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Results of Radiofrequency Ablation Treatment in Primary and Metastatic Liver Cancer

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ABSTRACT:

Results of radiofrequency ablation treatment in primary and metastatic liver cancer

Objective: The aim of this present study was to retrospectively evaluate the local therapeutic efficiency of radiofrequency ablation (RFA) treatment in patients with primary and metastatic liver cancer.

Material and Methods: A total of 35 patients who had undergone RFA in our clinic were included in the study and evaluated retrospectively. Patients were grouped according to their ages, lesion's primary or metastatic formation, number of lesions and lesion sizes. Local tumor growth, new lesion formation and general survival factors were evaluated statistically.

Results: During the follow-up after RFA treatment, the residual tumor was determined in the treatment area in only one (1.9%) lesion. Total ablation was achieved in 50 lesions (98.0%). Local tumor growth occured in 9 lesions of eight patients (17.6%). During follow-up, development of a new lesion at a different liver region was seen in 22 (62.8%) patients. Following RFA, one patient had cholecystitis while intraperitoneal minimal hemorrhage was encountered in two patients.

Conclusion: As RFA treatment protects intact liver tissues, directly targets the tumor, and the mortality and morbidity rates are lower when compared to other treatments, it is currently considered safe for the treatment of liver tumors.

Keywords: Liver cancer, local ablation, radiofrequency ablation

ÖZET:

Primer ve metastatik karaciğer kanserlerinde radyofrekans ablasyon tedavi sonuçları

Amaç: Bu çalışmada amacımız, primer veya metastatik karaciğer kanseri olan hastaların radyofrekans ablasyon (RFA) tedavisinin lokal terapötik etkinliğini retrospektif olarak değerlendirmekti.

Gereç ve Yöntem: Kliniğimizde radyofrekans ablasyon tedavisi uygulanmış 35 hasta çalışmaya dahil edildi ve retrospektif olarak değerlendirildi. Hastalar yaşlarına, lezyonun primer ya da metastatik oluşuna, lezyon sayılarına ve lezyon büyüklüklerine göre gruplandırıldı. Lokal tümör büyümesi, yeni lezyon oluşumu ve genel sağkalıma etki edebilecek unsurlar istatistiksel olarak değerlendirildi.

Bulgular: Radyofrekans ablasyon tedavisi sonrası takip sırasında sadece bir lezyonda (%1.9) tedavi edilen alanda rezidü saptandı. Takiplerde 50 lezyonda (%98.0) total ablasyon sağlandı. Lokal tümör büyümesi ise sekiz hastanın 9 lezyonunda (%17.6) gelişti. Yirmi iki hastada (%62.8) ise takiplerinde farklı bir karaciğer bölgesinde yeni bir lezyon geliştiği görüldü. RFA işlemi sonrası bir hastada kolesistit, iki hastada ise intraperitoneal minimal hemoraji gelişti.

Sonuç: RFA tedavisi sağlam karaciğer dokusunun korunması, tedavinin direk tümöre yönelik olması, mortalite ve morbiditenin diğer tedavilere kıyasla az olması sebebiyle karaciğer tümörlerinin tedavisinde günümüzde güvenle uygulanabilen bir yöntemdir.

Anahtar kelimeler: Karaciğer kanseri, lokal ablasyon, radyofrekans ablasyon

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INTRODUCTION

Surgical resection is the accepted and preferred curative treatment in the treatment of liver tumors. Nevertheless, in many of these cases, the number and distribution of tumoral lesions, markedly impaired liver functions, and other accompanying systemic problems reduce the chance of surgical resection (1). Treatment options have been developed to help provide local tumor control for such patients who are not eligible for surgery. Methods such as transarterial chemoembolization (TACE), percutaneous ethanol injection (PEI), cryotherapy, interstitial laser therapy, microwave coagulation and radiofrequency ablation (RFA) are currently available local ablative treatment methods (2,3). Radiofrequency ablation (RFA), especially when compared with other local ablation methods; is a more preferred method for local control of liver tumors in recent years due to its advantages such as lower cost and ease of application, less complication risk, more thermal damage at one session, and the most significant advantage over other ablation methods such as PEI, is that the size and severity of ablation can be determined previously and can be controlled during operation by RFA method (4,5). In addition, RFA therapy is considered to be the most effective method for local tumor control for tumors that can not currently undergo surgical resection (6).

