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ORIGINAL ARTICLE

Ablation effects of noninvasive radiofrequency field-induced hyperthermia on liver cancer cells

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KEYWORDS

Non-invasive radiofrequency;
Ablation of liver cancer;
Clinical efficacy

Abstract To have in-depth analysis of clinical ablation effect of noninvasive radiofrequency field-induced hyperthermia on liver cancer cells, this paper collected liver cancer patients' treatment information from 10 hospitals during January 2010 and December 2011, from which 1050 cases of patients were randomly selected as study object of observation group who underwent noninvasive radiofrequency field-induced hyperthermia treatment; in addition, 500 cases of liver cancer patients were randomly selected as study object of control group who underwent clinical surgical treatment. After treatment was completed, three years of return visit were done, survival rates of the two groups of patients after 1 year, 2 years, and 3 years were compared, and clinical effects of radiofrequency ablation of liver cancer were evaluated. Zoom results show that the two groups are similar in terms of survival rate, and the difference is without statistical significance. 125 patients in observation group had varying degrees of adverse reactions, while 253 patients in control group had adverse reactions. There was difference between groups $P < 0.05$, with significant statistical significance. It can be concluded that radiofrequency ablation of liver cancer is more secure. Therefore, the results of this study fully demonstrate that liver cancer treatment with noninvasive radiofrequency field-induced hyperthermia is with safety effect and satisfactory survival rate, thus with relatively high clinical value in clinical practice.
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1. Introduction

Liver cancer, liver malignant tumor, can be divided into primary and secondary ones. Primary liver malignant tumor originates from liver epithelial or mesenchymal tissue, which belongs to a serious malignant tumor (as shown in Fig. 1). Secondary liver cancer is relatively rare in comparison (Wu et al., 2015a, 2015b). Secondary or metastatic liver cancer refers to violations of the liver by malignant tumor that originates from multiple body organs (as shown in Fig. 2). In recent years, with

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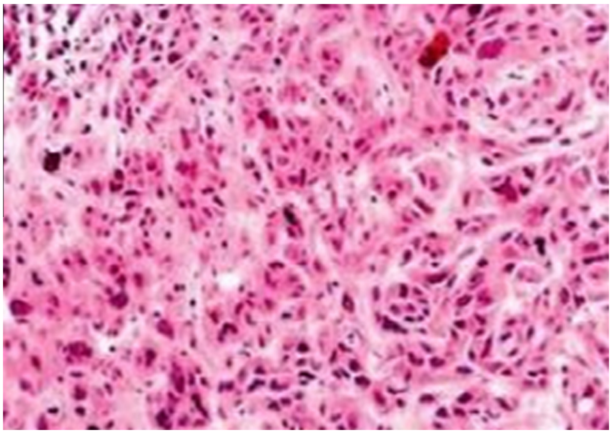

Figure 1 Primary liver cancer.

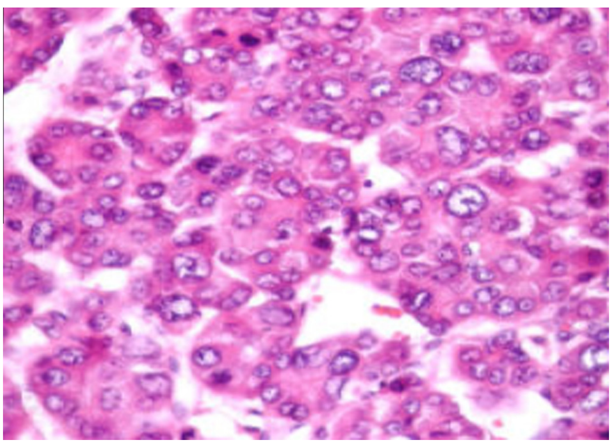

Figure 2 Secondary liver cancer.

the accelerating pace of life and the increasing bad habits in life, incidence of liver cancer in countries has increased year by year.

