and also of the relationship between the tumour and these structures, is essential. Preoperative angiography, three-dimensional reconstruction of computed tomograms (*Fig. 3*) and intraoperative ultrasonography are used to assess tumour resectability and to determine the resection line. Any compromise of the portal pedicle may cause damage to the remaining liver, resulting in serious complications.

All patients in this study had Child–Pugh class A liver disease with relatively good liver function and the median ICG-R15 was 9.7 per cent. One patient had an ICG-R15 of 22.7 per cent, which was too high for major hepatic resection to be performed, and had decreased liver function owing to preoperative TACE and radiation therapy in addition to cirrhosis. The decision was still made to perform central bisectionectomy, however, because the remaining liver was sufficiently hypertrophied to overcome hepatic failure.

Sixteen of 27 patients received preoperative TACE/TACI or radiation therapy to eradicate subclinical disease and reduce the risk of recurrence, and to achieve tumour necrosis to reduce tumour spillage during operative manipulation. The efficacy of preoperative TACE for patients with resectable HCC is still controversial¹⁷. Some authors have concluded that TACE does not yield any benefit, but causes adverse effects in patients with resectable large HCC^{10,18,19}. These preoperative treatments tended to make the operation more difficult in the present study as they caused distortion of the vascular anatomy and rendered the liver friable. Moreover, severe adhesions were found, which resulted in bleeding during dissection.

Operative outcomes such as operating time and volume of transfused RBCs were similar to those in previous studies, but the estimated blood loss was greater owing to the effect of TACE or radiation on the liver^{7–10}. The specimen weight was less than reported previously^{7–10}. This was thought to be due to liver atrophy following preoperative TACE/TACI and/or radiotherapy as well as accompanying chronic hepatitis or cirrhosis.

The resection margin was free from tumour in all procedures, and more than 1 cm in 17 patients. Wide margins may be impossible to achieve when the tumour is too close to major hepatic vessels, and central bisectionectomy is more likely to be associated with a margin smaller than 1 cm, although this did not have a negative impact on survival in other series^{5,7,20,21}.

Morbidity and mortality rates in the present series were comparable with those in the literature^{22–24}. Biliary complications developed in five patients, a somewhat

higher rate than anticipated and more than published rates of 4.6–7.6 per cent^{25,26}.

Impairment of liver function after central bisectionectomy may be attributed to insufficient hepatic venous outflow as well as compromised portal and arterial flow. Because of the great variability of the right portal vein and artery, and the right and middle hepatic veins, in complex surgery such as central bisectionectomy the authors recommend the use of preoperative three-dimensional reconstruction of the liver, which provides information about the vascular anatomy. Intraoperative ultrasonography should be performed to determine the resection lines without injury to the hepatic veins and portal pedicles.

Cholangiography during preoperative magnetic resonance imaging to characterize the HCC can provide information about the bile duct anatomy, including variations and the relationship with the tumour, which may help prevent bile duct injury. Intraoperative cholangiography can also give precise information about the bile duct anatomy. It is important to preserve the bile ducts to the lateral and posterior sections. If these bile ducts are transected, extended hepatectomy or hepaticojejunostomy should be performed. In addition, after completion of the resection, any bile leak from the resectional planes can be detected by infusion of water and air simultaneously via the cystic duct.

A comparison between central bisectionectomy and trisectionectomy was not possible in the present study because trisectionectomy for HCC combined with cirrhosis is rarely performed at this institution. However, previous studies have shown that central bisectionectomy has comparable or superior results to extended hepatectomy with regard to operating time, intraoperative bleeding, complications, hospital stay and outcomes^{7–11}. In one study, 1-, 3- and 6-year disease-free survival rates were 53, 31 and 21 per cent after 15 central bisectionectomies for HCC, compared with 38, 19 and 9 per cent respectively in patients who underwent extended hepatectomy for HCC; there were no statistically significant differences¹⁰. The outcomes of the 27 patients in this study were similar to those of previous reports^{6–10}.

Although biliary complications were common and the oncological safety of this procedure has not been fully confirmed as this experience was limited, central bisectionectomy for centrally located HCC seems relatively safe in terms of preservation of liver volume.

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