In this study; we aimed to retrospectively evaluate the local therapeutic efficacy of RFA therapy in patients with primary or metastatic liver cancer. Survival, local tumor growth and new lesion formation after RFA treatment in patients with clinical and radiological follow-up were evaluated. In addition, factors that might affect the survival, local tumor growth and the formation of new lesions were evaluated.

MATERIAL AND METHOD

Thirty-five patients were included in the study and the patients' files and transactional information and all available imaging techniques were evaluated retrospectively. Demographic data such as gender, age, duration of follow-up, and patient survival were recorded. Clinical and radiological evaluation results such as lesion size, lesion location, number of lesions, primary or metastatic lesion formation, etiologic cause of the lesion and follow-up residual disease, local tumor growth and new lesion development were recorded. The study was approved by the clinical research ethics committee.

RFA Treatment and Follow-up

All radiofrequency ablation procedures were performed by doctors of the Interventional Radiology Unit under the sedation applied by the Anesthesia and Reanimation clinic physicians in accordance with routine surgical sterilization rules, in a supine or supine-oblique position depending on the localization of the lesion. Radiofrequency ablation was applied to thirty-five lesions (68.6%) percutaneously, to 3 lesions (5.9%) with USG device guidance intraoperatively, and to 13 lesions (25.5%) percutaneously with computed tomography (CT). The target temperature of the ablation was determined to be 105°C. After reaching the target temperature, the ablation process was performed based on the lesion size in accordance with the protocol.

Patients were called for control at 1., 3., 6., 12., and 24th months after RFA therapy. Three-phase dynamic contrast-enhanced liver CT or magnetic resonance imaging (MRI) examinations were performed to determine local therapeutic efficacy, as well as evaluation of alpha-fetoprotein (AFP) and other laboratory findings. Three criteria were taken into account in CT or MRI scans to detect the presence of total ablation in the lesion. These criteria were; the absence of contrast enhancement around or within the tumor, the smoothness and sharpness of the borders of the ablation zone, the ablation area exceeding the previously determined tumor size. Presence of residue, local tumor growth and new lesion formation were evaluated in patients' follow-ups. The criterion for presence of residue was that the lesion had a part which has not been ablated at 1st month control post-RFA. The presence of the area in the lesion was considered to be residue when it showed nodular contrast enhancement. For local

tumor growth, the determined criterion was the recurrence of tumor formation at the totally necrotic ablated region, or at 1 cm adjacent parenchyma at the first control follow up. Again at follow up, a new tumor formation at a different site from the ablation site in the liver parenchyma of the patient who underwent RFA treatment was evaluated as new lesion formation.

Patients 65 years of age and below were grouped as Group I and as Group II when they were 65 years of age and over. For statistical analysis and comparison, patients were classified as metastatic and primer lesions according to lesion type, and as solitary and multiple lesions according to number of lesions. Another classification of lesions was performed according to lesion size. Patients with a lesion size of 25 mm or less were classified as Group A, as Group B with a size ranging from 26 mm to 40 mm, and as Group C with a lesion equal to or greater than or 41 mm in size.

The survival of patients with local tumor growth and new lesion formation were compared with patients who have none. In patients' follow-up; the effect of age, gender distribution, lesion type, number of lesions, size of lesion, with what RFA was performed and the Child-Pugh Score on local lesion growth with new lesion formation were evaluated, and in addition to these, the effect of localization of the lesion on local tumor growth was also evaluated. In addition, overall survival was determined in patients' follow-up. In addition to the effect of local tumor growth or new lesion formation on survival; age, gender distribution, Child-Pugh Score, with what RFA was performed, the type, number, location and size of the lesion were also evaluated statistically.

Statistical Analysis

Chi-square test, Kaplan-Meier survival curves and Log-Rank tests were used to assess the relationship between patient survival and new lesion formation and variables of patients and the lesions, and the relation between the 51 tumoral lesions and local tumor growth in 35 patients. A p value less than 0.05 was considered significant.

