

Efficacy of laparoscopic radiofrequency ablation for the treatment of patients with small solitary colorectal liver metastasis

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Background. Although radiofrequency ablation (RFA) has been incorporated to the treatment algorithm of patients with unresectable colorectal liver metastasis (CLM), its utility in patients with resectable disease has not been well studied. The aims of this study were to define the clinical profile of patients with a solitary CLM who underwent laparoscopic RFA and to analyze their oncologic outcomes.

Methods. Between 2000 and 2011, 44 patients underwent laparoscopic RFA and 60 patients resection of solitary CLM ≤ 3 cm. Data were analyzed from a prospectively maintained institutional review board-approved database using Student's *t* test, Chi-square, and Kaplan–Meier tests.

Results. The indications for RFA were patient decision in 61% ($n = 27$), comorbidities in 34% ($n = 15$), and intraoperative findings in 5% ($n = 2$). In comparison with the resection group, RFA patients had a greater American Society of Anesthesiologists score (3.0 ± 0.1 vs 2.6 ± 0.1 , respectively; $P = .002$), more frequent incidence of cardiopulmonary comorbidities (60% vs 38%, respectively; $P = .045$), and tumors located deeper in the liver parenchyma (39% vs 12%) that would have required a formal lobectomy. The 2 groups were otherwise similar for age, gender, carcinoembryonic antigen, synchronous versus metachronous presentation of CLM, tumor size, and tumor and nodal status of primary colorectal cancer. The local recurrence rate was 18% after RFA and 4% after resection ($P = .012$). The overall Kaplan–Meier, cancer-specific, 5-year survival was 47% for RFA and 57% for resection ($P = .464$). Median disease-free survival was 25 months after RFA and 22 months after resection ($P = .973$).

Conclusion. Our results suggest that laparoscopic RFA might spare a number of patients at greater risk with a small solitary CLM the risk of morbidity from a formal liver resection. Furthermore, laparoscopic RFA might also be acceptable as the first line of therapy for patients with tumors that otherwise would have required a formal lobectomy or open resection. Nevertheless, the local recurrence rate of RFA should be kept in mind and the patients followed closely to treat failures promptly. (*Surgery* 2013;154:556-62.)

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DESPITE A RECENT DECLINE IN INCIDENCE, COLORECTAL CANCER continues to be the third most common and lethal type of cancer for both genders in the United States. Of the anticipated 143,000 new cases in the United States in 2012, about a half will develop liver metastases during their life.^{1,2} Open liver resection (LR) has been the only modality giving the patients the chance of cure for

decades, although only 10–20% of patients are candidates for LR owing to the extent of disease and comorbidities.^{3,4} The 5-year survival rates with LR are 35–58% in most series,⁵⁻⁸ with a morbidity of 17–43% and a mortality of 0–4%.⁹⁻¹⁵

Over the last decade, minimally invasive options have been introduced to the treatment of colorectal liver metastases (CLM), including laparoscopic resection and ablative modalities.¹⁶⁻¹⁹ Among the ablative technologies, radiofrequency ablation (RFA) has been the most extensively studied modality, predominantly in unresectable patients. Various RFA studies have reported 5-year survivors in chemotherapy-failure patients.^{20,21} Compared with open LR, RFA is less invasive, associated with less morbidity, and can be done as an outpatient. These benefits have led to the question of whether RFA could be used in the treatment of resectable

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patients as well, and whether the oncologic outcomes would be equivalent. No such randomized study has been done, but there have been single-center, retrospective reports and meta-analyses comparing outcomes of patients who have undergone LR versus RFA.²²⁻²⁴ These studies in general have reported better survival and less local intrahepatic recurrence after LR compared with RFA.²²⁻²⁴ Furthermore, a study from the United States showed that, even in patients with small tumors, 5-year survival was significantly less after RFA (18%) compared with LR (72%).²⁵ Overall, there is agreement in the literature that a major limitation of these studies is that the 2 patient populations compared are not similar regarding the extent of disease and comorbidities.²²⁻²⁴ The aims of this study were to define the clinical profile of patients with a solitary CLM who underwent laparoscopic RFA and to analyze their oncologic outcomes in relation to patients with a similar in-size, solitary CLM who underwent resection.

