

Feasibility of radiofrequency ablation as an alternative to surgical intervention in patients with huge multiloculated pyogenic liver abscesses

A retrospective cohort study

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Abstract

This retrospective cohort study investigated the feasibility of radiofrequency (RF) ablation as an alternative to surgical intervention in patients with huge multiloculated pyogenic liver abscesses (PLAs).

From August 2010 to April 2016, 83 patients with PLA were admitted to Beijing Chao-Yang Hospital, China. Four of these patients had huge multiloculated PLAs and underwent RF ablation plus antibiotics. The inclusion criteria for RF ablation were as follows: multiloculated PLA confirmed by computed tomography (CT) or magnetic resonance imaging (MRI), widest diameter of the PLA ≥ 5 cm, failure to respond to or not suitable to treatment with percutaneous drainage (PD), and patient refusal of surgery. The safety and effectiveness of RF ablation were initially assessed. All patients were commenced on antibiotics on admission to our hospital. CT-guided percutaneous catheter drainage was attempted in one patient but was unsuccessful. The main organism isolated from cultures of these patients' blood or abscess samples was *Klebsiella pneumoniae* (3/4). RF ablation was performed as soon as eligibility according to the above criteria was established.

RF ablation was technically successful in all 4 study patients, all PLAs being completely eradicated. The median duration of fever after RF ablation was 4.5 days. No abscesses recurred; thus, this strategy for managing PLA was 100% successful (4/4). No procedure-related deaths or major complications occurred. One patient had an asymptomatic right pleural effusion that resolved with conservative treatment including albumin infusion and diuretics.

Our preliminary data indicate that RF ablation is a safe, feasible, and effective treatment for huge multiloculated PLAs. It should be considered as an alternative treatment for patients who fail to respond to or not suitable for PD plus antibiotics and refuse surgical intervention.

Abbreviations: CT = computed tomography, MRI = magnetic resonance imaging, PD = percutaneous drainage, PLA = pyogenic liver abscess, RF = radiofrequency.

Keywords: huge, multiloculated, pyogenic liver abscess, radiofrequency ablation

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1. Introduction

Pyogenic liver abscesses (PLAs) remain a rare and potentially life-threatening condition.^[1] Diabetes, malignancy, renal disease, and pneumonia are established and potentially treatable risk factors for this condition.^[2] With the rapidly increasing prevalence of diabetes in recent years,^[3] the incidence and severity of PLA will likely increase. There have been significant changes in the epidemiology, management, and mortality of PLA over the past few decades.^[4] Despite recent advances in the diagnosis and management of such abscesses, the mortality rate still ranges from 2% to 12%.^[2,5] Hence, it is necessary to recognize and treat this condition urgently.

Therapeutic options for PLA currently include effective antimicrobial therapy, image-guided interventional therapy (needle aspiration, catheter drainage, or endoscopic drainage), and surgical interventions. Most PLAs can be safely and effectively treated by percutaneous aspiration or drainage under antibiotic cover. Surgical intervention is prudent in patients who fail to respond to treatment with either aspiration or percutaneous drainage (PD) and antibiotics or who have concurrent intra-abdominal pathology that requires surgical treatment.^[4,6] However, some patients reject surgery because of the associated

perceived discomfort and high risk. A novel therapeutic strategy is required for patients who require surgical intervention but have refused it; such a strategy should be individualized according to the patient's clinical status and the characteristics of their abscess.

Radiofrequency (RF) ablation is an exciting modality that has been extensively used to treat various solid tumors.^[7–10] RF ablation has a very low rate of complications, and is generally well tolerated. It involves passing an alternating electrical current through the target tissues, thereby inducing agitation of ions and resistive heating in those tissues. The biological effects of RF ablation depend on the temperature and duration of heat exposure.^[11] Generally speaking, irreversible cell damage occurs when a temperature of 45°C is maintained for several hours. However, such damage occurs within only 4 to 5 minutes at temperatures of 50°C to 55°C. At temperatures between 60°C and 100°C, heat-induced denaturation of proteins results in immediate tissue coagulation associated with irreversible damage to mitochondrial and cytosolic enzymes. Above 100°C, tissue simply vaporizes. Thus, we postulated that the bacteria responsible for PLAs would easily be eradicated by RF ablation. However, there are thus far no published reports on the safety and efficacy of this modality for treating PLAs. As some patients with huge multiloculated PLAs refuse consent to surgical treatment, since 2010 we have attempted RF ablation as an alternative treatment for patients who refused or were not candidates for surgical interventions. In this article, we present the preliminary results of performing RF ablation on 4 huge multiloculated PLAs during the last 5 years.