RESULTS

Thirty-five patients underwent RFA for their 51 lesions at the first application due to primary and metastatic liver cancer. Of these patients, 22 (62.9%) were male and 13 (37.1%) were female. The age distribution of the patients ranged from 42 to 87 years and the mean age was 69.6±12.09. The distribution of patients according to age groups was as follows: 14 patients (40%) in Group I (≤65 years) and 21 patients (60%) in Group II. Sixteen of the thirty-five patients (45.7%) had primary liver cancer, and 19 (54.3%) had metastatic liver cancer. Thirty-one (37.3%) of the 51 lesions were primary lesions, 32 (62.7%) were metastatic lesions.

Of the 16 patients who received RFA treatment due to primary liver cancer, 11 (68.8%) patients had hepatitis B virus as the etiologic causative for cirrhosis, 3 had hepatitis C virus (18.8%) and 2 (12.4%) were cryptogenic. Eleven (68.8%) of the patients with primary lesions were Stage A according to Child-Pugh Score, 5 patients (31.2%) were Stage B. The primary cause of metastatic liver cancer were as follows: Colorectal cancer in 12 patients (63.1%), pancreatic cancer in 3 patients (15.8%), breast cancer in 2 patients (10.5%), stomach cancer in 1 patient (5.3%) and malignant melanoma in 1 (5.3%) patient. Distribution of 51 tumoral lesions according to liver lobes were as follows: 10 (19.6%) lesions in the left lobe and 41 (80.4%) lesions in the right lobe.

The lesion sizes ranged from 5.0 mm to 72 mm. The mean lesion size of 51 lesions of thirty-five patients was found to be 23.65±13.88 mm. In classification according to lesion size of patients; there were 33 (64.7%) lesions in group A, 10 (19.6%) lesions in group B, and 8 (15.7%) lesions in group C. The number of patients with solitary lesions was 22 (62.9%) while the number of patients with multiple lesions was 13 (37.1%). Among 13 patients with multiple lesions, there were 11 (84.62%) patients with 2 lesions, 1 patient (7.69%) with 3 lesions, and 1 patient (7.69%) with 4 lesions. Patients' follow-up ranged from 4 months to 48 months and the mean follow-up was 16.17±9.99 months.

Survival

Among the study period, 13 (37.1%) of the patients died and 22 (62.9%) were alive. Among the patients with primary tumoral lesions, 11 patients with etiological causative as hepatitis B were still all alive at the last follow-up and 5 (45.5%) of these patients had new lesions. All three patients with etiologic causal as hepatitis C had a new lesion at the follow-up and their follow ups were terminated due to the loss of the patients. One of the 2 patients with primary liver tumor due to cryptogenic cirrhosis was also lost at the follow up. Overall survival rates of the patients were calculated according to the 3rd, 6th, 12th, 24th and 36th months (Table-1). The statistical results obtained by evaluating the variables considered to affect the survival of the patients were calculated (Table-2). The negative effects of advanced age, local tumor growth and new lesion formation on survival were detected ($p<0.05$; $p<0.05$; $p<0.01$; Table-2).

Local Tumor Growth

Total ablation was achieved in 50 lesions (98%) in the follow up. Local tumor growth was detected in 8 of 35 patients (22.9%) and in 9 of 51 lesions (17.6%). The mean duration of local tumor growth was 9.67±6.42 months. In the follow up of these patients, 1 lesion was treated with TACE, 1 lesion with PEI and 5 lesions with RFA treatment. Two patients received systemic chemotherapy due to the presence of new lesions. Local tumor growth

Table-1: Overall survival rates of patients in follow-up

	%					Median survival (month)
Months	3. month	6. month	12. month	24. month	36. month	23.00±5.94
Rates	100	96.7	78.1	46.8	17.6	

Table-2: Evaluation of survival of patients according to the variables that can affect survival

