Clinical Science

Is less than 5 mm as the narrowest surgical margin width in central resections of hepatocellular carcinoma justified?

Kuo-Shyang Jeng, M.D. a, Wen-Juei Jeng, M.D. c, I-Shyan Sheen, M.D. c,*, Chien-Chu Lin, M.D. b, Cheng-Kuan Lin, M.D. b

aDepartment of Surgery and bDivision of Hepatogastroenterology, Far Eastern Memorial Hospital, Taipei, Taiwan; cDepartment of Hepatogastroenterology, Chang-Gung Memorial Hospital, Linkou Medical Center, Chang-Gung University, Gueishan, Taiwan

KEYWORDS:
Hepatocellular carcinoma; Centrally located; Surgical margin; Recurrence; Survival

Abstract

BACKGROUND: The aim of this study was to investigate whether <5 mm as the narrowest margin width may negatively affect a patient’s outcome.

METHODS: A prospective cohort study was designed. From January 1994 to July 2010, 196 patients with hepatocellular carcinoma undergoing central hepatectomy were divided into group A (n = 172; narrowest margin, ≥5 to <10 mm) and group B (n = 24; narrowest margin, <5 mm), and outcomes were compared.

RESULTS: Significant differences between groups A and B included tumor size (P = .057), infiltrative border (P = .021), satellite lesions (P = .021), and major perivascular abutment (P = .028). Marginal recurrence occurred in 50% of the patients in group B but none of those in group A (P < .001). There were no significant differences between the groups regarding recurrence, recurrence-related death, disease-free survival, and speed of recurrence, but a borderline significant difference was found regarding the cumulative probability of overall survival. After excluding early recurrence (within 1 year), group B had significantly lower cumulative probabilities of disease-free survival (P = .020) and overall survival (P < .001).

CONCLUSIONS: In central resections, narrowest margin width of <5 mm does not negatively affect recurrence and overall survival. However, it increases perimargin recurrence and inversely affects late outcomes.

© 2013 Elsevier Inc. All rights reserved.

The impact of resection margin for hepatocellular carcinoma (HCC) on surgical outcomes has been widely discussed for years. 1–17 The practice of using a ≥10-mm margin width is common, 1–4 but it remains controversial. 6–17 When an HCC is large (>3 cm) and centrally located (segments IV, V, and/or VIII), it is usually close to the hilar main portal trunks or hepatic veins. Maintaining a wide margin width often becomes a great challenge during central hepatectomy. The narrowest margin width from the final pathology report is sometimes less than what was expected during surgery. At present, there is still no consensus on the appropriate margin width for a centrally located HCC. We hypothesized that a margin resection of <5 mm may negatively affect surgical outcomes. The aim

The authors declare no conflicts of interest.

* Corresponding author. Tel.: +886-3-3281200 ext. 8107; fax: +886-3-327223.
E-mail address: kevin.ksjeng@gmail.com

Manuscript received December 31, 2011; revised manuscript June 5, 2012

0002-9610/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.amjsurg.2012.06.010
of this study was to compare outcomes between patients with \( \geq 5 \) to \( \leq 10 \) mm and those with \(< 5 \) mm as their narrowest margin width.

**Methods**

**Eligibility and exclusion criteria**

From a prospectively collected database with a retrospective analysis between January 1994 and July 2010, patients with centrally located HCCs (Couinaud segments IV, V, and VIII; involvement of either 2 or 3 segments) undergoing central resections with a narrowest surgical margin width of \( \leq 10 \) mm were included in this study. Thirty-six patients were excluded from our prospective database. The exclusion criteria were surgical margin width of 0 mm (exposure of the tumor surface) \((n = 8)\), positive margin (histologically confirmed) \((n = 2)\), multicentric HCCs \((n = 2)\), HCC size <3 cm or minor hepatectomy \((\leq 1 \) segmentectomy) \((n = 4)\), history of preoperative neoadjuvant therapies (eg, percutaneous ethanol injection, hepatic transcatheter arterial chemoembolization, radiofrequency ablation, or systemic chemotherapy) \((n = 13)\), previous hepatectomy \((n = 4)\), and no regular postoperative follow-up \((n = 3)\).

**Patients and operative procedures**

One hundred ninety-six consecutive patients (145 men, 51 women, mean age, 57.5 ± 14.2 years; range, 16–80 years) were enrolled.

