Analysis of the influence of the pregnant woman model on the whole body SAR of the fetus exposed to plane wave operating at 900MHz

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INTRODUCTION

Nowadays many questions are raised on a public level related to the biological effects associated to electromagnetic waves and in particular to possible effects on fetuses. The initial difficulty is to obtain heterogeneous whole body models of pregnant women. Most realistic pregnant woman models are built from the segmentation of 3D ultrasound images or from the segmentation of magnetic resonance imaging [1]. Since these images are dedicated to pregnancy follow-up, the derived models are limited to the region between the lungs and hips of the woman (Figure 1). To obtain complete models, it is important to add the remaining part of the body. It is also very important to analyze the influence of the heterogeneity of these added body parts on the whole body SAR (wbSAR) induced in the fetus. This study aims at analyzing the influence of the remaining body on wbSAR induced by an incident EM plane wave in fetus inserted into the heterogeneous women model. The wbSAR in the fetus is determined using the finite difference in time domain (FDTD) method. The source used for this study is a plane wave (vertical polarization) at 900 MHz.

MATERIALS AND METHODS

The first aim of this study is to estimate the wbSAR induced in fetus inserted into the heterogeneous women model named "NAOMI' without deformation (Figure 2). The heterogeneous fetus model used is obtained from MRI data, and contains five different tissues (eyes, lungs, brain, bladder and fetus body) [2] and with weight about 2.6 kg. The second aim is to replace the top and bottom part of women body by homogeneous tissues [3] (Figure 3). In this configuration the distance between the homogeneous part and the top of the fetus is about 24mm and on the bottom it is about 46mm. All models have a resolution of 2x2x2mm^3.

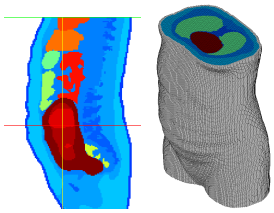

Fig. 1. Original acquisition pregnant woman

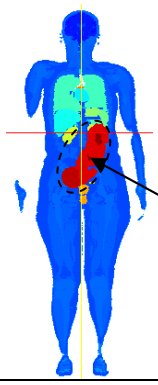

Fig. 2. Naomi model + fetus inserted

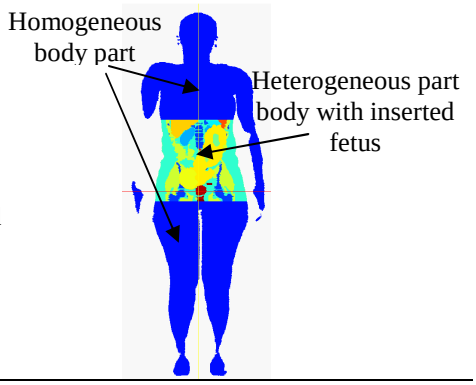

Fig. 3. Fetus + heterogeneous body part + homogeneous body part

RESULTS

The wbSAR has been estimated for a fetus at 34 weeks of pregnancy inserted into Naomi model. Table 1 shows that the wbSAR in the fetus when the women is not heterogeneous is lower than the fetus inserted in the heterogeneous model. The exposure decreases by using the equivalent liquid given by IEC 62209 [3] in the homogeneous part of body (about 8% for wbSAR) and 99% of peak SAR values are under 3.4% (Figure 4). These equivalent liquids do not overestimate the absorption induced in the fetus in this configuration. The new equivalent liquid will be defined to get the same SAR induced in the heterogeneous body.

Naomi model	wbSAR (mW/kg)
Naomi (Heterogeneous)	1,64
Naomi (Hetero/homog)	1,51
Variation	8 %

Table 1. wbSAR in the fetus

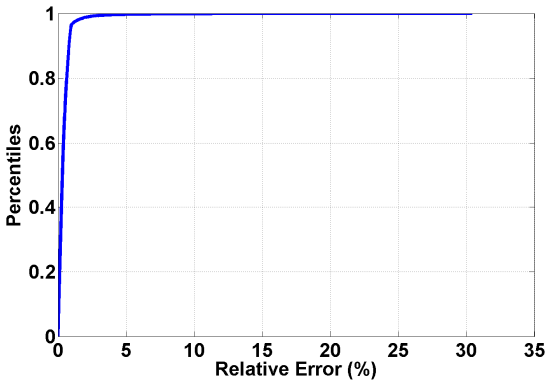

Fig. 4. Empirical CDF of the relative Error of the peak SAR.

CONCLUSIONS

A comparison of the wbSAR induced in fetus was performed employing an incident plane wave having a vertical polarization and operating at 900 MHz. The SAR was numerically estimated using the FDTD method. The use of the original acquisition of the heterogeneous pregnant women model can be used, with body homogeneous part added if the choice of equivalent liquid overestimate the wbSAR induced in fetus. Further work is needed for definitive conclusion since these simulations have been carried out only for specific cases: a specific fetus model inserted into the heterogeneous pregnant women without deformation.

ACKNOWLEDGMENTS

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