Variables		Survival					Duration of Survival (month)		
		Alive		Ex		p	Median±SD		p
		No. of patients	%	No. of patients	%				
Age	≤ 65	12	85.7	2	14.3	< 0.05	23.0	4.45	> 0.05
	> 65	10	47.6	11	52.4		21.0	7.62	
Gender	F	8	61.5	5	38.5	> 0.05	31.0	14.82	> 0.05
	M	14	63.6	8	36.4		21.0	2.31	
Tumor type	Primary	12	75.0	4	25.0	> 0.05	31.0	6.14	> 0.05
	Metastasis	10	52.6	9	47.4		24.8	2.8	
Child-Pugh score	A	9	81.8	2	18.2	> 0.05	17.7	1.4	> 0.05
	B	3	60.0	2	40.0		27.9	9.1	
Number of lesions	Solitary	14	63.6	8	36.4	> 0.05	23.0	2.06	> 0.05
	Multiple	8	61.5	5	38.5		31.0	11.45	
Lesion size	A	14	70.0	6	30.0	> 0.05	31.0	9.1	> 0.05
	B	3	42.9	4	57.1		24.0	5.6	
	C	5	62.5	3	37.5		27.8	5.9	
What RF is applied with	USG	15	57.7	11	42.3	> 0.05	23.0	4.3	> 0.05
	CT	4	66.7	2	33.3		21.0	3.2	
	Surgery	3	100	0	0		21.0	3.2	
Lobe distribution	Right	18	62.1	11	37.9	> 0.05	23.7	2.5	> 0.05
	Left	4	66.7	2	33.3		32.3	8.3	
Local tumor growth	Absent	20	74.1	7	25.9	< 0.05	35.0	7.5	< 0.05
	Present	2	25.0	6	75.0		19.0	2.5	
New lesion formation	Absent	12	92.3	1	7.7	< 0.01	35.0	0.0	< 0.05
	Present	10	45.5	12	54.5		19.0	5.9	

was observed in 3 (30%) of 10 tumoral lesions located in the left lobe, while tumor growth was detected in 6 of 41 (14.6%) lesions in the right lobe. In addition, in the evaluation of local tumor growth in patients with tumoral lesions treated with RFA, the factors that may affect local tumor growth in patients and the period of local tumor growth in relation to these factors were also calculated (Table-3). Assessment of local tumor growth revealed that lesion size was alone responsible for local tumor growth (p=0.056; Table-3).

Table-3: Evaluation of variables that may affect local tumor growth

Variables		Lokal tumor growth					Lokal tumor growth duration (months)		
		Absent		Present		p	Median±SD		p
		No. of lesions	%	No. of lesions	%				
Age	≤ 65	12	85.7	2	14.3	> 0.05	23.7	2.7	> 0.05
	> 65	15	71.4	6	28.6		34.3	4.6	
Gender	F	11	84.6	2	15.4	> 0.05	29.5	2.9	> 0.05
	M	16	72.7	6	27.3		33.7	4.8	
Tumor type	Primary	15	78.9	4	21.1	> 0.05	36.06	5.18	> 0.05
	Metastasis	27	84.4	5	15.6		30.31	2.23	
Child-Pugh score	A	9	81.8	2	18.2	> 0.05	15.3	2.7	> 0.05
	B	3	60.0	2	40.0		30.6	9.5	
No. of Lesions	Solitary	17	77.3	5	22.7	> 0.05	27.0	3.5	> 0.05
	Multiple	10	76.9	3	23.1		37.3	5.3	
Lesion size	A	28	84.8	5	15.2	> 0.05	36.80	3.68	0.056
	B	9	90.0	1	10.0		32.56	3.25	
	C	5	62.5	3	37.5		27.88	8.88	
What RF is applied with	USG	31	88.6	4	11.4	> 0.05	31.92	1.91	> 0.05
	CT	9	69.2	4	30.8		27.59	6.74	
	Surgery	2	66.7	1	33.3		33.50	10.25	
Lobe distribution	Right	35	85.4	6	14.6	> 0.05	30.3	2.1	> 0.05
	Left	7	70.0	3	30.0		33.9	6.6	

Table-4: Data and statistical evaluation of new lesion formation due to different variables and duration of new lesion formation

