JBUON 2016; 21(3): 645-649
ISSN: 1107-0625, online ISSN: 2241-6293 • www.jbuon.com
E-mail: editorial_office@jbuon.com

ORIGINAL ARTICLE

Application of a clamp method combined with bipolar coagulation for anatomical hepatectomy in the treatment of hepatic carcinoma

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Summary

Purpose: *This study investigated the effectiveness of a clamp method combined with bipolar coagulation for anatomical hepatectomy in the treatment of hepatocellular carcinoma (HCC).*

Methods: *In this prospective case-control study, three liver dissection methods were used: clamping combined with bipolar electric coagulation (group A), CUSA (Cavitron ultrasonic surgical aspirator) (group B), and ultrasonic knife (group C). Intraoperative blood loss, intraoperative blood transfusion volume, operation time, postoperative complications, aspartate aminotransferase (AST) levels, drainage volume and exhaust time, and length of postoperative hospital stay were compared among the three groups.*

Results: *Patients in group A had shorter operation times than those in group B ($p<0.05$), but more intraoperative blood loss. Patients in group A had shorter operations times than those in group B ($p<0.05$) and less intraoperative blood lost compared with group C. No statistically significant differences were found for postoperative exhaust time and length of postoperative hospital stay among groups ($p>0.05$).*

Conclusion: *The clamps method combined with bipolar electric coagulation for liver dissection requires no special equipment and has effects similar to CUSA and ultrasonic knife dissection. Therefore, this technique is worth promoting as a common liver dissection method for anatomical hepatectomy in the treatment of primary HCC.*

Key words: *anatomical hepatectomy, bipolar coagulation, clamp method*

Introduction

Primary HCC is one of most common malignant tumors worldwide. It is highly invasive and metastatic [1] and has a poor prognosis [2-4]. HCC is associated with liver cirrhosis, infection with hepatitis virus, aflatoxin use, environmental pollution and other factors. Due to its latent onset and rapid progression, HCC is the second-leading cause of tumor mortality in our country, and the death toll from HCC accounts for 45% of all liver cancer deaths worldwide. In recent years, as people focus more on their health and our diagnostic capabilities continue to improve, small HCC can be detected and treated earlier, and the number of cases has increased significantly. However, large HCC (>5 cm in diameter) still accounts for the majority of the cases. Surgical treatment remains the most effective method of treatment used for HCC. In our country, approximately 80% of the patients with HCC also have liver cirrhosis, and the influence of liver cirrhosis on the scope of liver resection, surgical risk, and postoperative complications is self-evident. In recent years, the anatomical hepatectomy [5] based on a hepatic segments has increased. The efficacy and safe-

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Received: 27/08/2015; Accepted: 30/10/2015

ty of HCC treatment are influenced by the type of radical hepatectomy method used [6-8], and a hepatic surgeon's goal is to improve the therapeutic efficacy of hepatectomy in the treatment of primary HCC to reduce the rate of complications and recurrence [9,10]. Anatomical hepatectomy is used worldwide along with minimally invasive modern surgical technologies that can achieve the best therapeutic effect and offer the highest degree of liver protection [11-14]. In this prospective study of anatomical hepatectomy in the treatment of primary HCC combined with liver cirrhosis, we compared the comprehensive efficacy of three kinds of liver dissection methods: the clamp method combined with bipolar electric coagulation, CUSA (Cavitron ultrasonic surgical aspirator), and ultrasound knife.

Methods

Patient data

From May 2013 to November 2014, male and female patients with HCC combined with liver cirrhosis treated at the Department of Hepatobiliary Surgery, Nanhua Hospital (affilated with Nanhua University) were selected using the following criteria: no jaundice or ascites found in preoperative examination; liver function evaluation indicated Child-Pugh grade A/B and indole cyanogen green retention value at 15 min (ICGR-15) <14%; and <2 tumor nodules seen in the same lobe of the liver (left liver lobe, the anterior and posterior right liver lobe) that could be completely resected, with no other intrahepatic metastatic nodules and no extrahepatic metastases. All patients underwent radiotherapy and chemotherapy of primary HCC combined with liver cirrhosis in the first 6 preoperative weeks. All study participants were volunteers who provided written informed consent. A total of 48 patients were enrolled in the study and were divided into three groups according to the type of liver dissection method used (Table 1). Group A (clamp method combined with bipolar electric coagulation) comprised 17 patients, group B (CUSA) 16 patients, and group C (ultrasonic knife) 15 patients. This study was conducted in accordance with the declaration of Helsinki and after approval from the Ethics Committee of Nanhua Hospital affiliated to Nanhua University. Written informed consent was obtained from all participants.