METHODS

Between 2000 and 2011, 44 patients underwent laparoscopic RFA and 60 patients LR for a solitary CLM ≤ 3 cm, without extrahepatic disease at the time of treatment at the Department of General Surgery, Cleveland Clinic. Tumor size was recorded from preoperative computed tomography (CT) reports obtained within 1 month of the operative procedure. All patients were seen by an oncologist and surgeons specializing in LR, as well as liver ablation, before finalizing treatment type. Preoperative positron emission tomography scans were not obtained routinely, but were done for a number of patients by the referring oncologists based on personal preference. Factors affecting decision for RFA instead of resection included unfit patient condition for a major LR, and patient choice after pros and cons of each option were presented. A typical scenario related to the patients who requested a laparoscopic RFA instead of resection was when a small, deep lesion was present that would have required an open and/or major hepatectomy. The patients were followed under a protocol with quarterly chest, abdomen, pelvis, and triphasic liver CTs and blood work including carcinoembryonic antigen (CEA) levels for the first 2 years and then biannually. The CTs were reviewed and reported by independent radiologists. A local treatment failure of RFA was defined as any tumor growth or enhancement within or at the periphery of the ablation zone or any new growth within 1 cm of the ablation zone.²⁶ A local treatment failure for resection was defined as any

recurrence within 1 cm along the liver transection line. The decision for a local treatment failure at the site of ablation or resection was made by the radiologists. The response of tumors to neoadjuvant chemotherapy was assessed by RECIST criteria.²⁷ Data were collected prospectively into an institutional review board-approved database and retrospectively analyzed.

Operative technique. The techniques for laparoscopic RFA and LR have been reported previously.^{17,20} All RFA procedures were done laparoscopically under general anesthesia. Two 12-mm trocars were used in the right upper quadrant, one for the laparoscope and the other for the ultrasound probe. Ablation equipment consisted of Angiodynamics Inc. Model 90 (Queensbury, NY), 5-cm catheter that was used with a 150-W generator. Ablations were performed by using standard algorithms by aiming for ≥ 1 cm of margin around the tumor under laparoscopic ultrasound guidance.²⁸

Open resections were performed using a combination of clamp-crush technique, Cavitron Ultrasonic Surgical Aspirator (CUSA; Valleylab Inc, Boulder, CO), TissueLink (Salient Surgical Technologies, Inc, Chicago, IL), Aquamantys (Salient Surgical Technologies, Inc), and bipolar Habib (Habib 4X, AngioDynamics, Inc, Manchester, GA) with or without in-flow (Pringle) occlusion. Laparoscopic LRs were performed after 2006 for lesions located in segments II, III, IVB, V, and VI. Techniques for laparoscopic resection included a combination of radiofrequency precoagulation, Harmonic scalpel, Tissue-Link, and mechanical staplers. No Pringle maneuver was used for laparoscopic resections owing to surgeon preference.^{17,29} The choice of open versus laparoscopic resection after 2006 was made based on surgeon preference, because the study included surgeons with and without experience in laparoscopic liver surgery.

Statistical analysis. Demographic and clinical data were assessed using *t* and Chi-square tests. Univariate overall and disease-free survival analysis was performed using the univariate Kaplan-Meier method. Those parameters with $P < .3$ were entered into a multivariate Cox proportional hazards model. Ipsilateral liver-lobe specific disease-free survival was also calculated. Summaries of continuous variables are represented as mean \pm standard error.

RESULTS

The groups were similar for age, gender, CEA levels, and synchronous versus metachronous presentation of CLM and tumor and nodal status of

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