Variables		New lesion					Duration of new lesion formation (months)		
		Absent		Present		p	Median±SD		p
		No. of patients	%	No. of patients	%				
Age	≤ 65	9	64.3	5	35.7	< 0.01	18.58	3.08	0.052
	> 65	4	19.0	17	81.0		11.93	2.31	
Gender	F	3	23.1	10	76.9	> 0.05	9.00	3.93	> 0.05
	M	10	45.5	12	54.5		17.00	3.86	
Tumor type	Primary	7	43.8	9	56.3	> 0.05	10.00	2.48	> 0.05
	Metastasis	6	31.6	13	68.4		17.00	4.49	
Child-Pugh score	A	7	63.6	4	36.4	< 0.05	12.61	2.61	> 0.05
	B	0	0	5	100		9.20	2.46	
No. of Lesions	Solitary	10	45.5	12	54.5	> 0.05	11.0	6.40	> 0.05
	Multiple	3	23.1	10	76.9		14.0	3.97	
Lesion size	A	6	30.0	14	70.0	> 0.05	11.0	3.04	> 0.05
	B	3	42.9	4	57.1		8.0	1.31	
	C	4	50.0	4	50.0		17.0	10.30	
What RF is applied with	USG	11	42.3	15	57.7	> 0.05	17.0	3.34	> 0.05
	BT	2	33.3	4	66.7		9.0	3.19	
	Surgery	0	0	3	100		3.0	081	

New Lesion Formation

In the evaluation of the new lesion formation of all patients, it was found that there were new lesions in 22 (62.85%) patients in 35 patients' follow-up. The mean period of new lesion formation was 11.0±2.9 months. For the treatment of these patients, TACE was preferred in 10 patients and systemic chemotherapy was preferred for the rest. The data related to the formation of new lesions due to different variables and the duration of new lesion formation were collected and statistically evaluated (Table-4). It was found that the patients' advanced age and patients with primary lesions to have Stage B Child-Pugh scores, were effective for the formation of new lesions ($p<0.01$; $p<0.05$; Table-4).

Residue Formation and Complications

During follow-up after RFA treatment, residue was detected at only one patient's lesion (1.9%) in the treated area. The patient had a single metastatic lesion in the right lobe of the liver. The patient underwent radiofrequency ablation. Contrast enhancement, which was evaluated as compatible with the residual lesion, was observed in the ablation-treated lesion on the contrast-enhanced CT scan at 1 month after the procedure. However, RFA was not applied after many new lesions were detected in this evaluation. In two patients after RFA treatment, intraperitoneal minimal hemorrhage was detected as an early complication in the control abdominal CT examinations obtained after treatment. Subsequent abdominal CT examinations of these patients showed spontaneous resorption of intraperitoneal hemorrhages. After the procedure, clinical and laboratory findings consistent with cholecystitis were detected in a patient. After the medical treatment related to the clinic of the patient, radiological improvement and concomitant regression of the clinical signs occurred in follow-up.

DISCUSSION

Increasing frequency of studies on radiofrequency ablation therapy are reported; liver cancer and other similar indications have made RFA treatment even more popular among alternatives that can be applied. Good evaluation of the patient group treated with RFA is necessary. RFA treatment is an available treatment option for the group of patients with both primary and metastatic liver cancer. In our study, we also had patients with both primary and metastatic lesions among whom we evaluated the results. There are studies in the literature reporting the outcomes of patients with only primary liver cancer or patients with only metastatic liver cancer, as well as there are studies reporting the results of both patient populations (7). Survival rates in patients with hepatocellular carcinoma in these studies range from 80% to 100% for the first year and from 63% to 98% for the second year. For metastatic lesions, survival rates range from 90% to 98% for the 1st year and 60% to 70% for the 2nd year (7). In these different studies, the reason for reporting a wide range of different survival rates may be the differences related with possibly the age distribution of the treated patients and the new lesion formation. In general, metastatic lesions are reported to have a lower survival rate compared to hepatocellular carcinoma in the literature (7). In a study conducted by Chen et al. (8), the survival rates of metastatic liver lesions were reported to be statistically lower than the survival rates in hepatocellular carcinomas. In our study, the survival rate of patients with primary liver cancer who underwent RFA treatment were found to be 75%, whereas it was 52.6% in the metastatic group. In studies evaluating patients with primary liver lesions; effect of patients having Child-Pugh Stage A and B on survival has been reported in patients who can be treated with RFA. In the study of Lencioni et al., 76% survival in Child-Pugh Stage A and 46% survival in Child-Pugh Stage B have been reported in the 3rd year. In this study, it was found that patients with primary liver lesions in Child-Pugh stage A had a statistically more favorable effect on survival compared to Child-Pugh stage B patients (9). In our study, 11 (68.8%) of patients with primary lesions were stage A according to Child-Pugh Score, and 5 (31.2%) patients were stage B. The survival rates of these patients with Child-Pugh stage A and B were 81.8% and 60%, respectively.