2. Patients and methods

Between August 2010 and April 2016, 83 patients with PLAs were admitted to Beijing Chao-Yang Hospital, China. PLA was diagnosed by imaging studies (abdominal ultrasonography, computed tomography (CT) with contrast enhancement, and/or magnetic resonance imaging (MRI) with contrast enhancement), and culture of bacteria from blood or abscess samples. These patients' relevant clinical characteristics, laboratory data, imaging and microbial findings, and treatment were retrospectively extracted from their case records and a computerized database. All abscesses resulting from fungal or amebic infection were excluded from the study. Of the 83 patients, 15 had histopathologically confirmed diagnoses of malignancy originating in the hepatobiliary–pancreatic system. Four patients with huge multiloculated PLAs had undergone RF ablation plus antibiotics. The inclusion criteria for RF ablation were as follows: multiloculated PLA confirmed by CT or MRI, widest diameter of the PLA ≥ 5 cm, failure to respond to or not suitable to treatment with PD, and patient refusal of surgery. Approval from our institutional review board and written informed consent from all participants had been obtained prior to treatment.

The clinical and follow-up data of these 4 patients are shown in Tables 1 and 2. Three of the patients were female and one male. The median age was 59 years. One patient was positive for hepatitis B surface antigen. The median duration of follow-up was 12 months. The median diameter of the PLA in this study was 6.1 cm (range 5.2–8.3 cm). Three PLAs were located in the right lobe of the liver and one in the left. Mortality and recurrence were assessed on the basis of documentation in the patients' charts, including any available information on subsequent admissions or outpatient visits. Time to defervescence and duration of hospitalization were also recorded.

2.1. Pretreatment studies

The pretreatment assessment of each patient included a complete history, physical examination, complete blood count, prothrombin time, α -fetoprotein, C-reactive protein, and procalcitonin concentrations, renal and liver function tests, electrocardiogram, chest X-ray, abdominal ultrasound examination, and either spiral CT or MRI of the abdomen.

2.2. Strategy for ablation of PLAs

The management team consisted of assigned hepatobiliary surgeons, anesthesiologists, and radiologists. The specific strategy for RF ablation was individualized, mainly according to the characteristics of the abscess(es). Percutaneous or laparoscopic RF ablations were the preferred approaches for performing PLA. Percutaneous RF ablation was performed in 2 patients using Cool-tip ACTC1525 or ACT1530 electrodes (Covidien Healthcare, Ireland) in the CT suite and guided with a Synergy Plus CT scanner (GE Yokogawa Medical Systems Ltd, Tokyo, Japan). An RF generator (Covidien Healthcare, Ireland), was used for RF ablation according to the manufacturer's protocol. Patients were positioned supine on the CT table and intubated under intravenous anesthesia. A Datex-Ohmeda Aestiva/5 ventilator (GE Healthcare, Buckinghamshire, UK) was used to provide ventilation. The optimal site of puncture and angle of insertion were calculated based on CT findings. The probe was inserted at the end of an expiration.

Laparoscopic RF ablation was performed in 2 patients according to their clinical conditions and medical history. A Cool-tip ACTC2025 electrode and RF generator (Covidien Healthcare, Ireland), were also used for laparoscopic RF ablation, which involved 3 to 4 laparoscopic ports (5–10 mm in diameter) placed according to the abscess location. A 10-mm subumbilical port was used for the laparoscope. A second trocar for passage of an ultrasound probe was inserted in the right or left upper quadrant (for right or left liver lesions, respectively, and according to liver anatomy). Intraoperative ultrasound was used to facilitate ablation of the lesion. Posttreatment assessment included dynamic monitoring by C-reactive protein and procalcitonin concentrations, CT scanning or MRI.

2.3. Image analysis and posttreatment assessment

Responses of the abscesses to RF ablation were assessed by CT or MRI scans 1 month after ablation. Two abdominal radiologists with 12 and 15 years of experience in abdominal imaging interpreted the imaging findings and reached consensus. The imaging evaluators were not blinded to the patients' medical histories. The radiological characteristics of the lesions were recorded pre- and posttreatment and the findings were compared. Images were read on a PACS work-station (Centricity RA1000; GE Healthcare). Treatment was defined as effective if the following criteria were met: imaging showed that the volume of the PLA had significantly diminished and its multiloculated or honeycomb structure completely destroyed, inflammatory markers such as white cell counts and C-reactive protein concentrations returned to normal, the patient's body temperature was normal for at least 3 days after termination of all medical treatment.

Postablation morbidities were broadly categorized into minor and major complications. Minor complications were defined as complications that could be treated conservatively or resolved with oral or intravenous medications without further intervention. Major complications were those requiring transfer to the intensive care unit or treatment by an interventional or surgical procedure or both.