After laparotomy, the tumor location and its relation to the Glisson sheath and hepatic veins were meticulously examined using intraoperative ultrasonography (IOUS), using an Aloka SDD 550 (Aloka Ltd, Tokyo, Japan) equipped with the standard 3-MHz to 6-MHz convex probe and with the 7.5-MHz to 10-MHz microconvex probe. Transection of liver parenchyma tissue was performed using a Cavitron Ultrasonic Surgical Aspirator (CUSA) and bipolar tissue coagulator. The intended resection line that was initially designed 10 mm away from the tumor was changed to prevent compromise of the main vessel.

Our operative technique was consistent throughout the study period.

**Definition of the subdivisions**

**Infiltrative types versus expansive types.** On the basis of preoperative imaging studies (ie, ultrasound, computed tomography, or magnetic resonance imaging) and/or IOUS, the gross types of HCCs in the patients were classified into either infiltrative or expansive types according to Sawabe’s classification of growth patterns. Complete encapsulated or sharply demarcated tumors were defined as expansive \((n = 116)\), while tumors without complete encapsulation or with irregular or indistinct borders were all defined as infiltrative \((n = 80)\).

**Major perivascular abutment.** After exploration was done before hepatectomy, the shortest distance between the HCC and the nearby detectable vessel (including adherence) was measured using IOUS. If it was \(< 3 \) mm, the HCCs were categorized as being too close to a major vessel. Among all patients, 106 belonged in this category, and 90 patients did not.

**Definition of the narrowest margin width.** The resection margin was defined as the shortest distance from the edge of the tumor to the line of resection. Macroscopic margins were usually approximated by the surgeon intraoperatively. Microscopic margin was determined by the pathologists. An involved margin was defined as the presence of tumor cells at the line of resection. In this study, the margin width we used was measured by the pathologist. The sectioning of the operative specimen was consistent. Prior standards for margin measurement had been established as follows: (1) The width of resection margin was the distance from the tumor edge to the transection plane of the liver parenchyma; (2) For multinodular lesions or satellite lesions, any neoplastic nodule closest to the margin was taken as the reference; and (3) Among the measurements of margin width from each dimension, the smallest value was defined as the narrowest width. The underestimate of the risk for any area HCC was thus minimized.

On the basis of the narrowest margin width of the pathology report, we categorized patients into group A \((\geq 5 \) to \( \leq 10 \) mm; \(n = 172\)) and group B \((< 5 \) mm; \(n = 24\)): 127 men, 45 women; mean age, 58.1 ± 14.0 years; mean margin width, 7.5 ± 1.5 mm) and group B \((< 5 \) mm; \(n = 24\)): 18 men, 6 women; mean age, 52.7 ± 15.0 years; mean margin width, 2.5 ± 1.5 mm). Their demographic characteristics are shown in Table 1.

**Follow-up**

After discharge, patients were regularly followed up at the outpatient clinic and received periodic assessment, including abdominal ultrasonography (every 2–3 months during the 1st 5 years, then every 4–6 months thereafter), serum \( \alpha \)-fetoprotein and liver biochemistry (every 2 months during the 1st 2 years, every 4 months during the following 3 years, and every 6 months thereafter), and triphase abdominal computed tomographic scans (every 6 months during the 1st 5 years, then annually), to detect tumor recurrence. Magnetic resonance imaging or hepatic arteriography was done selectively if there was suspicion of recurrence on ultrasonography or computed tomography or elevated serum \( \alpha \)-fetoprotein. Chest x-rays and bone scans were examined (every 6 months during the 1st 3 years then annually) to detect metastases.

The nonoperative treatments for recurrence include hepatic arterial chemoembolization, radiofrequency ablation, or percutaneous ethanol injection. The selection of
treatment options depends on the intrahepatic location of recurrence, the tumor size, and the reserve of the liver remnant. They did not vary between groups A and B. For example, liver function and the feasibility of high selectivity of angiographic catheterization are important concerns for transcatheter arterial chemoembolization. Tumors >4 cm are usually not good candidates for radiofrequency ablation.

Marginal recurrence

From imaging studies, when the distance between the detected recurrence lesion and the surgical margin (usually some clips retained) was <2 cm, marginal recurrence was defined.

Outcome measures

Irrespective of location, detection of tumor on any imaging study was defined as recurrence. In this study, those who developed recurrence within the 1st postoperative year were defined as having early recurrence, while those with recurrence after 1 year were defined as having late recurrence.