The statistically significant effect of advanced age, new lesion formation and local tumor growth was determined on the overall survival rates in which the most important interpretation of the successful results could be made. The overall survival rates of patients with and without local tumor growth were 74.1% and 25%, respectively. Similarly, median survival times in patients with and without local tumor growth were 35 months and 19 months, respectively. Similarly, there are studies emphasizing the relationship between survival and local tumor growth (10). In our study, we found statistically significant differences in survival rates between two different age groups in patients we evaluated as below or over 65 years of age. In patients over 65 years of age, 52.4% of patients were lost at follow-up, while those at and below 65 years, this rate was 14.3%. Local tumor growth was detected in 9 (17.6%) of 51 lesions of our patients. The mean local tumor growth time was 9.67 months. Local tumor growth rates reported in the literature may differ in both etiologic reasons and from study to study. Local tumor growth rates have increased in relation to the follow-up period in the literature, with primary tumors varying between 1.3-14% at 1st year, 1.7-24% at 2nd year and 1.7-30% at 3rd year (11,12-16). In the literature again, a wide range of results has also been reported for local tumor growth after RFA treatment in metastatic lesions. Values between 3-43% are seen in many different studies (17,18-22). Local tumor growth was present in 21.1% of our patients with primary liver lesions, compared with 15.6% in the metastatic group. The likelihood of local tumor growth in our study was found to be 2% at 3rd month, 6.2% at 6th month, 17.5% at 12th month, and 28.3% at 24th month. When the variables that may affect the local tumor growth, such as whether the lesion was primary or metastatic, the stage of the disease, and the distribution of the lesion according to the lobes were evaluated, the only significant effect was related to the lesion size. Local lesion growth rate was 15.2% in lesions with a lesion size of 25 mm or less, and 37.5% in lesions with a lesion size of 41 mm and above. The difference between these rates was not statistically significant but there was a statistically significant difference between the two groups regarding local tumor median growth duration. The median growth time of the local tumor was found to be 36.8 months in lesions of 25 mm and below, and 27.8 months in lesions of 41 mm and above. Komorizono et al. (23) reported the tumor size greater than 2 cm and subcapsular placement in the liver as major risk factors for recurrence in hepatocellular carcinomas. In the study of Hori et al. (24), the risk factors determined for local tumor growth were the tumor location and size. In this study, it was reported that this ratio increased in lesions larger than 2.5 cm in diameter (24).

In the study performed by Harrison et al. (6), the local tumor growth rate was reported as 30.4% and the significant risk factors were determined as tumor size and high AFP level. Zytoon et al. (25) reported total recurrence and local tumor recurrence rates as 65% and 23%, respectively. The risk factors detected for local tumor growth in this study were shown as the tumor size greater than 2.3 cm, poor safety margin, multinodular tumor, lesions localized in segments 5 and 8, and patients older than 65 years of age (25). Also in our study, the relationship between local tumor growth and patient age was examined. When the effect of age is examined; local tumor growth was 28.6% in patients over 65 years old and 14.3% in patients at 65 years of age and below.

