Percutaneous ultrasound-guided thermal ablation for intrahepatic cholangiocarcinoma

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Objective: The objective of this study was to evaluate the treatment efficacy and overall survival (OS) of percutaneous ultrasound-guided thermal ablation by means of microwave ablation or radiofrequency ablation for intrahepatic cholangiocarcinoma (ICC).

Methods: 18 patients with 25 ICC nodules underwent ultrasound-guided thermal ablation with curative intention. 8 patients were primary cases and 10 were recurrent cases after curative resection. The local treatment response, complications and survivals were analysed.

Results: Complete ablation was achieved in 23 (92.0%, 23/25) nodules (diameter, 0.7–4.3 cm; mean, 2.5 ± 0.9 cm) and incomplete ablation was found in 2 (8.0%, 2/25) larger tumours (6.4 and 6.9 cm in diameter). No death associated with the treatment was found. The major complication rate was 5.5% (1/18). The follow-up periods ranged from 1.3 to 86.2 months (mean, 20.5 ± 26.3 months; median, 8.7 months). OS rates for all patients at 6, 12, 36 and 60 months were 66.7%, 36.3%, 30.3% and 30.3%, respectively. By univariate analysis, the patient source (primary or recurrent case) was found to be a significant prognostic factor for OS rates ($p=0.001$). The patient source ($p=0.001$) and the number of nodules ($p=0.038$) were found to be significant prognostic factors for recurrence-free survival. OS rates for the primary ICC at 6, 12, 36 and 60 months were 87.5%, 75.0%, 62.5% and 62.5%, respectively.

Conclusion: Percutaneous ultrasound-guided thermal ablation is a safe and effective therapeutic technique for ICC. Acceptable survival can be achieved in primary ICCs, whereas the prognosis of recurrent ICCs is relatively poor.

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Intrahepatic cholangiocarcinoma (ICC) is a malignant tumour that arises from the epithelial cells of intrahepatic bile ducts (beyond the second order bile ducts). It constitutes approximately 5–30% of primary liver cancer, and the worldwide incidence of this malignancy has been increasing in recent years [1–6]. ICC often shows higher malignant grade and poorer prognosis than those of hepatocellular carcinoma (HCC). Until now, surgical resection has been the optimal therapy for ICC, offering a potential for curative treatment. However, many patients with tumours are not candidates for surgical resection because of the advanced stage of the disease at presentation, anatomical limitations and medical comorbidities. The high recurrence rate after resection and the lack of a valid treatment option also contribute to the poor prognosis. Currently there is no randomised study showing a survival benefit for a specific chemotherapeutic regimen. On the other hand, external radiotherapy

does not show a significant impact on survival or quality of life [7–9].

Image-guided thermal ablation by means of radiofrequency ablation (RFA) or microwave ablation (MWA) has been proven to be a viable option for the treatment of liver cancers, owing to its remarkable advantages, such as minimal invasiveness, easy performance, repeatability and cost-effectiveness [10–13]. In suitable cases, thermal ablation can be used as a curative option for HCC; however, the efficacy of thermal ablation for ICC lacks sufficient evidence [10]. In the present study, we analysed the local treatment response, complications and survival of 18 patients with ICC who had undergone ultrasound-guided thermal ablation.

Methods and materials

Patients

From October 1998 to August 2010, 18 patients with histopathologically proven ICCs who had undergone ultrasound-guided percutaneous MWA or RFA with curative intent at the institution were enrolled for the analysis. MWA was carried out in 6 patients with 6 nodules and RFA in 12 patients with 19 nodules,

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depending on the availability of the devices. The patients' ages ranged from 44 to 83 years, with a mean age of 60.0 ± 10.7 years (Table 1). The exclusion criteria were as follows: number of tumour nodules greater than five; maximum diameter of any one nodule >7 cm; evidence of vascular invasion; evidence of extrahepatic metastasis; liver function status of Child–Pugh C classification; refractory ascites; and poor coagulopathy (platelet count $<50 \times 10^3 \mu\text{l}^{-1}$; prolongation of prothrombin time >7 s). The number of tumour nodules and the absence of vascular invasion were established on the basis of ultrasound and contrast-enhanced CT. Maximal dimension of tumour was estimated by ultrasound. The absence of extrahepatic metastases was ascertained by means of chest radiography, abdominal ultrasound and CT. The study was approved by the ethics committee of the hospital and written informed consent was obtained from each patient before treatment. All data were collected prospectively.