2.4. Statistical analysis

The mean and median values of measurements were calculated with (SPSS Inc., Chicago, Illinois, United States).

3. Results

3.1. Safety

No procedure-related deaths or major complications occurred in this study. One patient had an asymptomatic right pleural effusion that resolved with conservative therapy including albumin infusion and diuretics.

3.2. Assessment of effectiveness of RF ablation

All patients were commenced on antibiotics on admission and the antibiotics were administered at least for 1 week. One of the patients underwent an attempt at CT-guided percutaneous catheter drainage (using an 8Fr catheter) by a well-trained and licensed radiologist using a modified Seldinger technique; unfortunately, this was unsuccessful. *Klebsiella pneumoniae* were the main bacteria isolated from blood or abscess cultures (3/4 patients). RF ablation was performed immediately as soon as the inclusion criteria listed above were met. RF ablation was technically successful in all 4 patients and all their PLAs were completely eradicated (Fig. 1). The median duration of fever after RF ablation was 4.5 days (Table 2). Antibiotics were terminated 2 or 3 days after the patients' temperatures had returned to normal. No abscesses recurred. Thus, this strategy for managing PLA was effective in 100% of cases (4/4).

4. Discussion

PLA is a rare but important disease with significant morbidity and mortality. PD and broad-spectrum antibiotics currently comprise the standard treatment for small liver abscesses and achieve good outcomes in most cases.^[12,13] However, the optimal treatment of large and multiple or multiloculated abscesses is still a subject of debate.^[11–16] They are often multiloculated and can contain thick, viscid pus, which may make PD difficult. In this study, the median size of PLAs was 6.1 cm. Intravenous antibiotics were given for a median of 15 days and oral antibiotics for longer periods. These data indicate that it is difficult for antibiotics to penetrate into those abscesses. In our study, PD was attempted unsuccessfully in 1 patient. The lesions of the other 3 cases had a honeycomb appearance and were not suitable for PD because of the thick, viscid pus that was detected and assessed by CT and ultrasound examination. Surgical interventions were advised; however, all 4 patients refused this option. RF ablation was then carefully considered and administered, and found to be a safe and effective treatment in all 4 cases.

In our study, RF ablation was unique in that it completely eradicated the PLAs, thus obviating the need for further invasive treatment such as drainage or partial or anatomic liver resection. Although it may seem a drastic modality to implement, RF ablation was successful in all 4 patients, and had the advantage of being minimally invasive. Additionally, many PLAs are associated with or derived from hepatobiliary or pancreatic cancer.^[17,18] Early surgical intervention has been the preferred option for managing PLAs that fail to resolve with PD plus antibiotics. Unfortunately, patients with malignancy are often malnourished, receiving chemotherapy or radiotherapy, or have a performance status that precludes major surgery. These patients may also be