Survival included disease-free survival and overall survival. Disease-free survival was defined as no recurrence detected after resection through the end of the study. Recurrence-related death was defined when the patient died of HCC before the end of the study.

Statistical analysis

Parameters for studies included preoperative clinical variables, pathologic findings, and perioperative characteristics. Comparisons between 2 groups were performed using chi-square tests (or Fisher’s exact tests) for continuous variables. Cumulative survival and recurrence rates were calculated using the Kaplan-Meier method and were compared according to log-rank testing. The Cox stepwise regression model was used for the multivariate analysis of associated factors. All statistical analyses were performed using SPSS
version 10.0 (SPSS, Inc, Chicago, IL). Statistical significance was defined as \( P < .05 \).

**Results**

No surgical mortality occurred in either group. Surgical morbidity occurred in 26 patients (22 in group A and 4 in group B); all events were minor and subsided after conservative treatment.

Table 1 shows similar clinicopathologic demographic characteristics in the 2 groups, but group B had significantly larger tumor size (6.9 vs 5.2 cm, \( P = .057 \)), more infiltrative lesions (\( P = .021 \)), more satellite lesions (\( P = .021 \)), and more lesions too close to major vessels (\( P = .028 \)).

**Outcomes measures**

During the follow-up period (mean, 45.82 ± 51.93 months), recurrence of HCC developed in 116 patients (59.2%), including 100 (58.1%) in group A and 16 (66.7%) in group B. The difference was not statistically significant (\( P = .426; \) Table 2). Early recurrence (within 1 year) developed in 80 patients (69.0%), and late recurrence developed in 36 patients (31.0%). Early recurrence occurred in 40.7% of recurrent cases in group A (70 of 172) and in 41.7% of recurrent cases in group B (10 of 24), without a significant difference between them (\( P = .189; \) Table 3).

Recurrence-related death occurred in 86 patients in group A and 13 in group B. There was no statistically significant difference in recurrence-related death (\( P = .702 \)) between groups A and B (Table 2). Early recurrence-related death (<1 year) occurred in 61 patients in group A and 7 patients in group B. The difference was without statistical significance (\( P = .084; \) Table 2).

**Impact of margin width on pattern and sites of recurrence**

Intrahepatic recurrence was the most common pattern of recurrence, irrespective of margin width and time to recurrence. However, compared with group A, the recurrence site of group B patients was more commonly in the marginal areas (\( P < .001 \)), regardless of time to recurrence (Table 3). The marginal recurrence was not found in group A but was found in 50% of patients in group B. The difference was statistically significant. The opportunity for marginal recurrence was similar among group B patients after stratification from 1-mm to 4-mm width intervals (Table 4).

On Kaplan-Meier analysis and log-rank testing, there were no statistically significant differences of the cumulative probability of disease-free survival (\( P = .066 \)) between groups A and B (Fig. 1A). However, there was borderline significance (\( P = .055 \)) regarding the cumulative probability of overall survival (Fig. 2A). After excluding those with early recurrence (<1 year), group B had a significantly lower cumulative probability of both disease-free survival (\( P = .020; \) Fig. 1B) and overall survival (\( P < .001; \) Fig. 2B).

**Factors associated with surgical outcomes**

On multivariate analyses, the significant factors affecting recurrence included high serum \( \alpha \)-fetoprotein (>200 ng/L) (\( P = .006 \)), satellite lesions (\( P = .003 \)), infiltrative type (\( P = .003 \)), and vascular permeation (\( P < .001 \)). The significant factors affecting disease-free survival included indocyanine green retention at 15 minutes (\( P < .001 \)) and vascular permeation (\( P < .001 \)), while those affecting overall survival included Child-Pugh grade (\( P = .001 \)), aspartate aminotransferase level (\( P = .044 \)), and vascular permeation (\( P < .001 \)) (Table 5).

**Comments**

For patients with liver cirrhosis, to preserve more functional liver parenchyma, mesohepatectomy or other central resection is preferred to extended hepatectomy.\(^8,19–22\) During such resections, preventing postoperative hepatic failure and obtaining a wider margin for surgical curability remain complex dilemmas for surgeons.

