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Microwave ablation in tumors: A state of the art review

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Abstract

This work is a review of the state of the art about Microwave Ablation (MWA) in tumors. This technique is a novel method to treat tumors in different organs, such as Lung, Liver, Kidney, Breast and others; and can be applied for patients that can't be treated by surgery.

It begins with a brief description of the recurrence and other types of tumors, as well as techniques used for the ablation of the same.

The patients reported in this review, was voluntaries that they can't be operated, so looking for another alternative, they found the MWA as the most compelling option.

Key words: Tumor, Ablation, Microwave.

1. Introduction

A tumor is a mass of cells transformed with growth and multiplication abnormal[1].

Tumors can be cancerous (malignant) or non-cancerous (benign) and occurs when cells multiply excessively in the body. Normally, the division and growth of cells are controlled in a strict manner. New cells are created to replace the old or to perform new functions. Cells that are damaged or already do not need die to replace them with good cells. If the balance of division and cell death is altered, a tumor can be appear[2].

Cancer cells can invade and damage tissues and organs near to the tumor. Cancer cells may be spreading of malignant tumor and enter to the lymphatic system or blood flow, which is the way in which the cancer reaches other parts of the body. The characteristic appearance of cancer is the ability of the cell to grow quickly, uncontrolled and independent of the tissue where it began. The spread of the cancer to other sites or organs in the body by the bloodstream or the lymphatic system is called metastasis. Malignant tumors can be classified into two categories:

- ✓ Carcinomas are the most common type of cancer which commonly appear in the skin, lung, breast, stomach, colon and uterus.
- ✓ Sarcomas are cancers of the connective tissue and support of all types. Sarcomas are found in any part of the body and often form secondary growths in the lungs[3].

2. Tumor Ablation

When surgery is not an option for the patients, new emerging techniques for tumor ablation, ablation understood as the use of heat, cold or chemical to destroy a tumor, using a needle or catheter.

In the case of heat, a common type of ablation is the radiofrequency ablation (RFA), uses a needle that carries an electric current, the end of the needle is placed into the tumor by CT (Tomography) or ultrasound. An electrical current that passes through the needle warms the tumor to destroy it. For the cold, the Cryoablation uses the probe placed in the tumor to freeze it and destroy cancer cells, other methods use heat too(laser-induced interstitial thermotherapy) or alcohol to destroy cells[4].

2.1 State of the Art, MWA

It is increasingly more frequent see appliances which based its operation in the generation of microwave for various purposes

whether it be communication, preparation and cooking of food, military and medical.

In medicine the microwave being used increasingly in the ablation of tumors, where through the application of microwave originates the tumor to burn and finish to get rid.

To achieve the tumor ablation through microwave several prototype antennas have been used. These antennas are designed to make them more small and with a better targeting of the power to prevent damage to healthy tissue.

During the ablation vivo temperatures not chilled antenna were 90 ° C or higher, which caused unwanted tissue coagulation, while the antenna with internal cooling temperatures were lower than 20° C in all processes without any unwanted tissue coagulation.

They came to the conclusion that the antenna with internal cooling best done with microwave ablation for models of liver and may be most suitable for the therapy of malignant liver tumors in clinical practice[5]. Other antennas for microwave application in order to talk about a tumor can observe them in designs like the Punit Prakash et al (2009)[6]. P. Keangin et al (2011) or Marta Cavagnaro et al (2011) to name a few, researchers are developing this type of antennas to generate heat via microwaves and are more and more patents granted under this type of antenna design[7, 8].

Using software COMSOL Pattarapong Phasukkit et al (2013), simulations were carried out to determine the effects of alignment of multiple antennas, simulating the difference of phase 0, 45, 90, 135 and 180 degrees. Concluding that the phase difference must take into account in a settlement multiantenna for ablation of tumors microwave[9]. Due to the development of software and studies researchers have proposed new methods and programs that involve the application of microwave for the ablation of tumors[10-13].

3. Analysis of results

Worldwide MWA for tumors in different organs has been increasingly applied.

The following is a summary of the research is presented about this technique.

In liver tumors has increased greatly the use of MWA, more and more patients that are not candidates for surgery and choose to treat their tumors MWA.

Some studies are made in animals, like the Pig or Bovine liver, for example Garrean S. et al (2009) conducted research where he achieved tumor ablations of 3 to 6.45 centimeters, in pig liver ablations lasted 4 minutes and were made at 2.45 GHz, another studies made in pig liver obtained a good results of ablation zone[14-17].

In the case of human patients, there are many registered studies, the therapy time is between 4 to 15 minutes, and the generator power is 915 MHz or 2450 MHz, and in a case was between 902 to 928 MHz, there were no complications in most of cases after the therapy. To mention some, in a study by Livraghi et al (2012), in 736 patients with 1037 tumors, only there was 22 major complications and 54 minor complications with no mortality[18-25].

For Lung tumors, the cases reported obtained similar results like liver tumors, there are a study reported by Little M et al (2013), in this study, was made ablations with different power (180 W and 120 W), was performed to compare and determine which is the best power and the time for ablation therapy, it concludes that in 180 W requires 2 minutes for less than 2 cm tumors, 4-6 minutes in 3 to 5 cm tumors, for the 120 W power, requires 1 minute for less than 1 cm tumors, 8 minutes for 2.4 cm tumors, they obtained 88 % ablation control. Another studies was achieved in other investigations for lung tumors[26-29].

In kidney tumors Guan W et al (2012) They made a comparison between partial nephrectomy and microwave ablation, 48 patients with MWA and 54 patients with partial nephrectomy, the 3-year survival was 91.3% for MWA and 96 % for partial nephrectomy[30, 31]. The applicators for MWA therapy was between 14 to 15 gauges.

To breast cancer, Cepeda (2011) in his doctoral studies suggested using MWA for this type of cancer, in patients, there are not studies reported[32].

Conclusion

As described are many cases of success of ablation of tumors by means of microwave technique, so that the MWA is a technique that thanks to the study and cases of success in recent years will be used increasingly in the ablation of cancerous tumors.

Although many successful tests have been made, the MWA has failed to consolidate in the Centers for the treatment of these diseases, so it has to give wider dissemination and provide patients with cancerous tumors using this technique, primarily to patients who are not candidates for the operation for the removal of the tumor.

It should also equip hospitals specializing in the treatment of teams that are capable of performing the MWA cancer and thus offer patients an alternative to the destruction of his tumor, explaining

the risks and benefits that brings this ablation technique.

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