Surgical procedure

For anatomical hepatectomy (group A), we adopted an inverted T-shape incision or J-shape incision of the right upper quadrant. The Glisson sheath approach was used for the fist porta hepatis to perform separation, ligation, and dissection of the artery, portal vein, and bile ducts. Hepatic lobectomy was strictly performed according to the segmental anatomy proposed by Couinaud [15]. After partial occlusion of pathological hepatic inflow, the liver tissue of corresponding hepatic segment, region, hemihepatic region, or three hepatic regions was dissected along the anatomical hepatic transection plane. For liver dissection, a clamp method combined with bipolar electric coagulation was used for group A, CUSA was used for group B, and an ultrasonic knife was used for group C. For the vast majority of vascular structures exposed during liver dissection, small blood vessels were cauterized by electric coagulation, medium-sized blood vessels were clipped with a titanium clip or ligated by a silk thread, and the hepatic vein, portal vein, and bile duct were continuously sutured with Prolene thread. The liver transection liquid leakage test was performed via the bile duct; if liquid leakage found in the liver transections, it was sutured with Prolene thread. No special hemostatic material was in need for liver transection wounds, and a silica gel drainage tube and two Winslow hole drainage

Table 1. Comparison of patient clinical data among the three group

Item	*Group A (N=17)*	*Group B (N=16)*	*Group C (N=15)*	*p value*
Age, years (mean±SD)	45.9±11.1	47.3±11.2	46.8±10.8	0.803
GenderM/F (N)	10:7	10:6	10:5	0.907
HbsAg +/-(N)	15:2	13:3	13:2	0.156
Child-Pugh grading A/B (N)	15:2	15:1	14:1	0.636
ICG-15, mean±SD	4.7±2.6	4.8±2.5	4.6±2.2	0.468
AFP (ng/ml)	279.9	268.7	284.1	0.365
Tumor diameter (cm)	6.3±3.4	6.4±3.1	6.2±2.8	0.362
Tumor location (left : right : middle)	6:7:5	6:8:2	7:7:1	0.772
HBV-DNA (copy/ml)	4781.0	5337.0	4769.0	0.532
ALT (IU/L), mean±SD	48.6±20.6	50.5±18.9	49.1±19.7	0.163
AST (IU/L), mean±SD	50.8±33.2	51.8±30.6	54.7±30.2	0.177
Total bilirubin (umol/L), mean±SD	17.5±6.1	18.4±7.2	171±5.3	0.265
Direct bilirubin (umol/L), mean±SD	7.9±5.3	7.3±4.7	8.8±5.1	0.456

tubes should were routinely indwelled.

Observation index

Intraoperative blood loss, intraoperative blood transfusion volume, operation time, postoperative complications, aspartate aminotransferase (AST) levels, drainage volume, exhaust time, and length of postoperative hospital stay were compared among the three groups.

Statistics

SPSS13.0 software was used for all statistical analyses. Means+standard deviations were compared between groups using an independent sample t-test. The chi-square test and continuity correction were used to make comparisons among groups. P<0.05 was considered as statistically significant.

Results

Patients in the anatomical hepatectomy group had longer operation times but less intraoperative blood loss, a smaller postoperative drainage volume during hepatic transection, fewer postoperative complications, and lower postoperative ALT levels than those in the non-anatomical hepatectomy group (p<0.05). No significant difference in postoperative exhaust time or length of postoperative hospital stay was found between groups (p>0.05; Table 2).

Discussion

HCC is one of the most common malignant tumors. It is highly invasive and metastatic, prone to recurrence and intrahepatic and extrahepatic metastasis, and carries a poor prognosis [4]. Because of improvements in appropriate preoperative evaluation, together with a richer understanding of the liver anatomy and function, hepatectomy techniques, and postoperative treatment, we can now successfully manage large HCCs previously considered to be a contraindication for surgery while offering good postoperative recovery and a reduced rate of complications [5,6]. In 1888, the German surgeon Langenbuch successfully completed the world's first selective hepatectomy, which opened the curtain of modern liver surgery [13]. After more than 100 years of development, liver surgery has advanced to include the techniques of wedge hepatectomy, regular hepatectomy, irregular local hepatecomy, and anatomical hepatectomy [14]. With the turn of the century and the dawn of the information era, thanks to modern science and technology platforms, traditional extensive liver surgery has quietly shifted toward the use of more modern and precise surgical techniques [16]. Anatomical hepatectomy is a modern surgical technique that can obtain the best therapeutic effects and offer the best degree of liver protection with minimal trauma, and it has been widely used throughout the world [17].

