Usefulness of Kelly clamp crushing technique during hepatic resection

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Abstract

Introduction. Recently, there are various kinds of parenchymal transection methods. The aim of this study is to evaluate the usefulness of the Kelly clamp crushing technique compared to ultrasonic dissector during hepatic resection. Materials and methods. Comparisons between 10 ultrasonic dissector group and 10 Kelly clamp crushing technique group were performed by using nine items (transaction time, right lobe volume, perioperative transfusion, total bilirubin (TB), aspartate aminotransferase (AST), alanine aminotransferase (ALT), hospital stay, postoperative morbidity, in-hospital mortality). Results. The mean transection time in the Kelly clamp crushing technique group was 27 ± 15.5 mins (range 15–60) and was 48 ± 7.1 mins (range 35–60) in the ultrasonic dissector group (p < 0.05), and no patients received transfusion in both groups. Conclusions. Since the Kelly clamp crushing technique shortens operative time and there is no significant difference in blood loss and in results of liver function tests compared to using the ultrasonic dissector, we propose that the Kelly clamp crushing technique should be considered as a standard method of liver resection.

Key Words: hepatocellular carcinoma, Kelly clamp crushing technique, ultrasonic dissector

Introduction

Hepatocellular carcinoma is one of the most common malignancies worldwide for which surgical resection is the basis of treatment. However, because the liver lies deep within the abdominal cavity of the right upper quadrant of the abdomen making it difficult for exposure and intrahepatic vessels and bile ducts are surrounded by soft and friable hepatic parenchyma, bleeding and bile leakage can occur following hepatic resection. In fact, early hepatic resections were associated with high mortality and morbidity due to postoperative bleeding and bile leakage. It was not until the 1950s when successful hepatic resections were performed. In 1952, Lortet-Jacob JL and Robert HG reported that intraoperative bleeding during hepatic lobectomy could be prevented by first isolating and ligating perihilar vessels [1] and in 1953, by using this method, Quattlebaum JK successfully performed three cases of right lobectomy and in doing so he was the first to use the knife handle for the transection of hepatic parenchyma and to ligate vessels at the cut surface of the liver [2]. In 1958, Lin introduced the finger fracture technique in which the thumb and index finger were used to transect the hepatic parenchyma [3]. The finger fracture technique, in which after inflow occlusion the hepatic parenchymal transection was done by crushing the parenchyma between the thumb and another finger isolating vessels and bile ducts which were ligated and divided, was subsequently improved through the use of a surgical instrument such as the Kelly clamp. Recent devices developed for hepatic resection include the ultrasonic dissector (CUSA, Tyco Healthcare, Mansfield, MA) using ultrasonic energy, the Hydrojet (Hydro-Jet, Erbe, Tubingen) which utilizes pressurized jet of water, and the dissecting sealer (TissueLink, Dover, NH) which uses radiofrequency energy [4]. Since 1989 at the Asan medical center, Seoul, Korea, we have performed 9229 cases of hepatic resections with almost all cases performed using the Kelly crushing technique excluding donor hepatectomy cases. Here we report the usefulness of the Kelly clamp crushing technique compared to ultrasonic dissector during hepatic resection.
Materials and methods

Of the patients who underwent right hepatic lobectomy from October 1st to December 31st in 2007, 10 patients who were diagnosed with five right intrahepatic duct stones, four peripheral cholangiocellular carcinomas, and one right hemangioma and 10 patients who were diagnosed with five peripheral cholangiocellular carcinomas, four right intrahepatic duct stones, and one right hepatic cyst were prospectively analyzed (Table I). All 20 patients had normal liver tissue without findings of hepatitis, cholestasis, and fibrosis. The ultrasonic dissector was used for parenchymal transection in the former group (Ultrasonic dissector group, U group) and the Kelly clamp crushing technique in the latter group (Kelly clamp crushing technique group, K group). Right lobectomy was performed in both groups and by using preoperative volumetric CT, 20 patients who had similar right lobe volumes except pathologic lesions were chosen for the study. The Pringle’s maneuver (hepatic inflow occlusion, with intermittent 15-minute occlusions followed by 5-minute perfusions) was applied in inflow occlusion, with intermittent 15-minute occlusions followed by 5-minute perfusions) was applied and central venous pressure (CVP) was maintained below 5 mmHg during surgery in both groups.