As reported in the literature, besides the reasons such as local tumor growth in patients' follow-up, another effective factor on survival is the intrahepatic new lesion formation. For this reason, intrahepatic new lesion formation leads to interpretations that adversely affect the success of RFA therapy, which is an effective alternative local treatment. In our study, 35 (37.14%) patients had new lesions in their follow-up. Patients with new lesions had an average new lesion formation duration of 11 months. When the factors that may affect the new lesion formation and may cause changes in these rates such as age, primary or metastatic formation of the tumor, number of lesions, and lesion size, were evaluated, it was found that only patients with advanced age and Child-Pugh Grade B had a higher incidence of new lesion formation. In our study, the metastatic origin of the tumor was found to be more effective on new lesion formation than the primary origin, but this

was not found statistically significant, such as age and Child-Pugh Score. The negative effect of new lesion formation on the survival of patients was an expected situation. In the related literature, as Ng et al. (26) described in their study, the negative effect of intrahepatic new lesion formation on general survival for RFA treatment in hepatocellular carcinoma has been reported. Similarly, in our study, when the effect of new lesion formation on the survival of patients was assessed, mortality rate was found to be 7.7% in patients without new lesions and 54.5% in patients with new lesions.

CONCLUSION

The results of our studies on survival, local tumor growth, new lesion formation and complications in patients with primary or metastatic liver cancer treated with RFA therapy extend and support the results of other studies to date in the literature on the same topic. In addition, our results are similarly successful when compared with other studies on this subject. Technological improvements in RFA therapy as well as increased experience in implementing this method have a positive effect on outcomes. However, considering the advantages of not requiring general anesthesia, minimal invasiveness, combination opportunity with other treatment modalities, low cost, and short duration of hospital stay, RFA therapy alone or in combination with other local treatment methods maintains its place in liver cancer therapy.

REFERENCES

1. *Dodd GD 3rd, Soulen MC, Kane RA, Livraghi T, Lees WR, Yamashita Y, et al. Minimally invasive treatment of malignant hepatic tumors: at the threshold of a major breakthrough. Radiographics 2000; 20: 9-27.* **[CrossRef]**
2. *Adson MA, van Heerden JA, Adson MH, Wagner JS, Ilstrup DM. Resection of hepatic metastases from colorectal cancer. Arch Surg 1984; 119: 647-51.* **[CrossRef]**
3. *Steele G Jr, Ravikumar TS. Resection of hepatic metastases from colorectal cancer. Biologic perspective. Ann Surg 1989; 210: 127-38.* **[CrossRef]**
4. *McWilliams JP, Yamamoto S, Raman SS, Loh CT, Lee EW, Liu DM, et al. Percutaneous ablation of hepatocellular carcinoma: current status J Vasc Interv Radiol 2010; 21: 204-13.* **[CrossRef]**
5. *Hong K, Georgiades C. Radiofrequency ablation: mechanism of action and devices J Vasc İnterv Radiol 2010; 21: 179-86.* **[CrossRef]**
6. *Harrison LE, Koneru B, Baramipour P, Fisher A, Barone A, Wilson D, et al. Locoregional recurrences are frequent after radiofrequency ablation for hepatocellular carcinoma. J Am Coll Surg 2003; 197: 759-64.* **[CrossRef]**
7. *Lin SM. Recent advances in radiofrequency ablation in the treatment of hepatocellular carcinoma and metastatic liver cancers. Chang Gung Med J 2009; 32: 22-32.*
8. *Chen MH, Yang W, Yan K, Gao W, Dai Y, Wang YB, et al. Treatment efficacy of radiofrequency ablation of 338 patients with hepatic malignant tumor and the relevant complications. World J Gastroenterol 2005; 11: 6395-401.* **[CrossRef]**
9. *Gillams AR. The use of radiofrequency in cancer. Br J Cancer 2005; 92: 1825-9.* **[CrossRef]**
10. *Zhou Y, Zhao Y, Li B, Xu D, Yin Z, Xie F, et al. Meta-analysis of radiofrequency ablation versus hepatic resection for small hepatocellular carcinoma. BMC Gastroenterol 2010; 10: 78.* **[CrossRef]**
11. *Lencioni RA, Allgaier HP, Cioni D, Olschewski M, Deibert P, Crocetti L, et al. Small hepatocellular carcinoma in cirrhosis: randomized comparison of radio-frequency thermal ablation versus percutaneous ethanol injection. Radiology 2003; 228: 235-40.* **[CrossRef]**
12. *Lin SM, Lin CJ, Lin CC, Hsu CW, Chen YC. Radiofrequency ablation improves prognosis compared with ethanol injection for hepatocellular carcinoma ≤ 4 cm. Gastroenterology 2004; 127: 1714-23.* **[CrossRef]**
13. *Lin SM, Lin CJ, Lin CC, Hsu CW, Chen YC. Randomized controlled trial comparing percutaneous radio-frequency thermal ablation, percutaneous ethanol injection and percutaneous acetic acid injection to treat hepatocellular carcinoma of 3 cm or less. Gut 2005; 54: 1151-6.* **[CrossRef]**
14. *Shiina S, Teratani T, Obi S, Sato S, Tateishi R, Fujishima T, et al. A randomized controlled trial of radiofrequency ablation with ethanol injection for small hepatocellular carcinoma. Gastroenterology 2005; 129: 122-30.* **[CrossRef]**
15. *Lencioni R, Cioni D, Crocetti L, Franchini C, Pina CD, Lera J, et al. Early-stage hepatocellular carcinoma in patients with cirrhosis: long-term results of percuataneous image-guided radiofrequency ablation. Radiology 2005; 234: 961-7.* **[CrossRef]**
16. *Cammà C, Di Marco V, Orlando A, Sandonato L, Casaril A, Parisi P, et al. Treatment of hepatocellular carcinoma in compensated cirrhosis with radio-frequency thermal ablation (RFTA): a prospective study. J Hepatol 2005; 42: 535-40.* **[CrossRef]**
17. *Curley SA, Izzo F, Delrio P, Ellis LM, Granchi J, Vallone P, et al. Radiofrequency ablation of unresectable primary and metastatic hepatic malignancies: results in 123 patients. Ann Surg 1999; 230: 1-8.* **[CrossRef]**
18. *Solbiati L, Livraghi T, Goldberg SN, Ierace T, Meloni F, Dellanoce M, et al. Percutaneous radio-frequency ablation of hepatic metastases from colorectal cancer: long-term results in 117 patients. Radiology 2001; 221: 159-66.* **[CrossRef]**
19. *Gillams AR, Lees WR. Radio-frequency ablation of colorectal liver metastases in 167 patients. Eur Radiol 2004; 14: 2261-7.* **[CrossRef]**
20. *de Baere T, Elias D, Dromain C, Din MG, Kuoch V, Ducreux M, et al. Radiofrequency ablation of 100 hepatic metastases with a mean follow-up of more than 1 year. AJR Am J Roentgenol 2000; 175: 1619-25.* **[CrossRef]**