Achieving a 10-mm margin width remains the goal of resection. The issue of narrow or positive margins is more frequent because of the central location of HCC.
margins of each dimension of parenchymal dissection of hepatectomy must be concerned. Positive surgical margins had a significant effect on survival. We found that in patients with negative margins, there were differences in outcomes according to whether the margin was $\geq 5$ or $<5$ mm. This is the reason we limited the study to central HCC. Factors contributing to the failure to achieve margin width $\geq 5$ mm consist of large tumor size, an infiltrative border, the presence of satellite lesions, and major perivascular abutment (Table 1). These factors may be associated with one another. A large HCC is usually associated with vascular invasion, satellite lesions, and tumor hemorrhage. Different from the expansive type, infiltrative HCC may invade surrounding parenchyma or vessels and usually coexists with satellite lesions. Tralhãois et al found that both infiltrative tumor type and narrow margin width affected overall survival. Practically, some factors of surgical technique may affect resection margins. Our data (Table 1) show that HCCs in group B patients were large, had more frequent satellitosis, major perivascular abutment, infiltrating morphology type, and a greater though not statistically significant increase in vascular invasion. Clearly, HCC was heterogeneous. These suggest that HCC pathology might guide our margin size. We agree with Scudamore et al that it is difficult to always maintain a margin width straightforwardly during parenchyma transection. The exposed vessels and ducts and the incidental intraoperative findings may distort the originally planned transection line. The discrepancies between the resection plan designed on the basis of IOUS findings and the final true margin

| Table 3 | Impact of margin width on time to recurrence |
| --- | --- | --- |
| Margin width | Time to recurrence |
| | $\leq 1$ y | $>1$ y |
| Group A (n = 172) Recurrence |  |
| Yes (n = 100) | 70 (40.7%) | 30 (31.9%) |
| No (n = 72) | 8 | 64 |
| Recurrence-related death |  |
| Yes (n = 86) | 61 (35.5%) | 25 (26.6%) |
| No (n = 86) | 17 | 69 |
| Group B (n = 24) Recurrence |  |
| Yes (n = 16) | 10 (41.7%) | 6 (54.5%) |
| No (n = 8) | 3 | 5 |
| Recurrence-related death |  |
| Yes (n = 13) | 7 (53.8%) | 6 (54.5%) |
| No (n = 11) | 6 | 5 |

$^*P = .426.$  
$^1P = .702.$  
$^1P = .189.$  
$^1P = .135.$  
$^1P = .084.$  
$^*P = .079.$

| Table 4 | Correlation between stratification of margin width and marginal recurrence |
| --- | --- | --- |
| Margin width | Number of patients | Number with marginal recurrence $^*$ | $P$ |
| $\geq 5$ mm | 172 | 0 (0%) | .001 |
| $<5$ mm | 24 | 12 (50%) | .267 |
| 1 mm | 5 | 2 (40%) |  |
| 2 mm | 14 | 9 (64.3%) |  |
| 3 mm | 3 | 1 (33.3%) |  |
| 4 mm | 2 | 0 (0%) |  |

$^*Distance$ between the recurrence and the surgical margin $<2$ cm.

Figure 1  (A) Kaplan-Meier curves estimate of the comparison of cumulative probability of disease-free survival between group A patients and group B patients. There was no significant difference on the log-rank test ($P = .066$). (B) After excluding those with early recurrence, the difference became significant ($P = .020$) between groups A and B.
width are due to the presence of the cirrhotic nodularity, the infiltrative tumor border, and the incidental finding of tiny satellite lesions.

In addition, the transection effect of the parenchyma, resulting from the intraoperative use of CUSA, bipolar electrocautery, and vessel suturing, may also affect margin width. Fan et al\textsuperscript{26} found that the margin of using an ultrasonic dissector is wider than that of using crushing and finger fracture techniques. Another important factor affecting margin width is the CUSA technique itself. This is because the use of ultrasonic dissectors aspirates a portion of liver parenchyma between the tumor and normal liver. In addition, the friability of the liver makes the assessment of margins difficult. CUSA uses a vibrating metal tip to fragment issue and then aspirates the debris through the hollow center of the tip to increase safety, given that CUSA can destroy approximately 1 mm to 1 cm along the transection plane because of transection debridement. An immeasurable volume of the liver may also be evaporated by CUSA. An accurate assessment of the true margin may thus be affected. It seems that this effect may alter margin width and status. However, the degree of the machine’s use was the same for each resection. All resections were performed by the same operator and team. The difference in CUSA control was thus minimized.