The abdomen was explored using an inverted T-shaped skin incision and the liver was drawn with the round ligament for hepatectomy. The Glissonian approach was used primarily. Using electrocautery, the Glisson capsule covering the confluent portion of the Glisson sheath was cut in the lower portion of the quadrate lobe in the transverse direction. The hilar plate was dissected from the hepatic parenchyma using the suction tip. After dissection 1 cm on the right and left ends, the deeply dorsal portion was dissected. Bleeding from the hepatic parenchyma could be controlled by compression. The Mixter clamp was inserted from the cephalic portion to the caudal portion and the hepatoduodenal ligament was drawn to the left. The end of the Mixter clamp, located between the caudate lobe and the hilar plate, could then be seen through the Winslow foramen. The Glisson sheath was split using the suction tip or electrocautery. If there was resistance at the end of the Mixter clamp, it was important not to forcefully insert it. We therefore tried to find an area through which it could be passed so as not to damage the branch of the caudate lobe. After dissection, an umbilical tape was encircled for marking.

In a separate procedure applied to the hilar vascular structures, we first confirmed the location of the bile duct and dissected the connective tissue of the bile duct right dorsal portion toward the hilum. This exposed the neural plexus around the right hepatic artery and a vessel loop was placed in the right hepatic artery. During dissection of the neural plexus and connective tissue of the dorsal portion of the right hepatic artery, we drew the extrahepatic bile duct and right hepatic artery to the left, exposing the right-sided wall of the portal vein which was encircled with a vessel loop [5].

The right Glisson sheath or the right hepatic artery with the right portal vein marked by umbilical tape or vessel loops respectively were clamped to produce a demarcation line on the liver surface along which and to the right of the middle hepatic vein transection was performed (Figure 1). When using the Kelly clamp to perform right lobectomy, especially while exposing the right side of the middle hepatic vein, care was taken not to injure or tear the small branches (tributaries) draining into the main trunk that could cause bleeding (Figure 2). The statistical analyses between the two groups were compared using the Mann-Whitney U test for continuous data which were performed with the SPSS12.0 (SPSS Inc., Chicago, IL).

Results

Both groups comprised of 10 persons and the male to female ratio was the same (1:1). Also the mean age in the K group was 58.5 years while in the

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Table I. Characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Ultrasonic dissection (n=10)</th>
<th>Clamp crushing (n=10)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>55±9.2(45-72)</td>
<td>58.5±9.0(49-75)</td>
<td>NS</td>
</tr>
<tr>
<td>Gender(M/F)</td>
<td>5/5</td>
<td>5/5</td>
<td>NS</td>
</tr>
<tr>
<td>Transection time, mins</td>
<td>48±7.1(35-60)</td>
<td>27±15.5(15-60)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Right lobe volume, ml</td>
<td>655±42.4 (590-710)</td>
<td>657±46.2 (590-720)</td>
<td>NS</td>
</tr>
<tr>
<td>Perioperative transfusion</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Indication</td>
<td>Six RIHDS, three PCCC, one Hemangioma</td>
<td>Five PCCC, four RIHDS, one Hepatic cyst</td>
<td></td>
</tr>
<tr>
<td>Laboratory data on day 3</td>
<td>Total bilirubin,mg/dL</td>
<td>1.43±0.7(0.6-2.9)</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>AST, IU/L</td>
<td>83±15.5(61-106)</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>ALT, IU/L</td>
<td>86±22.8 (58-128)</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Hospital stay, days</td>
<td>18.5±6.0 (12-29)</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Postoperative morbidity</td>
<td>1</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>In-hospital mortality</td>
<td>0</td>
<td>NS</td>
</tr>
</tbody>
</table>

AST: aspartate aminotransferase; ALT: alanine aminotransferase; RIHDS: right intrahepatic duct stone; PCCC: peripheral cholangiocellular carcinoma.
U group it was 55 years. The mean transection time in the K group was 27 ± 15.5 mins (range 15–60) and was 48 ± 7.1 mins (range 35–60) in the U group, and no patients received transfusion in both groups. The mean aspartate aminotransferase (AST) on the third postoperative day in the K group was 83.2 ± 32.8 IU/L (range 54–167) and was 83 ± 15.5 IU/L (range 61–106) in the U group, also the mean alanine aminotransferase (ALT) in the K group was 100.7 ± 47.8 IU/L (range 28–194) and was 86 ± 22.8 IU/L (range 58–128) in the U group. The mean total bilirubin (TB) in the K group was 1.63 ± 0.9 mg/dl (range 0.4–3.4) and was 1.43 ± 0.7 mg/dl (range 0.6–2.9) in the U group. The mean postoperative hospital stay in the K group was 19.4 ± 7.3 days (range 11–32) and 18.5 ± 6.0 days (range 12–29) in the U group. Regarding postoperative complications, there were two cases of wound infection in the K group and one case of pleural effusion in the U group. There was no postoperative mortality in either group (Table I).

