

Radiofrequency Ablation Versus Surgical Resection for Small Unifocal Hepatocellular Carcinomas

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Abstract: We aimed to compare the effectiveness and safety of hepatic resection and radiofrequency ablation (RFA) for small hepatocellular carcinomas (HCCs) less than 5 cm in diameter.

A total of 289 patients were diagnosed with a small HCC (a single tumor no larger than 5 cm). Among these patients, 133 underwent hepatic resection, and 156 received RFA. Demographic data, intraoperative data, post-operative recovery data, and the baseline characteristics of the 2 groups of patients were compared. The incidence of post-operative complications; 1-, 3-, and 5-year survival rates; and tumor recurrence were determined.

No statistically significant differences in the baseline characteristics were noted between the 2 groups. By contrast, operation time ($P = 0.003$), intraoperative blood loss ($P = 0.000$), and the length of post-operative hospital stay ($P = 0.000$) were significantly lower in the RFA group compared with the surgical resection group. The 2 groups displayed similar post-operative complication rates (12% or 16/133 in the liver resection group vs. 8.3% or 13/156 in the RFA group, $P = 0.395$). The 1-, 3-, and 5-year overall survival rates of the patients in the liver resection group were 88.7%, 78.2%, and 66.2%, respectively, whereas the rates in the RFA group were 90.4%, 76.3%, and 66.0%, respectively ($P = 0.722$). The 1-, 3-, and 5-year tumor-free survival rates of patients in the resection group were 87.2%, 69.9%, and 58.6%, respectively, whereas the rates in the RFA group were 85.9%, 66.0%, and 54.5%, respectively ($P = 0.327$). In addition, among HCC patients receiving RFA, patients with tumors no greater than 3 cm in diameter exhibited no significant differences regarding overall survival and tumor-free survival rates compared with patients with tumors 3 to 5 cm in diameter (all $P > 0.05$).

RFA is an effective and safe treatment option for small HCCs and may be a preferred choice for HCC patients with small lesions.

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Abbreviations: AFP = alpha-fetoprotein, HBV DNA = hepatitis B virus deoxyribonucleic acid, HCC = hepatocellular carcinoma, LT = liver transplantation, RAF = radiofrequency ablation, TACE = transarterial chemo-embolization.

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Lei and Wang proposed the study. They performed research and wrote the first draft. They also collected and analyzed the data. All authors contributed to the design and interpretation of the study and to further drafts. Wang is the guarantor.

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INTRODUCTION

Hepatocellular carcinoma (HCC) is one of the most common malignant tumors. HCC is the 5th most common cancer worldwide and the 3rd leading cause of cancer deaths worldwide.¹⁻³ Given that China has a large population infected with hepatitis B, HCC is more common in this country. Overall, 55% of HCC patients worldwide live in China,² and HCC is the 3rd leading cause of cancer deaths in China, followed by gastric cancer and lung cancer.⁴ Given the rapid development of medical technology, the steady improvement in medical care systems, and the recent trend of early HCC detection and diagnosis in China, curative therapy has become possible for HCC patients. This therapy includes liver transplantation (LT), hepatic resection, and radiofrequency ablation (RFA). LT is the only treatment method that can simultaneously alleviate HCC and cirrhosis due to liver cancer.⁵ However, LTs are associated with numerous problems, such as an extreme shortage of donor livers since early 2013,⁶ a high hospital mortality rate of approximately 10%,⁷ and a high infection risk due to post-operative rejection and long-term use of immunosuppressive agents.^{7,8} Hepatic resection and RFA are simpler therapies that are more efficient, safer, and easier to perform. Given the satisfactory post-operative 5-year survival rate, hepatic resection has been routinely applied for the treatment of small HCC tumors.⁹ Recently, RFA has been widely used as an alternative treatment for hepatic resection in clinical practice. RFA denatures the protein via heat coagulation of the target tissue. The heat is applied locally at a high temperature through an RFA needle, which treats the carcinoma.⁴ However, recent studies on the effectiveness of resection and radiofrequency in small HCCs have generated considerable controversy.¹⁰ In this study, the intraoperative and post-operative complications, patient recovery during hospitalization, post-operative tumor recurrence, and overall survival of patients with small HCCs treated by RFA and hepatic resection were comprehensively compared to evaluate these 2 treatment methods. In addition, small HCCs were divided into central small HCCs and peripheral small HCCs, and the safety and efficacy of the 2 treatment methods for these 2 types of small HCC lesions were compared.