Another cause is that a discrepancy exists between the width measured from unfixed fresh specimens by the surgeon and the width measured from postoperative fixed specimens by the pathologist. Some shrinkage occurs after fixation for pathology. In this study, we used the pathology report as our reference, and discrepancy of measurement of margin width between the surgeon and pathologist was thus avoided.

From an oncologic point of view, the definition of so-called curative resection remains somewhat unclear. Conflicting conclusions among different surgeons result from differences in patient demographics, tumor location, tumor size, cirrhotic status, resection feasibility, and follow-up periods.\textsuperscript{6–17} Maeda et al\textsuperscript{27} considered ≥1 cm to be necessary because the area surrounding the tumor location harbors undetected lesions resulting from the stepwise progression of HCC. Yoshida et al found 1-cm width to be inadequate if tumor size is >4 cm.\textsuperscript{17} Lai et al\textsuperscript{3} suggested that 5-mm width is necessary for multinodular HCC. From the outcome point of view, Chau et al\textsuperscript{7} and Abdel-Wahab et al\textsuperscript{9} found that the cut margin significantly affected recurrence and survival. Hu et al\textsuperscript{8} found that margin width <1 cm affected overall survival in central hepatectomy. In contrast, Wu et al\textsuperscript{28} suggested that it is not necessary to consider margin width for central HCC in the cirrhotic liver. Furthermore, Matsui et al\textsuperscript{15} suggested that no-margin resection for HCC did not negatively affect the rate of recurrence or overall survival. Nanashima et al\textsuperscript{29} emphasized that a surgical margin >0 mm (not exposed) may provide similar tumor-free and overall survival as conventional anatomic liver resection. Ochiai et al\textsuperscript{13} indicated that surgical margin does not affect survival or recurrence unless the tumor is exposed on the raw liver surface. However, no perimargin recurrence was found in our patients with ≥5-mm margin width. This means that a 5-mm width seems adequate in eradicating microscopically marginally residual cancer in our study. When the margin width is <5 mm, the risk for marginal recurrence is as high as 50%, and the risk seems similar varying from 1 to 4 mm (Table 4).

The differences in recurrence rate and disease-free survival and overall survival rates between groups A and B had no statistical significance. However, after excluding those with recurrence within 1 year, group A patients had a significantly better cumulative probability of both disease-free survival and overall survival (Figs. 1B and 2B).

We attributed this discrepancy to the possibility that the development of early recurrence arises mainly from the

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{(A) Kaplan-Meier curve estimate of the comparison of cumulative probability of overall survival between group A patients and group B patients. There was no significant difference on the log-rank test ($P = 0.055$). (B) After excluding those with early recurrence, the difference became significant ($P < 0.001$) between groups A and B.}
\end{figure}
vascular route. To develop a detectable recurrence result from marginal microscopic residual cancer may require a period of about 1 year. From this point, vascular permeation is the main significant factor contributing to early recurrence. This corresponds with our data that vascular permeation is an important prognostic factor in tumor recurrence, tumor-free survival, and overall survival (Table 6). Poon et al16 also found that most intrahepatic recurrence arose from venous dissemination, and a wide resection margin could not prevent it. Lai et al5 suggested that no distance could ensure a complete cancer clearance if there is microsatellites or histologic venous permeation.

Postresection follow-up should be intensively administered for those with margin widths <5 mm, because of the high risk for marginal recurrence. The nonoperative treatments for recurrence include hepatic arterial chemoembolization, radiofrequency ablation, or percutaneous ethanol injection. The selection of treatment options depends on the intrahepatic location of recurrence, the tumor size, and the reserve of the liver remnant. They did not vary between groups A and B. For example, liver function and the feasibility of high selectivity of angiographic catheterization are important concerns for transcatheter arterial chemoembolization. Tumors >4 cm are usually not good candidates for radiofrequency ablation.

The limitations of this study were that the tumor hemodynamics and the viral load in the liver were not included. Sakon et al30 proposed that blood drainage of a tumor affects resection results. Sasaki et al,31 Hung et al,32 and Kondo et al33 suggested viral loading influences outcomes. These factors will be taken into consideration in future studies.

