Laparoscopic and thoracoscopic thermal ablation for hepatocellular carcinoma

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Abstract

The optimal treatment for hepatocellular carcinoma (HCC) is surgical resection, however operative candidates are limited. Thermal ablation for small HCC is less invasive and effective therapy. Thermal ablation with endoscopy is highly recommended for contraindicated patients for percutaneous thermal ablation therapy, such as lesions located at surface of the liver or adjacent to the gallbladder, digestive organs, bile duct and heart.

In this review, we summarized the published English literatures including the study with endoscopic microwave coagulation therapy (MCT) and radiofrequency ablation (RFA) for HCC. Survival outcome and complication of thermal ablation are presented and discussed.

In conclusion, endoscopic thermal ablation has progressed with devices and is safe and feasible treatment modality in selected patients with unresectable HCC that are not suitable for the percutaneous approach.

Key words: hepatocellular carcinoma, radiofrequency ablation, microwave coagulation therapy, endoscopic ablation

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Introduction

Hepatic resection is one of conventional treatment for patients with hepatocellular carcinoma (HCC). However, the majority of HCC are not suitable for curative resection due to tumor size, tumor site, number of tumor, vascular and extrahepatic involvement as well as liver function. Thermal ablation is one of the less invasive and effective treatments for small hepatocellular carcinoma even if liver function is very poor\(^1\).

There are three approaches of thermal ablation which include percutaneous, endoscopic and open one. The appropriate approach for thermal ablation is selected according to the size and location of the tumor. In particular, endoscopic approach is chosen for tumors located on the liver surface or adjacent to gallbladder and digestive tract, for the purpose of preventing neoplastic seeding and organs thermal injury. For the tumors located at the hepatic dome, which we cannot observe the tumor image by ultrasonography due to lung artifact, we had better select thoracoscopic ablation therapy. Thus we can extend the indication for the treatment.

We reviewed the evidence supporting the usefulness of endoscopic thermal ablation for HCC.

Procedure of endoscopic thermal ablation therapy

1. **Endoscopic MCT**

Microwave coagulation therapy (MCT) was initially developed as a coagulation tool to be used after liver biopsy, and then adapted for hepatic tumor ablation. The majority of the experiences about MCT have obtained in Japan and China. Endoscopic MCT was accomplished primarily with monopolar-type electrodes. The microwaves act chiefly on the water component in tissues, producing dielectric heat and tissue coagulation. The ablative area of MCT forms a column with a 1 cm diameter surrounding the electrode (Fig. 1). A relatively large number of needle insertions can be necessary to coagulate the entire tumor and the surrounding liver tissue using MCT. Yu et al. reported on a comparison of standards single straight, triangular triple straight, and spherical triple-loop antennas along with pathologic findings. They concluded that multiple straight or loop antennas can generate large coagulation volumes during short procedure times, and with low complication rates\(^2\).

2. **Endoscopic RFA**

RFA is achieved using internally cooled electrodes (Cool-tip) or expandable electrodes (LeVeen and RITA). The ablative area for RFA with internally cooled electrodes forms a spheroid with a 3 cm diameter surrounding the needle (Fig. 2). Complete ablation of a tumor smaller than 2 cm can thus be accomplished with a single puncture. Shibata et al. reported on differences between internally cooled and expandable electrodes. Both devices are equally effective, and have similar complications, tumor progression free survivals, and the internally cooled needle is superior when being guided with ultrasound during its placement\(^3\).

![Figure 1 Electrode for microwave coagulation therapy (MCT)](image)

A: Straight needles of various lengths.
B: Flexible type needle.
A cylindrical coagulated area, 1 cm in diameter with a length depending on the electrode length is obtained after MCT. The coagulated area is shown as a grey area along the length of the needle.
Indication of endoscopic thermal ablation for hepatocellular carcinoma

Thermal ablation can be performed for patients with poor hepatic reserves. Indications for thermal ablation are described in Table 1. Relevant tumor parameter to be considered are: HCCs should be 4 cm or less in diameter smaller. The tumors should not be close to major vessels; and there should be no tumor thrombosis in portal and hepatic vein. Other essential functional factors for liver are: total-bilirubin, levels of less than or equal to 3 mg/dL; prothrombin activity equal to or higher than 40%; and the presence of no uncontrollable ascites. It is suitable for the area of dome by thoracoscopic approach and for superficial lesion in the liver or adjacent to the organs (gallbladder, intestine, heart, i.e.) by laparoscopic approach. It is desirable to endoscopic thermal, in case of tumor which is difficult to visualize percutaneously or high risk for bleeding. Endoscopic ablation is usually carried out under general anesthesia. So it is required good general condition enduring general anesthesia.

Among the reports describing the endoscopic MCT and RFA long term survival were summarized in Table 2-4.