MATERIALS AND METHODS

Clinical Data

All of the HCC patients treated at our hospital were retrospectively screened for small HCCs. A total of 289 patients with small HCCs were included in this study. The inclusion criteria included the following: a tumor diameter of ≤ 5 cm; child Class A or B liver function; 18 to 80 years of age; a histological confirmation of HCC; an initial diagnosis of HCC; and RFA treatment or hepatic resection. The exclusion criteria included the following: tumor invasion in vascular or adjacent tissues and organs or distant metastasis; a history of treatment for liver cancer, excluding anti-viral therapy; cardiovascular and

cerebrovascular disease, which are surgical contraindications; coagulation disorders; or bile duct-derived or mixed liver cancer. All of the cases of liver cancer were pre-operatively diagnosed based on the guidelines in “China’s Common Malignancy Specifications: Primary Liver Cancer”.¹¹ Additionally, HCC cases were pathologically confirmed after surgery.

Experimental Grouping and Study Methods

The 289 cases of small HCCs were divided into 2 groups according to the treatment method: the RFA group (156 cases) and the surgical resection group (133 cases). A retrospective analysis was performed to compare the intraoperative parameters (operation time, blood loss, and blood transfusion), post-operative recovery data during hospitalization (total length of hospital stay, total hospital cost, and post-operative complications), and post-operative long-term data (post-operative tumor recurrence and metastasis rates; 1-, 3-, and 5-year survival rates; and tumor-free survival rates) between these 2 groups. In addition, the 289 cases of small HCCs were classified as central small HCCs (102 cases) and peripheral small HCCs (187 cases) based on the tumor location. The safety and efficacy of the 2 treatment methods for these 2 types of small HCCs were compared. Additionally, the intraoperative and post-operative safety and efficacy were compared between percutaneous RFA (59 cases) and laparotomy RFA (97 cases).

Surgical Method

Surgical Resection

All surgical resections were conducted via laparotomy with standard resection of the liver lobe or liver segment using the clamp method. The resected section was at least 3 cm from the tumor border based on Doppler ultrasonography guidance. Intraoperative in vivo radiotherapy and chemotherapy were not applied, and portal vein chemotherapy was not provided.

Radiofrequency Ablation

RFA was conducted under general anesthesia. A conventional B-ultrasound-guided biopsy was performed thrice before the ablation, and B-ultrasound-guided ablation was performed with tumor positioning and assessment after the ablation. The RadioTherapeutics TM RF2000 RF ablation system was used with a 3.5-cm LeVeen ablation needle. A single-pin or 3-pin ablation needle was selected based on the tumor size and location. The timing of each RFA was determined based on the size of the tumor. Repeated RFA at multiple points was applied to the large targets. After the ablation, the burning scope and the residual situation were assessed by intraoperative B-ultrasound.

Post-Operative Follow-Up

In the first post-operative year, all patients received follow-up and were examined by abdominal color Doppler ultrasound angiography or enhanced computed tomography (CT) every 2 months starting the first month. Additionally, an alpha-fetoprotein (AFP) assay was performed monthly during follow-up. During the second year of follow-up, all examinations were conducted every 3 months. If AFP levels continued to increase and abdominal imaging studies did not indicate recurrence, enhanced chest CT and a whole body bone scan were recommended. When a tumor recurrence was identified, re-excision was implemented according to the tumor location and size and the patient’s liver function. RFA,

transarterial chemoembolization (TACE), and sorafenib were administered. When lung metastases were identified, γ knife served as the primary recommended treatment.

Statistical Methods

SPSS 17.0 (SPSS Inc, Chicago, IL) was used for data management and analysis. Measured data with a normal distribution were expressed as the mean \pm standard deviation. Continuous data were analyzed using *t* tests, and categorical data were analyzed using χ^2 tests. The overall survival and tumor-free survival of the 2 groups were compared using a Kaplan–Meier analysis. The differences between the groups were considered statistically significant when $P < 0.05$.

RESULTS

Comparison of Baseline Patient Data

Comparisons of the pre-operative demographic data from 133 patients in the resection group and 156 patients in the RFA group are presented in Table 1. Differences in age, gender, body weight, height, body mass index (BMI), hepatitis virus-related conditions, and hepatitis B virus (HBV)-DNA loads between the 2 groups were not statistically significant ($P > 0.05$). The pre-operative liver function of the patients in both groups was defined as Class A or Class B; however, no Class C cases were identified. In total, 71.4% of patients (95 cases) in the resection group were classified as Class A compared with 60.9% of patients (95 cases) in the RFA group; however, this difference was not statistically significant ($P = 0.079$).

