UNIVERSITI TEKNOLOGI MARA

MODIFIED RECTANGULAR MICROSTRIP APPLICATOR FOR NONINVASIVE HYPERTHERMIA BREAST CANCER TREATMENT

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ABSTRACT

Hyperthermia is an alternative treatment for cancer procedure, which utilizes high temperature of 41^0C-46^0C for cancer cells denaturation into necrotic cells. In particular, hyperthermia treatment procedure (HTP) has been employed as therapeutic systems in oncology to overcome the limitations of conventional therapeutics such as infertility, radiation injury and massive bleeding. However, poor penetration depth and focusing capability on the treated tissue of an existing applicator contribute to the low success rates of hyperthermia cancer treatment, especially when non-invasive treatment was concerned. Hence, this research is conducted to develop a modified rectangular microstrip applicator for hyperthermia treatment to improve the limitations, and thus increase the success rate of hyperthermia cancer treatment. Besides, the adverse health effects from available applicators such as the unwanted hot area surrounding cancer tissue would reduce with the improvement of the applicator focusing capability. A conventional rectangular microstrip antenna is selected as the main element of the applicator since it has shown good penetration depth and focus position distance with its simple structure. The antenna is modified by adding a structure of rectangular corner with Y-slot and then integrated with a metal antenna lens structure, to form a proposed applicator for hyperthermia breast cancer treatment. A SEMCAD X simulator software is used to design, develop, modify, and carry out EM-simulation of the hyperthermia applicator. A simulated breast phantom also constructed with SEMCAD X software. The breast phantom is developed using actual human breast character parameters to observe the specific absorption rate (SAR) distribution that use to determine depth penetration and focusing energy distances. The results have shown a penetration depth up to 80mm, and the focus energy position for breast cancer treatment could be better controlled with an energy focus distance between 20 mm to 80 mm. Therefore, it resulted in reducing the unwanted hotspots, which then decrease the adverse health effects on the surrounding healthy tissues. A water bolus is then added to the treatment procedure to complete the setup arrangement for HTP execution. Based on the observation, the addition of water bolus can reshape the effective field size (EFS) of the SAR deposition. In summary, the proposed modified rectangular microstrip applicator can improve penetration depth and EM energy focus capability. It is envisaged that an improved penetration depth and energy focusing capability can increase the success rate of hyperthermia cancer treatment. However, for further research, it is recommended to carry out experiments by fabricating this prototype applicator to further verify the outcomes of this research.

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

This chapter presents an introduction to the research. Sections 1.2, 1.3, 1.4, and 1.5 provide motivation, problem statement, objectives, and research hypotheses. Next, Sections 1.6, 1.7, 1.8, 1.9 and 1.10 discuss the significance of study, knowledge contribution, research process, the scope of work, and research outlines.

1.2 Research Motivation

Non-invasive hyperthermia treatment procedure (HTP) is a cancer treatment modality that utilizes high heat for cancer cells denaturation into necrotic cells. This treatment is safer than current conventional cancer treatment procedures such as chemotherapy, radiotherapy, and surgery. As in previous research, main concern of HTP is the massive skin burn problem. However, it can be reduced by adding a water bolus to the treatment procedure. Moreover, HTP can be used as an adjuvant to chemotherapy to enhance cytotoxic effects. Besides, it is also used as an adjuvant to radiotherapy to intensify the radiation sensitivity of cancer cells [1]–[3]. With such abilities, HTP could become an alternative for cancer treatment.

Nevertheless, poor penetration depth and focusing capability of the HTP applicator contribute to the low success rate of non-invasive hyperthermia cancer treatment. This situation is the motivation to carry out this research to improve HTP by developing a modified HTP applicator. Figure 1.1 shows a penetration depth and focusing on the treated tissue that required to be radiated by the proposed applicator.

In this research, breast cancer tissue is used as the treated tissue. This selection is driven by the increasing number of breast cancer incidences, as reported by the Ministry of Health Malaysia in *National Cancer Registry Report, Malaysia Cancer Statistics 2007 to 2011* [4]. Breast cancer was reported to have the highest incidence with 17.7%, compared to other cancer incidences such as colorectal and trachea, bronchus and lung with 13.2% and 10.2%, respectively. According to global statistics, which was presented by Sayed et al. (2017), breast cancer is the most common type of