Of 18 patients, 8 (44.4%) were primary cases and were initially treated by thermal ablation, and the remaining 10 (55.6%) were recurrent ICCs after hepatectomy of the primary ICCs with curative intention. In the 10 recurrent cases, the median time from the surgery to ablation was 4.4 months (range, 0.6–5.9 months; mean, 3.7 ± 1.8 months). All the patients refused to undergo surgical resection. Among them, an 83-year-old man refused surgery because of his age, and the recurrent cases refused surgery because of a recent surgical resection.

The number of patients with 1, 2, 3 and 4 nodules were 13, 4, 0 and 1, respectively, and all 25 nodules were treated. The diameters of tumours ranged from 0.7 to 6.9 cm (mean, 2.8 ± 1.5 cm). Liver function status was classified as Child–Pugh Class A in 16 (88.9%) patients and B in 2 (11.1%) patients.

Thermal ablation techniques

Thermal ablation was performed under ultrasound guidance with the patient under conscious sedation and local anaesthesia. For MWA, local anaesthesia with 1% lidocaine was given to patients with nodules measuring ≤ 2 cm, and additional intravenous administration of propofol and ketamine was used for patients with nodules >2 cm. For RFA, the anaesthetic was a local injection of 1% lidocaine in combination with fentanyl citrate and droperidol intravenously. Heart rate, PO_2 saturation and respiratory rate were monitored continuously, and blood pressure was determined every 5 min.

Both ablation procedures were performed percutaneously under real-time ultrasound guidance, with the use of an SSD 2000 scanner (Aloka, Tokyo, Japan), SSA-250A scanner (Toshiba, Tokyo, Japan) or Acuson SequoiaTM 512 scanner (Siemens Medical Solutions, Mountain View, CA). The aim of the treatment was to completely destroy the tumour, with a surrounding 0.5–1 cm safety margin.

According to the availability of ablation devices, MWA was performed from August 1997 to March 2000, and RFA was performed from March 2000 to August 2010. For MWA, a UMC-I microwave generator (Institute 207 of Aerospace Industry, Beijing, China, and PLA General Hospital, Beijing, China) with a frequency of 2450 MHz

Table 1. Clinical data and follow-up of 18 patients with intrahepatic cholangiocarcinoma

Case Number	Gender	Age (years)	Maximal tumour size (cm)	Number of tumour nodules	Primary case	Child–Pugh class	Initial treatment	Treatment method	Complete ablation	Recurrence	RFS (months)	Status	OS (months)
1	F	63	1.4	2	No	A	Surgery	RFA	Yes	Yes	1.1	Dead	10
2	F	66	3.1	1	Yes	A	MWA	MWA	Yes	No	73	Alive	73
3	M	46	4.3	1	Yes	A	MWA	MWA	Yes	No	86.2	Alive	86.2
4	M	83	4.2	1	Yes	A	MWA	MWA	Yes	No	62.3	Dead	62.3
5	M	74	1.8	1	No	A	Surgery	MWA	Yes	Yes	4.2	Dead	6
6	F	73	2.8	1	Yes	A	RFA	RFA	Yes	Yes	2.8	Dead	8.8
7	M	66	3.4	2	No	B	Surgery	RFA	Yes	Yes	4	Dead	9.7
8	M	44	2.7	1	No	A	Surgery	RFA	Yes	Yes	1.1	Dead	3.4
9	M	51	2.3	1	Yes	B	MWA	MWA	Yes	No	8.5	Dead	8.5
10	M	63	4	1	Yes	A	MWA	MWA	Yes	Yes	6.8	Dead	13.5
11	F	58	6.4	1	Yes	A	RFA	RFA	No	Yes	NA	Alive	19.2
12	M	63	2.8	1	No	A	Surgery	RFA	Yes	Yes	1.2	Dead	6
13	M	60	2	1	No	A	Surgery	RFA	Yes	Yes	2	Dead	3.4
14	M	67	2.7	4	No	A	Surgery	RFA	Yes	Yes	1.1	Dead	1.3
15	F	50	6.9	2	No	A	Surgery	RFA	No	Yes	NA	Dead	2.7
16	M	52	1.9	1	Yes	A	RFA	RFA	Yes	Yes	7.5	Alive	39.4
17	M	47	1.4	2	No	A	Surgery	RFA	Yes	Yes	1	Alive	7
18	M	54	2.3	1	No	A	Surgery	RFA	Yes	Yes	2.8	Dead	8