Tumor-Related Characteristics

All of the resected specimens were pathologically confirmed as HCC. As shown in Table 2, the average HCC diameters did not significantly differ between the 2 groups. Pre-operative AFP levels and grading did not differ between the

TABLE 1. A Comparison of the Patient Baseline Data in the Resection Group and the RFA Group

	Resection Group 133	RFA Group 156	P-Value
Age	51.5 \pm 8.9	53.2 \pm 10.2	0.799
Gender ratio (male:female)	78:55	84:72	0.389
Body weight (kg)	67.2 \pm 6.1	68.1 \pm 9.7	0.881
Height (cm)	168.2 \pm 6.9	167.4 \pm 8.2	0.913
BMI (kg/m ²)	23.1 \pm 2.1	23.3 \pm 2.3	0.773
Virological examination			0.879
Hepatitis B	126	148	
Hepatitis C	2	3	
Hepatitis B and C	2	2	
No hepatitis virus	3	3	
Hepatitis B virus DNA (copies/ml)			0.465
<1.0E+03	66	80	
\geq 1.0E+03	62	70	
Child score			0.079
A (5–6)	95	95	
B (7–9)	38	61	
C (\geq 10)	0	0	

TABLE 2. A Comparison of the Tumor-Related Characteristics Between the Resection Group and the RFA Group

	Resection Group 133	RFA Group 156	P-Value
Tumor diameter (cm)	3.9 ± 0.6	3.7 ± 0.5	0.858
≤3 cm	59	71	
3–5 cm	74	85	
Preoperative AFP level (ng/ml)	1813.2 ± 1347.2	1989.5 ± 1745.4	0.779
≥1,200 ng/ml	60	71	
400–1200 ng/ml	30	34	
12–400 ng/ml	22	24	
<12 ng/ml	21	27	
Degree of tumor differentiation			0.258
Highly differentiated	67	75	
Moderately differentiated	43	46	
Poorly differentiated	23	35	
Tumor location			0.066
Central	39	63	
Peripheral	94	93	

2 groups. The post-operative pathology results confirmed that the differences in the degree of tumor differentiation between the resection group and the RFA group were not statistically significant. The proportion of cases in the RFA group with a central tumor location was increased compared with the resection group (40.4% vs. 29.3%); however, this difference did not achieve statistical significance ($P = 0.066$).

Comparison of Intraoperative and Post-Operative Data

The average operation time in the resection group was 4.6 ± 1.3 hours, which was significantly increased compared with the operation time in the RFA group (2.8 ± 2.5 hours [$P = 0.003$]). In addition, mean intraoperative blood loss in the resection group was significantly increased compared with the RFA group (322 ml vs. 105 ml, $P = 0.000$). This blood loss resulted in a 9.0% (12 cases) transfusion rate in the resection group, which was significantly increased compared with the transfusion rate of 1.3% (2 cases) in the RFA group. Additionally, the number of patients requiring admission to the intensive care unit (ICU) after surgery was increased in the resection group compared with the RFA group; however, this difference was not statistically significant ($P = 0.072$). The overall hospital costs did not significantly differ between the 2 groups of patients ($P = 0.877$). Regarding the intraoperative and post-operative recovery of patients, no significant differences ($P > 0.05$) were observed between the laparotomy RFA group and the percutaneous RFA group.

Intraoperative and Post-Operative Complications

The intraoperative complications of the 2 groups included 2 cases of intraoperative bleeding in the resection group and 1 case of injury to the gastric body in the RFA group due to percutaneous radiofrequency on the left lateral lobe of the liver. These complications were repaired by laparotomy. The Clavien classification system was used to grade and compare the post-operative complications. As shown in Table 3, the overall incidence of post-operative complications was 12.0% (16/133) in the resection group and 8.3% (13/156) in the RFA group. The complication incidence in the RFA group was reduced compared with the hepatic resection group; however, the difference was not statistically significant ($P = 0.395$). For severe complications (\geq level III), the incidence rates were 5.3% in the resection group (7/133) and 3.8% (6/156) in the RFA group; no statistically significant differences were noted between the groups ($P = 0.563$). As shown in Table 4, the incidence of level I to V complications did not significantly differ between the 2 groups. The incidence of post-operative complications was 11.3% in 97 patients in the laparotomy RFA group, which was significantly increased compared with 3.4% in 59 patients in the percutaneous RFA group ($P = 0.042$).