How margin width can be more accurately determined during resection remains a question. Zeng et al34 recommended that the enlarged enhancement area of HCC on preoperative contrast-enhanced ultrasonography may identify the actual tumor size and invasion range. Intraoperative contrast-enhanced ultrasonography using Kupffer imaging may be a recommendable method to precisely discover minute tumors or small intravascular tumor thrombi. Yang et al35 found that methylation-based molecular surgical analyses offered a tool to detect preneoplastic lesions.

### Table 5  Univariate analysis of variables associated with recurrence, recurrence-free survival, and overall survival

<table>
<thead>
<tr>
<th>Variable</th>
<th>Recurrence (P)</th>
<th>Recurrence-free survival (P)</th>
<th>Overall survival (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis*</td>
<td>.0260</td>
<td>.0210</td>
<td>.0040</td>
</tr>
<tr>
<td>Child-Pugh grade</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>ICGR15 &lt; 10%</td>
<td>.0010</td>
<td>.0000</td>
<td>.0030</td>
</tr>
<tr>
<td>AST</td>
<td>.0060</td>
<td>.9400</td>
<td>.0000</td>
</tr>
<tr>
<td>AFP &gt; 200 ng/L</td>
<td>.0000</td>
<td>.0350</td>
<td>.1530</td>
</tr>
<tr>
<td>Margin width &lt; 5 mm</td>
<td>.4260</td>
<td>NS</td>
<td>.7020</td>
</tr>
<tr>
<td>Complete encapsulation</td>
<td>.0000</td>
<td>.1890</td>
<td>.0020</td>
</tr>
<tr>
<td>Satellite lesions</td>
<td>.0000</td>
<td>.7730</td>
<td>.0000</td>
</tr>
<tr>
<td>Major perivascular abutment</td>
<td>.0000</td>
<td>.0780</td>
<td>.0000</td>
</tr>
<tr>
<td>Infiltrative type</td>
<td>.0000</td>
<td>.7730</td>
<td>.0000</td>
</tr>
<tr>
<td>Vascular permeation</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
</tr>
</tbody>
</table>

AFP = a-fetoprotein; AST = aspartate aminotransferase; ICGR15 = indocyanine green retention at 15 minutes.

*Hepatitis included hepatitis B (hepatitis B surface antigen), C (antibody to hepatitis C virus), and no infection of hepatitis B or hepatitis C.

### Table 6  Multivariate analysis of significant variables associated with recurrence, recurrence-free survival, and overall survival

<table>
<thead>
<tr>
<th>Variable</th>
<th>Recurrence</th>
<th>Recurrence-free survival</th>
<th>Overall survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>95% CI</td>
<td>P</td>
</tr>
<tr>
<td>Hepatitis*</td>
<td>.145</td>
<td>NS</td>
<td>.119</td>
</tr>
<tr>
<td>Child-Pugh grade</td>
<td>.07</td>
<td>NS</td>
<td>0</td>
</tr>
<tr>
<td>ICGR15 &lt; 10%</td>
<td>.087</td>
<td>0</td>
<td>2.574–12.202</td>
</tr>
<tr>
<td>AST</td>
<td>.484</td>
<td>NS</td>
<td>.044</td>
</tr>
<tr>
<td>AFP &gt; 200 ng/L</td>
<td>.006</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Margin width &lt; 5 mm</td>
<td>.544</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Complete encapsulation</td>
<td>.064</td>
<td>NS</td>
<td>.138</td>
</tr>
<tr>
<td>Satellite lesions</td>
<td>.003</td>
<td>NS</td>
<td>.147</td>
</tr>
<tr>
<td>Major perivascular abutment</td>
<td>.754</td>
<td>NS</td>
<td>.111</td>
</tr>
<tr>
<td>Infiltrative type</td>
<td>.003</td>
<td>NS</td>
<td>.147</td>
</tr>
<tr>
<td>Vascular permeation</td>
<td>0</td>
<td>0</td>
<td>7.498–38.380</td>
</tr>
</tbody>
</table>

AFP = a-fetoprotein; AST = aspartate aminotransferase; CI = confidence interval; ICGR15 = indocyanine green retention at 15 minutes.

*Hepatitis included hepatitis B (hepatitis B surface antigen), C (antibody to hepatitis C virus), and no infection of hepatitis B or hepatitis C.
However, further experience is needed to apply this technique intraoperatorically.

In conclusion, during central resections of HCC, a narrowest margin width <5 mm does not negatively affect recurrence and overall survival. However, it does increase perimargin recurrence significantly and inversely affects late outcomes.

References