F, female; M, male; MWA, microwave ablation; NA, not applicable; OS, overall survival; RFA, radiofrequency ablation; RFS, recurrence-free survival.

and a power output of 10–80 W was used. The electrode is 1.6 mm in diameter and 24.7 cm in length, with a 2.7-cm exposed antenna at its terminus. A 14-gauge 15-cm guiding needle was used for puncture guidance. Single-electrode insertion with one-site energy delivery was applied for tumours <2 cm in diameter. For tumours >2 cm in diameter, a composite ablation technique—namely, multiple insertions with an interelectrode distance of 1.5–2 cm and multiple site energy applications—was employed to ensure adequate coagulation necrosis. Commonly, two to four insertions were used for tumours 2.1–4.0 cm in diameter and five to six insertions were used for tumours with a diameter of >4 cm. Microwave energy was set at 60 W for 5 min for each application. Each nodule received two sessions of MWA within 1 week as the ablation volume was only $3.7 \times 2.6 \times 2.6$ cm *ex vivo*, and two sessions was regarded as the standard protocol to ensure enough coagulation volume [14].

RFA was performed by using a WE-7568 radio-frequency delivery system (Welfare Electronic, Beijing, China) or a RITA device (Rita Medical Systems, Mountain View, CA). WE-7568 consists of a radio-frequency generator with a frequency of 290 kHz and maximum power output of 200 W, and an expandable multitined electrode. The electrode was 14 gauge and 15 cm long; a thermocouple was embedded in its tip for continuous measurement of local tissue temperature during ablation. When ten expandable tines inside the electrode sheath were fully deployed, a space 4.5 cm in diameter could be covered. Radiofrequency energy delivery was set for 10 min, with a tissue temperature of 90 °C achieved, lasting for at least 6 min. With the RITA device, ablation was performed using an expandable needle electrode (Starburst, 2–3 cm; or Starburst XL, 3–5 cm). The maximum power output was 150 W and the target temperature was set at 105 °C. Grounding was achieved by attaching a dispersive pad to each thigh of the patient. Single-electrode insertion with one-site energy delivery was used for tumours measuring <3 cm; overlapping ablation with two to three electrode insertions was employed for tumours sized 3.0–5.0 cm; and four to six electrode insertions were used for tumours sized >5.0 cm. In both ablation procedures, the deepest portion of the tumour was ablated first, and the more superficial portions were ablated after the electrode had been withdrawn by about 1.5–2.0 cm. For each nodule, one session was required for RFA.

All of the patients receiving MWA or RFA required an overnight stay in the hospital. The patients were asked to stay in bed for 4 h and blood pressures were measured three times every 2 h. If the patients had no abnormal findings on the second-day ultrasound examination and no obvious discomfort, they were asked to leave the hospital.

Therapeutic efficacy assessment and follow-up

Local therapeutic efficacy was determined by abdominal contrast-enhanced CT 1 month after treatment. The CT images were reviewed by two skilled radiologists who had experience in liver imaging of more than 20 years. Complete ablation was defined as uniform non-enhancement during arterial phase in the ablated area;

otherwise, ablation was considered incomplete. Mortality related to thermal ablation was defined as death within 30 days after ablation. Major complications were defined as any event that resulted in additional treatment, including an increase in level of care, hospital stay beyond observation status, re-admission after initial discharge and permanent adverse sequelae (e.g. substantial morbidity and disability, and death). All other complications were classified as minor.

After the treatment, all patients were evaluated monthly with abdominal colour Doppler ultrasound or contrast-enhanced ultrasound for the first 6 months, and thereafter every 3–6 months. When there were suspicious findings on ultrasound (*i.e.* enlargement of the treated area, changes in ultrasound pattern, presence of intralesional Doppler signal, emergence of hyperenhancement in the ablated area on contrast-enhanced ultrasound, appearance of new lesion), contrast-enhanced CT was performed to confirm the diagnosis. Local recurrence was defined as regrowth of tumour inside or adjacent to the successfully treated nodule (after 1 month), and distant recurrence as presence of intra- or extrahepatic new foci.

The incompletely ablated tumour, local recurrence and intrahepatic distant recurrence were treated by additional MWA or RFA whenever possible. Alternative therapeutic approaches, such as liver resection, percutaneous ethanol ablation and chemotherapy, were performed according to tumour stage, liver function reserve, and the wishes and general condition of the patient.