Post-Operative Survival and Tumor Recurrence

The mean follow-up times for the resection group and the RFA group were 8.1 (5.1–13.1) years and 8.0 (5.2–12.7) years, respectively. The 1-, 3-, and 5-year survival rates of the

TABLE 3. Intraoperative, Post-Operative, and Recovery Data From the 2 Groups of Patients

	Resection Group 133	RFA Group 156	P-Value
Operation time (hour)	4.6 ± 1.3	2.4 ± 1.5	0.003
Intraoperative blood loss (ml)	322.5 ± 145.2	105.2 ± 94.3	0.000
Intraoperative transfusion (yes/no)	12/121	2/154	0.002
ICU care (yes/no)	19/114	12/144	0.072
Hospitalization (day)	11.6 ± 6.8	6.8 ± 4.5	0.000
Total hospital cost (RMB)	24054 ± 2207.4	21567.3 ± 1786.3	0.877

TABLE 4. Site of HCC Recurrence or Metastasis After Liver Resection or RFA

	Liver	Lung	Bone	Liver and Lung	Liver and Abdominal Lymph Nodes	Multiple Organs
Liver resection (49)	14	6	1	11	8	9
RFA (70)	20	8	2	18	15	7

133 patients who underwent surgical resection were 88.7%, 78.2%, and 66.2%, respectively. The 1-, 3-, and 5-year survival rates of the 156 patients who received RFA were 90.4%, 76.3%, and 66.0%, respectively. No significant differences between the 2 groups were noted ($P = 0.722$) (Figure 1). The 1-, 3-, and 5-year tumor-free survival rates were 87.2%, 69.9%, and 58.6% in the resection group and 85.9%, 66.0%, and 54.5% in the RFA group, respectively. The tumor-free survival rates in the resection group were increased compared with the RFA group; however, the differences between the 2 groups were not statistically significant ($P = 0.327$) (Figure 2). For HCC tumors with a diameter ≤ 3 cm, the survival rates did not significantly differ between the hepatic resection group and the RFA group ($P = 0.129$). For tumors with a diameter of 3–5 cm, the survival rates did not significantly differ between the 2 groups ($P = 0.762$). As shown in Figures 3 and 4, the 1-, 3-, and 5-year survival rates of the 71 patients with an HCC lesion no greater than 3 cm in diameter were 93.0%, 80.3%, and 70.4%, respectively, which is comparable with that observed in the 85 patients with an HCC diameter of 3 to 5 cm (88.2%, 72.9%, and 62.3%, respectively, $P = 0.138$). In addition, the long-term tumor-free survival rate was comparable between 2 groups (88.7%, 70.4%, and 59.2%, respectively, for HCC tumors no greater than 3 cm in diameter vs. 83.5%, 62.3%, and 50.6%, respectively, for tumors 3–5 cm in diameter, $P = 0.101$). As shown in Table 4, recurrence or metastasis of HCC occurred

in 49 patients (14 cases with only liver recurrence and 35 cases with other organ metastases) of the 133 patients in the surgical resection group during the follow-up period. Of the 39 cases with liver recurrence, 18 cases experienced local recurrence, whereas 21 cases experienced distant recurrence. Among the 156 patients in the RFA group, recurrence or metastasis occurred in 70 patients (20 cases with only liver recurrence and 50 cases with other organ metastases). Of the 58 cases with liver recurrence, recurrence was local in 31 cases and distant in 27 cases. In the RFA group, 1 case was post-operatively diagnosed with nasopharyngeal cancer after 13 months, and surgical pathology excluded liver metastasis. The lungs and abdominal lymph nodes were the most common organ and tissue sites for extrahepatic metastases, followed by bones.