The dissection methods of liver parenchyma are classified according to the routine common equipment and special equipment methods used. The most common types of special equipment are CUSA and the ultrasonic knife. The advantages of CUSA liver dissection is that it can very carefully dissect tiny blood vessels, while significantly reducing the amount of blood loss, intraoperative blood transfusion, compresses on the liver due to bleeding, and the possibility of intraoperative tumor spread during surgery, which makes it more

Table 2. Comparison of observation indexes among the three groups

Observation indexes	*Group A (N=17)*	*Group B (N=16)*	*Group C (N=15)*	*p value*
Operation time (min), mean±SD	248.7±44.3	301.8±48.8	224.7±40.5	0.001
Intraoperative blood loss (ml), mean±SD	398.4±58.4	284.6±63.1	563.6±60.7	0.022
Blood transfusion rate N (%)	2(11.76)	1 (6.25)	2 (13.33)	0.025
Cases of postoperative complications (%)	7	14	13	0.188
Bile leakage	0	5	3	----
Hemorrhage	0	1	1	----
Pleural effusion	6	9	10	----
Infection of incision	3	3	3	----
ALT of postoperative 3^{rd} day, mean±SD	60.6±14.8	84.8±15.5	88.8±16.3	0.020
Postoperative drainage volume of hepatic cross section, mean±SD	159.2±24.9	380.6±33.4	395.6±40.4	0.033
Postoperative exhaust time (hrs), mean±SD	57.8±10.5	57.3±12.9	57.3±11.6	0.623
Postoperative hospital stay (days), mean±SD	12.1±3.9	12.6±4.2	12.7±4.3	0.854

consistent with the tumor-free principle. The ultrasonic knife technique is not meticulous enough to treat micro-blood vessels, and its transection resolution is inherently defective; although it may look clear, there remains a possibility of postoperative re-bleeding.

In the clinical practice of hepatectomy, the clamp method of hepatectomy can dissect out tiny blood vessels to achieve the goal of reducing blood loss. Special equipment may not be needed, which makes it easy to implement this technique in a basic-level hospital. The clamp method is to compress the liver parenchyma with common vessel forceps and then perform ligation to dissect residual blood vessels. After blood flow is blocked during hepatectomy, the liver capsule will be opened using an electronic knife, and the vascular clamp tip should be kept perpendicular to the transection to clamp the liver tissue 1 cm tissue each time, which should be repeated along the dissection line. As long as the depth of each clamp is no more than 1 cm, hepatic parenchymal bleeding will not be excessive, and the surgeon can perform compression hemostasis with a finger in the transection. When the liver is deeply dissected, bleeding mostly comes from damaged hepatic vein branches. If there is large amount of venous bleeding, the vessel cannot be blindly clipped, as the slit could get larger and cause disastrous results. If the hepatic vein is to be reserved, the surrounding liver parenchyma should be fully dissected at the same time of compression hemostasis to facilitate easier hemostatic suturing. If the hepatic vein can be cut off, it can be sutured after complete dissection. In anatomical hepatectomy, the hepatic vein must be completely exposed during transection. Although bleeding may occur during hepatic vein exposure, this is usually easy to control. Not fully exposing the hepatic vein can cause more bleeding that will not be easy to control. After the hepatic vein is exposed, the exposed liver tissue can be quickly dissected along the hepatic vein. At this time, an appropriate technique is extremely important and should be performed with care. Vessel clamps should be used to remove external liver tissue of the hepatic vein along an inverse direction of hepatic vein blood flow. After removal of excess liver tissue, the small branches of the hepatic vein trunk are carefully pulled out with small rectangular bending pliers, clamped, and cut off [18]. Using a microclamp method of liver dissection, the hepatic Glisson vessel is certain to be encountered during removal of tissue [19-21]. As mishandling of the liver Glisson vessel could damage the hepatic vein and cause portal vein hepatic arterial branch hemorrhage, bile leakage, and other complications that are difficult to control, the liver parenchyma in front of the broken Glisson vessel should be fully exposed and taken as a starting point along the longitudinal axial of the Glisson sheath, isolated by 1 cm on each side, and small rectangular bending pliers are used to cross over the posterior wall of the Glisson sheath to perform the bilateral suture.

The clamp method combined with bipolar electric coagulation for liver dissection requires no special equipment and has an effect similar to CUSA and ultrasonic knife. Therefore, this technique is worth promoting as a common liver dissection method in anatomical hepatectomy in the treatment of primary HCC.

Conflict of interests

The authors declare no confict of interests.

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