Statistical analysis

The quantitative data were expressed as mean $\pm$ standard deviation. Overall survival (OS) was computed from the beginning of the ablation to death or the last visit. The recurrence-free survival was defined as the interval between completion of ablation and the appearance of local recurrence or the new tumour. OS was analysed in the whole series of 18 patients, and recurrence-free survival was analysed in 16 patients after exclusion of 2 patients with incomplete ablation. OS and recurrence-free survival were estimated by the Kaplan–Meier method. In univariate analysis, survival comparisons between subgroups of patients were made using the log-rank test. A *p*-value of <0.05 was considered statistically significant. The statistical analysis was performed using SPSS® v. 13.0 statistical software (SPSS Inc., Chicago, IL).

Results

Local therapeutic efficacy

After initial treatment, 23 (23/25, 92.0%) nodules (diameter ranged from 0.7 to 4.3 cm; mean, 2.5 ± 0.9 cm) had complete ablation, while 2 (2/25, 8.0%) larger tumours (6.4 and 6.9 cm in diameter) had residual tumour (Figure 1). The complete ablation rate in tumours ≤ 5 cm was 100% (23/23). One of the two residual tumours had additional ablation and was eventually completely ablated, and the remaining tumour failed to achieve complete

Figure 1. A 66-year-old female with intrahepatic cholangiocarcinoma (ICC). (a) The ICC (arrows), 3.1 cm in diameter, shows hyperenhancement during arterial phase on contrast-enhanced ultrasound before microwave ablation. (b) The nodule (arrows) shows non-enhancement on contrast-enhanced ultrasound 1 month after ablation, indicating a complete necrosis. (c) Contrast-enhanced CT 1 month after ablation demonstrates a uniform hypoattenuating area without enhancement (arrow), also indicating complete ablation.

necrosis after a second ablation. The patient was referred to surgical resection.

Complications

No mortality associated with thermal ablation was found. All patients tolerated the procedure. Nearly 50% of patients felt mild pain during the procedures, but all tolerated them. A minor complication was found in one patient (5.5%), who had portal vein thrombosis after ablation, which was left untreated and resolved spontaneously on follow-up ultrasound. A major complication was observed in one patient (5.5%), who had fever over 38.5°C, which resolved with antibiotic treatment.

Follow-up

The follow-up period ranged from 1.3 to 86.2 months (mean, 20.5 ± 26.3 months; median, 8.7 months). 12 (66.6%) patients were followed up for <1 year; 3 (16.7%) for 1–5 years; and 3 (16.7%) for >5 years. All patients who were followed-up for >5 years were primary cases. 4 (50.0%) of 8 primary cases survived and 4 (50.0%) died, and the survival ranged from 8.5 to 86.2 months (median, 29.3 months). Of the remaining 10 recurrent cases, 1 (10.0%) survived and 9 (90.0%) died, and the survival ranged from 1.3 to 10.0 months (median, 6 months).

Of the 18 patients, 13 (72.2%) died and 5 (27.8%) were still alive during the observation period. The causes of death were tumour progression (11/13, 84.6%), liver failure (1/13, 7.7%) and unknown (1/13, 7.7%).

The median OS was 8.8 months (95% confidence interval, 6.6 to 11.0 months; standard error, 1.1 months). OS rates after thermal ablation at 6, 12, 36 and 60 months were 66.7%, 36.3%, 30.3% and 30.3% for all patients, and 87.5%, 75.0%, 62.5% and 62.5% for the primary ICC, respectively.

Of 16 patients who had undergone complete ablation, 12 (75.0%) developed recurrence during follow-up. The

median recurrence-free survival was 4.0 months (95% confidence interval, 1.9–6.1 months; standard error, 1.1 months). Two of the surviving five patients were still recurrence free. By contrast, of the four patients who did not develop recurrence, two were alive at the observation period and two died.

By univariate analysis, the patient source (primary or recurrent case) was found to be the significant prognostic factor for OS rates ($p=0.001$), whereas gender ($p=0.482$), number of tumour nodules ($p=0.205$), treatment method ($p=0.147$), complete ablation ($p=0.822$) and development of recurrence after ablation ($p=0.064$) were insignificant factors (Figure 2 and Table 2). The patient source ($p=0.001$) and number of tumour nodules ($p=0.038$) were found to be significant prognostic factors for recurrence-free survival rate.

Figure 2. Overall (cumulation) survival rates according to patient source in 18 patients who underwent percutaneous thermal ablation. There was significant difference between primary intrahepatic cholangiocarcinoma (ICC; green line) and recurrent ICC (blue line; $p=0.001$).

