

Modeling and Simulation of Radiation-proof Clothing for Pregnant Women based on Finite Element Method^{*}

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Abstract

Relevant research shows that pregnant women have a high sensitivity to electromagnetic radiation. At present, there is a lack of digital evaluation system for the simulation model of the degree of electromagnetic radiation exposure of pregnant women and the effectiveness of electromagnetic radiation shielding clothing for pregnant women. In this paper, the simulation model of pregnant woman and fetus is proposed, and the virtual fitting software is used to model the clothing, and finally the three-dimensional electromagnetic simulation software is used to combine the model and simulate the real situation. In this paper, the effects of electromagnetic radiation on pregnant women and fetuses before and after wearing electromagnetic radiation protective clothing were studied by means of digital evaluation. The results showed that the influence of electromagnetic radiation on pregnant women concentrated in the neck, chest, abdomen, leg; To a certain extent, electromagnetic radiation protective clothing can reduce the impact of radiation on pregnant women and fetuses. In this paper, a digital evaluation method is proposed, which provides a new idea for testing the effectiveness of electromagnetic shielding for pregnant women.

Keywords: Radiation proof clothing; A pregnant woman; Finite element model construction; Shielding effectiveness

1 Introduction

At present, the frequency band used in mobile communication is microwave frequency band, which is closely related to People's Daily life. Microwave is a physical occupational disease hazard factor, its impact on the human body has been more and more attention [1]. In life, electromagnetic radiation has penetrated into every corner, electromagnetic radiation is colorless and silent, so that people tend to neglect their own protection. Research shows that pregnant women this kind of special groups are more vulnerable to electromagnetic radiation damage [2], so some anti-electromagnetic radiation maternity clothes came into being.

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As a kind of functional clothing, how to evaluate the protective effect of radiation-proof maternity clothing has aroused people's thinking. Scholars at home and abroad have also carried out corresponding studies on the effectiveness and influencing factors of electromagnetic shielding of clothing. In terms of physical experiments, considering the harm of electromagnetic radiation to human body, real dressed human bodies are generally not used for experiments. Peng Zhang et al. [3] adopted full-wave darkroom method to test the shielding efficiency of dummy chest and abdomen. Zhang Xiaoxia [4] made the FRP pregnant woman table and experimental sample for the experiment, and analyzed the factors affecting the shielding efficiency of the clothing combined with the structural characteristics of the clothing. Chaochan Chen et al. [5] established a darkroom electromagnetic shielding suit performance test system. In the aspect of finite element simulation experiment, Zhang Lili et al. [6] used Ansoft HFSS to simulate and analyze the influence of body shape changes of pregnant women in different pregnancies on clothing shielding effectiveness. Yao Li [7] used HFSS to simulate the GTEM cell shielding test system. Sun Ruili [8] established a simulation model of clothing pores based on clothing structure. Ma Liang [9] established a simplified model of human body and clothing, and simulated the electromagnetic radiation values at different tissue levels of the human body by using electromagnetic field finite element technology. According to previous studies, the finite element method greatly simplifies the experimental process when studying the shielding efficiency of clothing, and can accurately reflect the distribution of electromagnetic field on the human body, saving economic cost and time cost.

In the evaluation of the shielding effectiveness of pregnant women's clothing, most studies mainly focus on the effects of clothing structure, clothing pores, dummy models and other aspects on the shielding effectiveness, while few studies on biological electromagnetic models and clothing models with similar real situations. The research content of this paper will be based on finite element simulation, modeling of pregnant women and fetuses and modeling and simulation of radiation protective clothing. At present, in the field of clothing performance simulation, biomechanical model and clothing mechanical performance simulation are mostly used. This study created a more complete biological electromagnetic model of pregnant women and fetuses on the basis of previous studies, and combined with virtual fitting software for clothing modeling that is more in line with the reality. The purpose of this paper is to provide a safe and convenient method for testing the effectiveness of clothing shielding, and to provide a new idea for the optimization of clothing products. As for the functional clothing against electromagnetic radiation, it is necessary to ensure the reliability of clothing performance, and multiple physical experiments will increase the production cost of clothing, so using computer simulation method will provide a more convenient new idea for clothing product design.

2 Establishment of simulation model

2.1 Establishment of human body model

The simulation model mainly includes two parts: the pregnant woman model (late pregnancy) and the fetus model (late pregnancy). The two models are constructed by using the method of reverse modeling. The general steps of reverse modeling are as follows: determine the scanning scheme – solid point cloud scanning – conduct point cloud data – establish surface – solid modeling. In this study, the non-contact 3D body scanning equipment used in the pregnant woman model was the