21. *Gillams AR, Lees WR. Survival after percutaneous, image-guided, thermal ablation of hepatic metastases from colorectal cancer. Dis Colon Rectum 2000; 43: 656-61.* **[CrossRef]**
22. *Pawlik TM, Izzo F, Cohen DS, Morris JS, Curley SA. Combined resection and radiofrequency ablation for advanced hepatic malignancies: results in 172 patients. Ann Surg Oncol 2003; 10: 1059-69.* **[CrossRef]**
23. *Komorizono Y, Oketani M, Sako K, Yamasaki N, Shibatou T, Maeda M, et al. Risk factors for local recurrence of small hepatocellular carcinoma tumors after a single session, single application of percutaneous radiofrequency ablation. Cancer 2003; 97: 1253-62.* **[CrossRef]**
24. *Hori T, Nagata K, Hasuike S, Onaga M, Motoda M, Moriuchi A, et al. Risk factors for the local recurrence of hepatocellular carcinoma after a single session of percutaneous radiofrequency ablation. J Gastroenterol 2003; 38: 977-81.* **[CrossRef]**
25. *Zytoon AA, Ishii H, Murakami K, El-Kholy MR, Furuse J, El-Dorry A, et al. Recurrence-free survival after radiofrequency ablation of hepatocellular carcinoma. A registry report of the impact of risk factors on outcome. JPN J Clin Oncol 2007; 37: 658-72.* **[CrossRef]**
26. *Ng KK, Poon RT, Lo CM, Yuen J, Tso WK, Fan ST. Analysis of recurrence pattern and its influence on survival outcome after radiofrequency ablation of hepatocellular carcinoma. J Gastrointest Surg 2008; 12: 183-91.* **[CrossRef]**