Table 2. Prognostic factors and results of univariate analysis of overall survival for 18 patients with intrahepatic cholangiocarcinoma after thermal ablation, and recurrence-free survival for 16 patients who had obtained complete ablation

Factors	n	OS		n	RFS	
		Median (months)	p-value		Median (months)	p-value
Gender			0.482			0.783
Male	13	8.5		13	4.0	
Female	5	10.0		3	2.8	
Number of nodules			0.205			0.038
Solitary	13	8.8		12	4.2	
Multiple	5	9.7		4	1.1	
Patient source			0.001			0.001
Primary case	8	62.3		7	62.3	
Recurrent case	10	9.7		9	1.2	
Treatment method			0.147			
MWA	6	13.5				
RFA	12	8.0				
Complete ablation			0.822			
Yes	16	8.8				
No	2	2.7				
Recurrence			0.064			
Yes	14	8.0				
No	4	62.3				

MWA, microwave ablation; OS, overall survival; RFA, radiofrequency ablation; RFS, recurrence-free survival.

Discussion

ICC is a malignant liver cancer with poor prognosis. The median survival time is 3.9 months if it is untreated [15]. Surgical resection offers the best chance for long-term survival. Even after curative resection for ICC, patient survival rates remain low, with 5-year survival rates of 15–36% [16–18]. The poor prognosis is largely due to the high rate of recurrence after resection [19]; up to 70% of the patients develop local or distant recurrence after surgery [19–21]. Predictors of poor outcome include positive resection margin, lymphatic and vascular invasion, periductal infiltrating diseases, and pre-operative CA19-9 level. On the other hand, patients with ICC are typically at an advanced stage at the time of diagnosis because of the lack of symptoms until late in disease progression, and are not candidates for surgery. Some patients are unable or unwilling to undergo surgery or have limited functioning hepatic tissue [16–23]. The prognosis of ICC patients who received liver transplantation treatment is not satisfactory. Owing to restricted resources of liver donors and poor prognosis after liver transplantation, transplantation for ICC remains a controversial area. Furthermore, there are not standard chemotherapeutic protocols for ICC [24].

Thermal ablation has been confirmed as a valid option for treating HCC. The tumour is destroyed by generating heat within the lesion, which results in coagulation necrosis of the tumour tissue. Percutaneous image-guided ablation therapy is widely used for the treatment of liver cancer because of its minimal invasiveness, repeatability, relatively low cost, easy performance and potential application in a wide spectrum of patients. RFA and MWA are two of the most commonly used modalities and are valuable therapeutic modalities for HCC. The local tumour control, complications related to treatment and long-term survival were equivalent for these two modalities in treating HCC [25].

Chiou et al [26] first evaluated the clinical applications of percutaneous RFA in 10 patients with ICC, and they

demonstrated that ablation had satisfactory local therapeutic efficacy, especially when the tumour size was <5 cm, with a complete ablation rate of 89% for ICC <5 cm. Zgodzinski and Espat [27] also reported the use of RFA in treating ICC in 2005. A 78-year-old man with a solitary ICC was successfully treated by RFA and remained free of disease after a follow-up of 24 months. Since then, thermal ablation has been increasingly applied in treating ICC, including both RFA and MWA [7, 24, 28–30]. The complete ablation rates for ICC <5 cm were 88–97% [7, 29]. The present study showed that the overall complete ablation rate was 92.0%, and the complete ablation rate for tumours with diameters of ≤5 cm was 100%. It demonstrated that percutaneous thermal ablation for ICC has a satisfactory local response.

Prognosis has not been well documented for patients with ICC treated by thermal ablation. In the present study, the 5-year survival rate was 30%, whereas it was 15% in a series of Kim et al [7]. The 5-year survival rate after ablation was comparable with that after curative resection (15–36%) [16–18]. The median overall survival and disease-free survival time of ICC after ablation were 8.8 and 4.0 months, respectively, so it has a poorer prognosis than that of HCC. In the same centre, the median overall survival and disease-free survival of HCC were 27.0 and 8.2 months, respectively [12]. The underlying reason may be attributed to the histological features of ICC. ICC is non-encapsulated and always has a tendency to infiltrate adjacent tissues. It is the invasion of local and hepatic ducts by ICC that leads to the low rate of curative resection and the high recurrence rate after treatment. In general, it is necessary to completely destroy the tumour plus 0.5–1 cm of adjacent liver in an attempt to ensure a tumour-free margin. Because of the aggressive nature of ICC, a larger area of coagulation necrosis should be recommended in clinics, in order to ensure enough safety margin. The median recurrence-free survival of ICC was shorter than that of HCC, indicating that shorter

interval of follow-up might be necessary in patients with ICC.