In clinical surgery, excision is usually adopted for liver cancer patients. But because of stealthiness of primary liver cancer, many patients in the early stages of hospitalization are diagnosed as terminal stages of cancer. In this case, there is relatively great risk for surgery, and only about 20% of patients can receive surgical treatment. But the effect after treatment is generally difficult to be satisfactory. Usually at six months after the treatment, 30% of patients will have relapse of illness (Wu et al., 2015a, 2015b; Xu et al., 2014; Han et al., 2015). With the passage of time, the recurrence rate also rises, and there are patients with metastasis and progression of the disease. It can be seen that effect of surgical treatment is difficult to make people completely satisfied, and cannot provide strong guarantee for health and safety of patients. In recent years, with continuous development of medical concepts and medical technology, radiofrequency ablation (RFA) therapy has become one of important treatment means in comprehensive treatment of liver cancer. Compared with surgical treatment, non-invasive radiofrequency ablation treatment enjoys advantages such as less trauma, safety and reliability, repeatability, and low treatment costs (He et al., 2015; Zhang et al., 2015).

Radiofrequency ablation is to insert radiofrequency electrode into the tumor tissue under ultrasound or CT guidance. Radiofrequency electrode emits radio frequency of 400 kHz, polar molecules and ions in the tumor tissue have high-speed motion vibration with the same rate as radiofrequency current, generating frictional heat which is transmitted to adjacent tissue, leading to internal temperature rise of tumor tissue, water evaporation, drying, condensation in inner and exterior cells, and thus aseptic necrosis, thereby killing tumor cells and achieving therapeutic purposes. Thus, heat of radiofrequency ablation derives from tissue surrounding electrode rather than electrode itself (as shown in Fig. 3). Under normal circumstances, under 42 °C, cells already have thermal damage. If the temperature is increased to 45 °C and lasts 3–50 h, cells will have progressive degeneration. As the temperature rises, time for irreversible cell damage is exponentially shorter. When temperature is greater than 60 °C, protein solidification occurs instantaneously, resulting in cell death. Temperature over 100 °C can cause boiling water within the tissue, evaporation and until carbonization (August et al., 2016; Sang et al., 2014). Fundamentally, lesion necrosis caused by radiofrequency ablation is different from classic "necrosis". During radiofrequency ablation, temperature of 80–110 °C can make tissue in vicinity of electrode directly freeze, which constitutes the main body of radiofrequency ablation lesion. Life structure affected by the heat energy, especially cytosolic enzyme protein, will be instantaneously solidified. This heat-induced structural variability and functional inactivation of the enzyme protein determine that radiofrequency ablation is impossible to have progressive enzymatic tissue damage or cell degradation as classic necrosis. Under the microscope, radiofrequency ablation lesion section exhibits five tissue damage reaction bands of temperature inclined curve from the center to the outer periphery: A band – electrode needle tract, carbonization or evaporation center caused by high heat production in the periphery; B band and C band – tumors or tumor adjacent to tissue paleness or reddish-brown coagulation necrosis caused by moderate heat production; D band – sharp-edged reddish or brown bleeding band caused by mild fever; and E band – outer layer of edema caused by mild fever. Generally, central region (A band) of radiofrequency ablation lesion and two outer zones (D and E band) can be confirmed based on characteristic change of tissue structure and cell components. Intermediate solidification zone (B band and C band) constitutes the main body of ablation lesions.

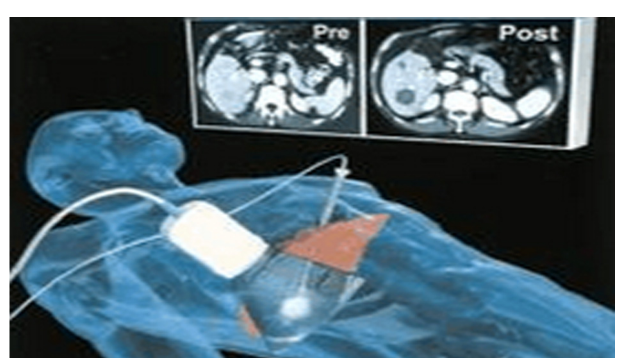

Figure 3 Liver cancer treatment model with radiofrequency ablation.

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