DISCUSSION

Hepatic resection has long been considered a preferred treatment for small HCCs because this method is associated with a post-operative mortality of approximately 3%.¹² However, the role of hepatic resection in the treatment of small HCCs is under scrutiny. LT is considered the best treatment method for small HCCs. However, the increasing shortage of donor livers and a post-operative hospital mortality rate of approximately 10% strictly limit its wide application in clinical practice. Therefore, other localized treatments, such as RFA, are considered preferred treatments.^{13,14} However, the extensive

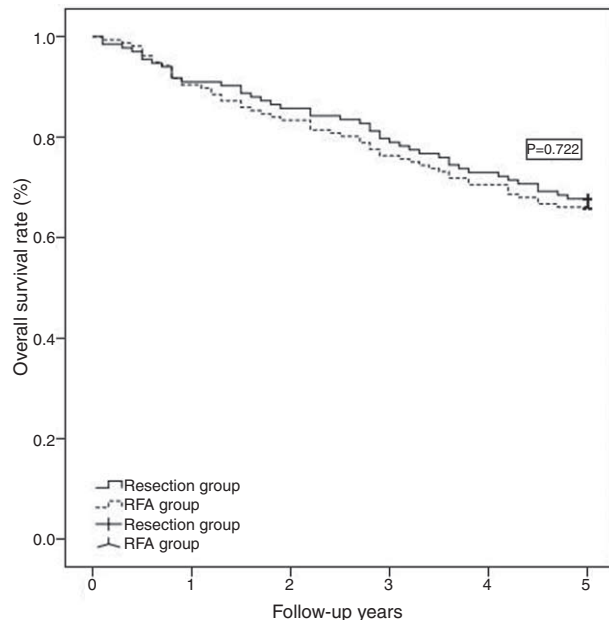


FIGURE 1. A comparison of the post-operative overall survival rates between the 2 groups of patients: the liver resection group and radiofrequency ablation (RFA) group demonstrated no significant differences regarding 1-, 3-, and 5-year overall survival rates ($P = 0.722$).

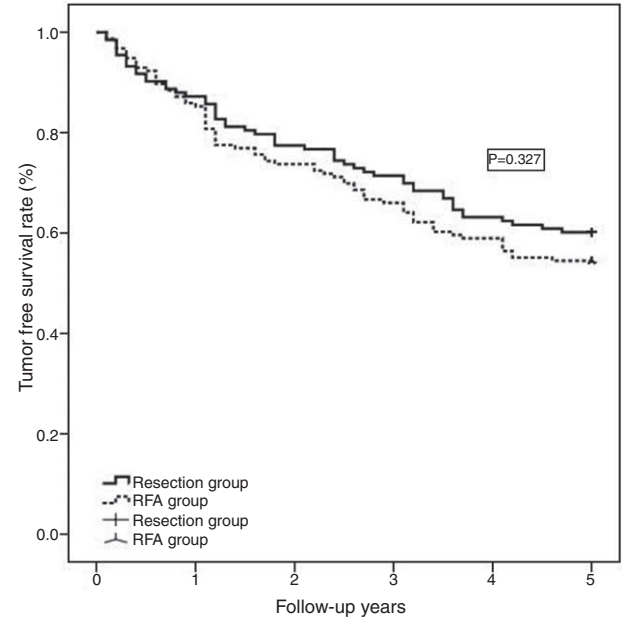


FIGURE 2. A comparison of the post-operative tumor-free survival rates between the 2 groups of patients: the long-term tumor-free survival was comparable between the liver resection and radiofrequency ablation (RFA) groups ($P = 0.327$).

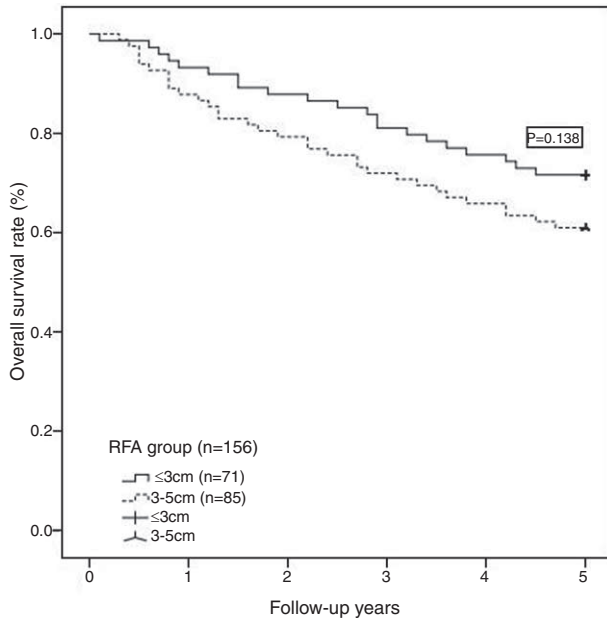


FIGURE 3. A comparison of the overall survival rates between the hepatocellular carcinomas (HCCs) ≤ 3 cm in diameter and those 3 to 5 cm in diameter in the radiofrequency ablation (RFA) subgroup: the 2 groups exhibited comparable 1-, 3-, and 5-year overall survival rates ($P=0.138$).