In the current study, univariate analysis indicated that the patient source was a significant prognostic factor for OS and recurrence-free survival. All patients who survived for more than 5 years were primary cases. 50.0% of primary cases survived during the observation period and the median survival time was 29.3 months, whereas only 10.0% of recurrent cases survived and the median survival time was 6 months. For the primary ICC patients, the OS rate at 5 years was as high as 62.5%. Kim et al [7] also reported that the median survival time of 38.5 months was achieved in primary ICC patients after RFA. Therefore, thermal ablation resulted in an acceptable survival for primary cases. On the other hand, recurrent ICC patients after hepatectomy might have a higher tendency for re-recurrence, which would lead to tumour progression and, finally, poor prognosis [28]. Although the recurrent cases were treated with a curative intention in this study, the patients might already have developed intrahepatic recurrence after surgical resection, and there might have been small intrahepatic recurrent foci that the imaging techniques could not detect, which would also be responsible for the poor prognosis. Despite this, thermal ablation is still a choice for recurrent ICC after curative resection because repeat hepatectomy may not be performed in most patients with recurrent ICC. Repeat hepatectomy is limited by poor remnant liver function or multifocal recurrence. In addition to that, technical and anatomical difficulties make repeat hepatectomy less feasible and more difficult to perform than initial hepatectomy [29, 31].

The data from univariate analysis indicated that recurrence after ablation and complete ablation did not significantly influence the OS, which might be attributed to limited subject numbers in the present study; thus, further studies with large numbers might reveal the real impact of the two factors on prognosis. However, thermal ablation has the advantage of easy repeatability, so the incompletely ablated tumour, local recurrence and intrahepatic distant recurrence can be treated by additional MWA or RFA if the patients still meet the inclusion criteria for ablation.

The complication rate after ablation for HCC was reported to range from 0 to 12%, and the mortality rate from 0 to 1% [32]. For HCC or metastatic liver cancer, the major complications included tumour seeding, liver abscess, haemorrhage, pleural effusion and so on. With regard to ICC, Chiou et al [26] reported that 1 (10%) of 10 ICC patients had a serious complication: a large biloma developed after ablation, but it was totally resolved after 6 months with percutaneous drainage. A complication rate of 7% was reported by Kim et al [29], comprising one liver abscess and one biliary stricture. In another series, Kim et al reported a complication rate of 6%, which was also a liver abscess, and the patient died of sepsis 3.3 months later, despite percutaneous drainage and antibiotic therapy [7]. In the present study, both the major and minor complication rates were 5.5%, and only one patient needed additional care, suggesting that thermal ablation of ICC has a low complication rate and is a safe procedure.

For the patients with HCC, the major causes of death after ablation were tumour progression or liver failure,

which accounted for nearly 50 and 30% of deaths, respectively [12, 13]. However, in the present study of ICC, the major cause of death was tumour progression, which accounted for approximately 85% of deaths, followed by liver failure (7.7%) and others (7.7%). In the study by Kim et al [7], tumour progression accounted for 67% of deaths, followed by liver abscess (11%), upper gastrointestinal bleeding (11%) and infection related to biliary stricture (11%). These results suggest that the causes of death are different between HCC and ICC. Death from liver failure and upper gastrointestinal bleeding for HCC after ablation is higher than that for ICC. This might be due to the different liver background. Patients with HCC have a higher hepatitis virus infection rate, worse liver function status and a higher cirrhosis rate than patients with ICC. On the other hand, ICC has a tendency to infiltrate the surrounding bile duct, blood vessels and/or hepatic parenchyma.

Conclusion

Percutaneous ultrasound-guided thermal ablation by means of MWA or RFA is safe and effective in the treatment of ICC. It may be an alternative treatment approach in some cases of ICC, particularly for tumours measuring <5 cm and for patients who are not candidates for surgery. It has satisfactory local therapeutic efficacy, low complication rate and acceptable survival. Acceptable survival can be achieved in primary ICCs, whereas the prognosis of recurrent ICCs is relatively poor. Further studies with larger numbers of subjects and longer follow-up are mandatory in the future to evaluate the long-term outcome and identify the significant prognostic factor. Comparison between ablation and hepatectomy for ICC is also necessary in future studies.

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