Local recurrence in endoscopic thermal ablation for HCC

The local recurrence rate of laparoscopic and thoracoscopic thermal ablation varies from 0 to 12% \(^{4,5,9,10}\). Many of these studies have suggested that secure local control treated by endoscopic ablation is an advantage compared with the treatment by percutaneous approach \(^{9,7,17,18}\). The factors associated with the risk of local recurrence include an HCC with age, tumor size, thoracoscopic approach and inadequate ablation margin \(^{10}\).

The assessment of survival in endoscopic thermal ablation

Several reports demonstrated 1-year, 3-year, 5-year disease-free survival rate were 59% to 82%, 28% to 48%, and 22%, respectively \(^{5,8,11-13}\), and 1-year, 3-year, 5-year overall survival rates were 81% to 95%, 40% to 89%, and 27% to 82%, respectively \(^{4,5,10}\) (Table 2-4). It is reported Child class and AFP level and were independent favorable predictors of overall survival on multivariate analysis \(^{4,5,10}\).

Usefulness of intraoperative endoscopic ultrasonography

One of the merits of endoscopic thermal ablation is that it is able to perform endoscopic ultrasonography to detect the new lesions which were not observed by preoperative imaging. Santambrogio et al. reported that it permits to treat lesions not treatable with the percutaneous approach, to detect new HCC nodules which consisted 27% of all lesions by intraoperative endoscopic ultrasonography \(^{7}\).

![Figure 2](image)

Electrodes for radio-frequency ablation (RFA)

A: Single cool-tip needle.  
B: Cluster needle.  
A cool-tip needle can form a bulbous coagulated area, approximately 3 cm in diameter. A cluster needle, consisting of three cool-tip needles, can coagulate larger areas of liver tissue, up to 4.5 cm in diameter. The coagulated area is shown as a grey area around the needle in the lower part of the figure.

**Table 1** Indication of thermal ablation

- Essentially unresectable
- Superficial type, Tumor size ≤ 4 cm, up to three nodule
- Without tumor thrombs
- Without being adjacent to hepatic portal region
- No uncontrollable ascites
- T-bil level ≤ 3 mg/dL, PT activity ≥ 40%
Complication

Complications specific to endoscopic thermal ablation therapy are pneumoniae, pneumothorax, trocar injuries, post-operative bleeding from abdominal wall. Complication rate in endoscopic ablation ranged from 2.2% to 29% (Table 2-4). Llovet reported that dissemination along puncture route was observed in 12.5% of their patients treated with percutaneous RFA. However, there was no report about tumor seeding after endoscopic thermal ablation. Because operator is able to observe the treatment site in endoscopic ablation and wash the treatment area if tumor bursts into abdominal cavity in thermal ablation.

The assessment of efficacy and complication in elderly patients

Tesche et al. reported that 2 year-overall survival rate in laparoscopic RFA for elderly patients of age 60 years or elder with HCC was 75% and complication rate was 10%. The prognosis factor of mortality was not high age, but the number of ablated lesions, platelets count, and AFP level by multivariate analysis. Laparoscopic RFA is well tolerated in elderly patients with HCC.

Comparison of efficacy between endoscopic RFA and MCT

It was reported that MCT and RFA had equivalent with regard to therapeutic effects, complication rates, and incomplete tumor necrosis in percutaneous ablation. Ohmoto et al. reported that RFA can achieve a lower local recurrence rate and a higher survival rate. While, there were two reports comparing endoscopic MCT and RFA. Sakaguchi et al. reported that it was no differences in the effect on survival and local recurrence between MCT and RFA in multicenter study. Simo et al. reported that average ablation volume and the effects of survival were almost equal.
Laparoscopic thermal ablation for HCC in the caudate lobe

The treatment for HCC in caudal lobe is very difficult, because of anatomic location. It was reported that laparoscopic with hand assisted RFA was safely performed in five patients. There was no operative mortality but 1 patient who had minor bile leakage which was treated conservatively. At a mean follow-up 32.2 months, one patients had local recurrence after 3 months, 3 patients had tumor recurrences in another segments after 6 months. All patients are alive and local recurrence was observed in 1 patient.

Hybrid thermal ablation for multinodular HCC

In cases of multi nodular HCC located both superficial and deeper sites in liver, it is relatively difficult to perform an accurate puncture the deep- site tumor in pure laparoscopic ablation. In such cases, hybrid ablation was useful. The procedure is to perform with endoscopic ablation first, followed by the percutaneous ablation with artificial ascites. It is easier to treat deeper-site tumor compared to pure laparoscopic ablation therapy. The complete disappearance of tumor enhancement was observed in 76 of 77 (98.7%) percutaneously-treated and 61 of 62 (98.4%) endoscopically-treated tumors. The mean amount of Intraoperative bleeding, median postoperative hospital stay, major complication rate and 5-year survival rate in hybrid ablation were similar to pure laparoscopic ablation.

Conclusion

Endoscopic ablation is a safe and feasible treatment to cure an HCC tumor in selected patients. The main advantage of the endoscopic approach is possible to treat lesions which percutaneous ablation therapy is contraindicated or risky.

References