application of RFA as a new treatment is considerably controversial. Many studies in China and other countries have compared the effectiveness of RFA and surgical resection for small HCC. Several studies suggested that the overall survival

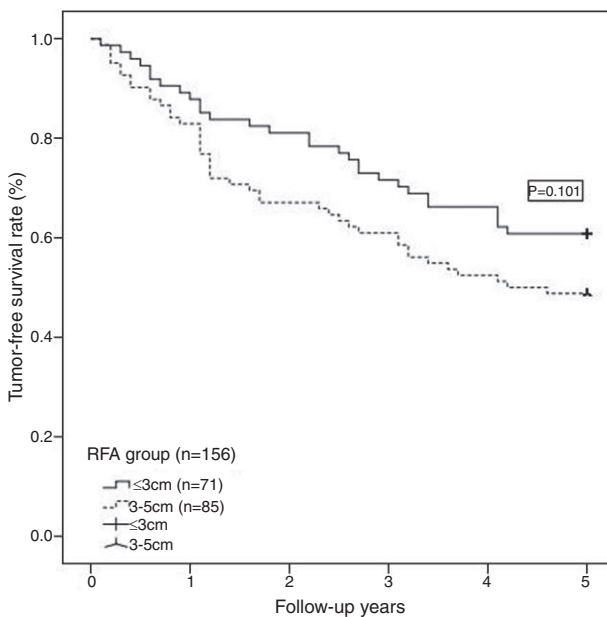


FIGURE 4. A comparison of the tumor-free survival rates between hepatocellular carcinomas (HCCs) ≤ 3 cm in diameter and those 3 to 5 cm in diameter in the radiofrequency ablation (RFA) subgroup: no significantly differences were observed regarding 1-, 3-, and 5-year tumor-free survival rates between the 2 groups ($P=0.101$).

and tumor-free survival of patients with small HCCs who undergo surgical resection are significantly increased compared with patients who received RFA.^{4,14–16} In contrast, other studies reported that post-operative survival and tumor recurrence did not differ between the 2 methods.^{17–19} Therefore, a comprehensive analysis of RFA and hepatic resection for the treatment of small HCCs was performed in this study based on related data and our approximately decade-long experience treating patients with small HCCs. Patient survival, tumor recurrence, post-operative complications, and intraoperative data were compared between the 2 methods. This comparison resulted in more comprehensive and robust results.

In this study, we first compared the demographic data of the 2 groups of patients and identified no differences between the groups. Regarding the tumor characteristics, the proportion of cases in the RFA group with a central tumor location was increased compared with the resection group; this result was attributed to our patient selection. When the tumor is located in the peripheral liver, such as segments II or III, surgical resection is easier, especially for tumors in the left lateral lobe. In this case, RFA may easily damage the stomach or other surrounding tissue, including the colon, and may be difficult to perform. This situation is particularly common with percutaneous RFA. The use of RFA on peripheral small HCCs is more likely to cause tumor rupture and subsequent metastasis.¹⁹ When the tumor is located in the center of the liver, especially the junction of the right hepatic V to VIII segments, hepatic resection may easily damage excessive normal liver tissue, and the surgery may be extremely difficult. In contrast, RFA is extremely easy in such cases, and the risk of post-operative complications is reduced.²⁰ In addition, when the tumor is close to a large perivascular area, the efficacy of RFA is poor, and tumor tissue often remains because blood flow in blood vessels diminishes the heat, thereby leading to incomplete ablation.²¹ Therefore, to achieve better results, factors such as tumor location and size should be considered in the clinical application of RFA.

RFA is easy to perform and is associated with minimally invasive damage and rapid recovery. As demonstrated in the analysis in this study, the mean operation time in the RFA group was significantly reduced compared with the surgical resection group. For HCC tumors ≤ 3 cm in diameter, RFA typically requires only one ablation needle to achieve satisfactory results within approximately 10 min after accurately positioning the needle.²² For HCCs greater than 3 cm in diameter, RFA can be used to achieve complete ablation with appropriate repeated ablations at multiple points, as guided by B-ultrasound.²³ Repeated RFA can avoid the steps involving freeing and transecting the liver and hemostasis; therefore, operation time and blood loss can be reduced. A shorter operation time, reduced blood loss, and a minimally invasive procedure (percutaneous radiofrequency) improve the post-operative recovery of patients and reduce the length of hospital stay and medical costs. However, the price of an RFA needle remains high in China, whereas the cost of surgical resection alone is low. Therefore, the overall cost for patients receiving RFA did not significantly differ from the costs for patients undergoing resection surgery.