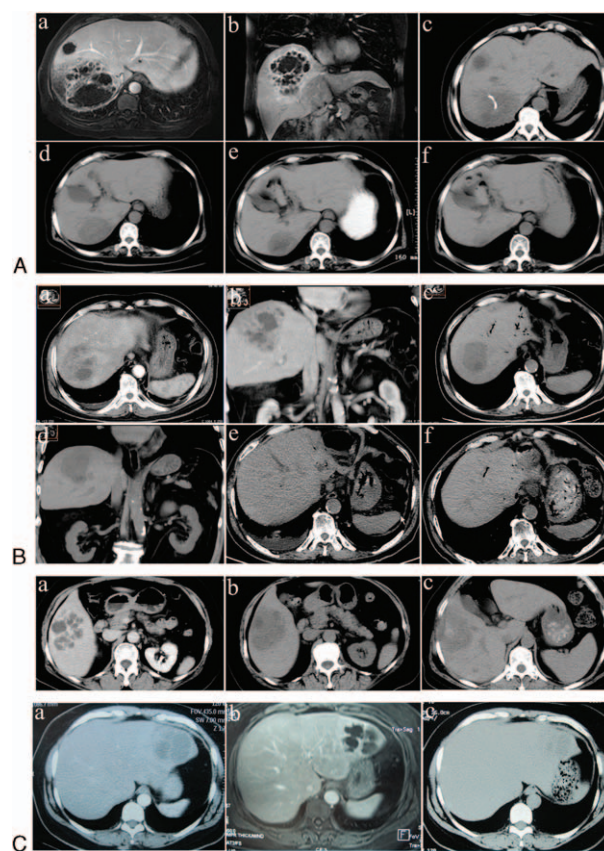


Figure 1. Four typical cases of PLA treated by the RF ablation. (A) The first case of PLA who was treated with percutaneous RF ablation. (a) and (b) MRI imaging before admitted in our hospital. (c) CT scan after percutaneous drainage. (d) One-month CT scan after the RF ablation. (e) Three-month CT scan after the RF ablation. (f) One-year CT scan after the RF ablation. (B) The second case of PLA who was treated with percutaneous RF ablation. (a) and (b) CT scan before RF ablation. (c) and (d) One-month CT scan after the RF ablation. (e) Six-month CT scan after the RF ablation. (f) One-year CT scan after the RF ablation. (C) The third case of PLA who was treated with laparoscopic RF ablation. (a) CT scan before RF ablation. (b) Six-month CT scan after the RF ablation. (c) One-year CT scan after the RF ablation. (D) The fourth case of PLA who was treated with laparoscopic RF ablation. (a) CT scan before RF ablation. (b) MRI before RF ablation. (c) Three-month CT scan after the RF ablation. CT = computed tomography, PLA = pyogenic liver abscess, MRI = magnetic resonance imaging, RF = radiofrequency.

undergoing liver-directed treatments such as hepatic artery embolization, RF ablation, and resection. Thus, RF ablation may be a preferable treatment approach for patients with malignant disease complicated by PLAs. Selection of optimal therapy would be facilitated by identifying the clinicopathologic factors that predict failure in such individuals.

In our study, the most common bacteria isolated were *K pneumoniae*. The patients' characteristics were similar to those in other series (Table 1),^[19,20] apart from the slight female predominance in our cohort. Three patients were diagnosed with diabetes mellitus and found to have very high blood glucose concentrations when they were admitted to our hospital, indicating that their glucose metabolism had been uncontrolled for a long time. We cannot be certain whether this contributed to the development of multiloculated abscesses. More studies are required to clarify this.

The main limitation of our study was that our cohort was so small, preventing us from comparing RF ablation with surgical

Table 1**Clinical features, imaging results, and etiologies of pyogenic liver abscess.**

Patient	Age /sex	Coexisting diseases	Clinical features	Abscess location	Abscess type	Widest diameter of abscess, cm	Microbiological findings from blood or abscess cultures
1	59/F	HT, DM	Pain, fever, septic shock	Right lobe (VII, VIII)	Multiple and multiloculated	8.3	<i>Klebsiella pneumoniae</i>
2	70/M	DM, biliary disorders	Pain, fever	Right lobe (VII, VIII)	Multiloculated	6.9	<i>K pneumoniae</i>
3	59/F	DM	Pain, fever, septic shock	Right lobe (VI)	Multiloculated	5.3	<i>Escherichia coli</i>
4	44/F	DM	Pain, fever	Left lobe (II, III)	Multiloculated	5.2	<i>K pneumoniae</i>

DM = diabetes mellitus, HT = hypertension.

Table 2**Indications, nature, and outcome of radiofrequency ablation.**

Patient	Initial intervention	Indications of RF ablation	Initial proposal after failed to PD plus antibiotics	Session number of RF ablation	Type of RF ablation	Minor complications	Major complications	Duration of fever after RF ablation, d	Hospitalization, d	Outcome
1	Antibiotics and CT-guided PD attempted	Failed to PD and refuse to surgery	Open surgical drainage	1	Percutaneous RF ablation	Asymptomatic right pleural effusion	No	7	22	Survive
2	Antibiotics	PD not suitable and refuse to surgery	Open surgical drainage	1	Percutaneous RF ablation	No	No	5	19	Survive
3	Antibiotics	PD not suitable and refuse to surgery	Open surgical drainage	1	Laparoscopic RF ablation	No	No	4	17	Survive
4	Antibiotics	PD not suitable and refuse to surgery	Open surgical drainage	1	Laparoscopic RF ablation	No	No	3	15	Survive

CT = computed tomography, PD = percutaneous drainage, RF = radiofrequency ablation.

intervention for the treatment of huge, multiloculated PLAs. Although this preliminary study has the limitations of all retrospective studies, namely, selection bias and small sample size, we believe that our data will be useful for clinicians selecting treatment for the rare patient with a huge, multiloculated PLA.

Our findings in this preliminary study indicate that RF ablation is a safe, feasible, and effective treatment for huge, multiloculated PLAs. We recommend it as an alternative treatment for patients with such abscesses who have failed to respond to or are not suitable for PD plus antibiotics, and who have refused surgical intervention.

Although this preliminary report case series is provocative and quite clear with the message suggesting RF ablation might become the “standard of care of huge liver abscesses,” the results cannot be extrapolated to the patients with huge liver abscesses until other lines of evidence (e.g., large observational studies, more prospective and large randomized studies) have been presented.

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