**Discussion**

The most important factor of a successful hepatic resection is the surgeon's accurate knowledge of anatomic structures. Without an accurate knowledge of liver anatomy, hepatic resection can be very dangerous regardless of surgical methods. The mean transection time was 27 ± 15.5 mins in the K group which was shorter than the U group (48 ± 7.1 mins) statistically and since all patients had similar volumes of liver resected, transection speed (transection area divided by transection time) was not calculated. Although Lesurtel et al. [4] reported that the clamp crushing technique during hepatic resection was significantly faster than using CUSA, Hydrojet or dissecting sealer, Takayama et al. [6] reported no differences when comparing the ultrasonic dissector group and the clamp crushing group. In this study, all procedures were performed by one experienced hepatobiliary surgeon and the resection time was 1.7 times as fast when the Kelly clamp crushing technique was applied. When crushing the hepatic parenchyma along a demarcation line, formed after ligating of right Glissonian sheath or right hepatic artery with right portal vein, peripheral branches (tributaries) of the middle hepatic vein can be seen and it is important to carefully expose the middle hepatic vein while crushing the hepatic parenchyma to prevent bleeding. Allen and Jarnagin reported that in the setting of hepatic cirrhosis, the crushing technique for parenchymal transection was probably not ideal, since the liver tissue tended to fracture and small vascular or biliary structures were easily torn [7]. Because this study only included patients who underwent hepatic resection having normal parenchyma and without cirrhosis there were no specific problems in both groups. However from our experience, using the Kelly clamp technique during hepatic resection of cirrhotic liver resulted in less operative time and helped obtaining a more clear operative field. There was no perioperative transfusion in both groups. Since the normal saline (used for irrigation) was mixed with blood leading to inaccurate measure of blood loss during surgery, perioperative transfusion was investigated in this study. Lesurtel et al. [4] reported that the clamp crushing group had the lowest blood loss and was associated with the lowest need for transfusion. Takayama et al. [6] also reported less blood loss in the clamp crushing group. Although the Pringle’s maneuver, in which inflow occlusion is performed, is used to prevent intraoperative bleeding, the use of low CVP anesthesia also minimizes blood loss and helps in creating a clear operative field. We also maintain the CVP below 5 mmHg during hepatic resection so long as there is no problem in blood pressure. Although the mean AST, ALT and TB levels on the third postoperative day were slightly higher in the clamp crushing group, there was no statistical significance. Lesurtel et al. [4] reported, although not statistically

**Figure 1.** Kelly clamp crushing technique along the demarcation line.

**Figure 2.** Careful exposing of the middle hepatic vein.
significant, slightly higher mean peak AST, ALT and TB levels in the clamp crushing group where inflow occlusion was routinely performed. However, Takayama et al. [6] reported, after applying the Pringle’s maneuver in all cases, higher mean postoperative third day AST level in the ultrasonic dissector group and higher TB level in the clamp crushing group although these results were not statistically significant. In this study, the mean postoperative hospital stay was 18.5 ± 6.0 days in the U group which was similar with the K group (19.4 ± 7.3 days) statistically. Of the three patients in the K group who underwent surgery for right intrahepatic duct stone recurrence after cholecystectomy was done at another hospital, two patients had wound infections resulting in no surgical intervention. There was one pleural effusion which was managed conservatively in the U group. In other reports, there was no significant difference among groups regarding mean hospital stay [4,6]. Although not compared in this study, the Kelly clamping technique may be superior than other methods in terms of cost-saving potential since it is least expensive and no additional cost is charged for equipment. From our experience, we believe the ultrasonic dissector is useful in donor hepatectomy and in hilar cholangiocarcinoma resection procedures when trying to obtain a negative resection margin of the hepatic duct while resecting the perihilar parenchyma and also during partial hepatectomy when hepatic resection using the Kelly clamp is not feasible due to tumor location.

In conclusion, since the Kelly clamp crushing technique shortens operative time and there is no significant difference in blood loss and in results of liver function tests compared to using the ultrasonic dissector, we propose that the Kelly clamp crushing technique should be considered as a standard method of liver resection.

References