RFA (laparotomy or percutaneous) has the advantage of being minimally invasive. For hepatic resection, the most commonly accepted scope of resection occurs 3 cm from the tumor margin,²⁴ and a standard lobe or liver segment resection is recommended.²⁵ Additionally, resection destroys the blood supply and the hepatic venous blood in the residual liver, thereby resulting in congestion. These factors unavoidably

destroy excessive normal liver tissue. RFA only ablates the tumor and a small amount of the surrounding normal liver tissue without destroying excessive normal liver tissue. In laparotomy RFA, the incision size is considerably smaller compared with hepatic resection, which leads to a reduced risk of post-operative complications, such as incision fat liquefaction and incision infection. The minimally invasive RFA results in a reduced incidence of post-operative complications in the RFA group compared with the resection group (12.0% vs. 8.3%). However, several complications are specific to RFA, such as biloma (2 cases in this study), side injuries (1 case in this study), needle tract moving, pneumothorax, and bile duct bleeding.^{26,27} Given these specific complications, the differences in the complications between the 2 groups did not achieve statistical significance. Compared with laparotomy RFA, the incidence of post-operative complications after percutaneous RFA for the treatment of liver cancer was significantly reduced ($P = 0.042$). Laparotomy RFA requires an abdominal incision, which increases the chance of an incision infection. Additionally, this treatment method requires the liver ligament to be freed, which may increase the risk of post-operative bleeding and pleural effusion.

In this study, the comparative analysis was focused on the survival of patients who underwent resection compared with patients who received RFA. Our analysis revealed no statistically significant differences in the survival rates and the tumor-free survival rates of patients with small HCCs. The most important factor that affects the survival and tumor-free survival of patients with small HCCs is tumor recurrence.²⁸ Most of the current studies have suggested that resection is superior to RFA because the scope of a single ablation using RFA is a spherical region of approximately 4 to 5 cm.²² In addition, when the tumor is approximately 5 cm in size and especially when the tumor is irregularly shaped, it is difficult to fully ablate the surrounding area of the tumor. The 5-year overall survival rates have been reported to range from 55% to 77.8%, whereas 5-year recurrence rates range from 54.8 to 80% in patients who receive RFA.¹⁶ The efficacy of RFA is highly size dependent; a unified understanding of the effectiveness between liver resection and RFA for small liver tumors ≤ 3 cm in diameter is evident.²⁹ As shown in our study, RFA can achieve a long-term outcome that is similar to liver resection for HCC tumors 3 to 5 cm in diameter; however, this is a controversial field.²⁶ In our center, all RFA procedures are performed under Doppler ultrasonography, and a 3-pin ablation needle is selected if the tumor diameter is greater than 3 cm. Repeated RFA at multiple points can achieve satisfactory ablation results and may contribute to the similar long-term outcomes noted between the 2 groups. Comparing the long-term outcome between patients with tumors no greater than 3 cm in diameter and those with tumors 3 to 5 cm in diameter in the RFA subgroup, no significant difference was noted. This result indicates that RFA can be applied to HCCs less than 5 cm in diameter.²³ Additionally, numerous reports have attributed local recurrence after RFA to insufficient intraoperative ablation of normal liver tissue.³⁰ The ablation scope of RFA must exceed the tumor edge by 4 to 5 mm,³¹ and this exact distance is difficult to measure during surgery. The ablation area can be appropriately extended to achieve satisfactory results because RFA-induced damage to residual liver tissue is less than the damage caused by resection. The stratified analysis demonstrated that post-operative survival and tumor recurrence in patients with tumors ≤ 3 cm versus 3 to 5 cm did not vary based on RFA and hepatic resection.

This study suggests that RFA provides a new treatment method for small HCCs that exhibits survival and tumor

recurrence rates similar to surgical resection. Because RFA is minimally invasive, simple, safe, and associated with faster post-operative recovery, this method may be considered as a preferred treatment for small HCCs. However, the tumor location and potential risks of RFA must be considered.

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