COMPREHENSIVE STUDY OF DIELECTRIC PROPERTIES OF PORCINE HEAD AND NECK TISSUES AT MICROWAVE FREQUENCIES

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INTRODUCTION

It is essential to have accurate knowledge of the dielectric properties of head tissues when determining the distribution of Specific Absorption Rate (SAR) in the human head. These data are needed in computer simulation of the human head and the development of appropriate tissue equivalent materials to be used for measurement. Most of the data in the literature [1] and the extensive database published at 1996 [2-4] pertain to excised tissues. It is generally agreed that data obtained in-vivo are more relevant to the assessment of the exposure of people. This paper deals with the determination of the dielectric properties of porcine head tissue, measured in vivo, in frequency range 50 MHz to 20 GHz.

OBJECTIVE

The objective of this study is to provide a comprehensive database of dielectric properties of porcine head and neck tissues in-vivo and an assessment of the associated uncertainty. The skull tissue is studied in detail and the dielectric properties of different regions are compared. An attempt is made at relating the measured dielectric data with the physiological and histology properties of skull and bone marrow.

METHODOLOGY

The dielectric measurements are made using an optimal size (2-3mm diameter) open ended coaxial probe and computer controlled network analyzers following a previously reported procedure [5].The minimal handling involved makes this procedure ideally suited for in-vivo measurements. The accuracy oft his technique is between 1-2% for measurements on homogenous samples. Measurements were made on 50-70kg pigs under general anesthesia. These conditions are thought to provide an acceptable substitute for living human tissue data. Multiple measurements are made on each tissue and a statistical analysis is applied to the pooled data from all pigs. A special effort is made to characterize as many head tissues as possible (up to 13 tissues). The data obtained from recently killed animals are compared with those obtained from live animals. A comprehensive method to calculate the uncertainty associated with dielectric measurement is developed and applied to all measured tissues.

RESULTS AND DISCUSSION

The results of dielectric measurements of different soft head tissues show that Grey matter, archnoid and pia matter have higher permittivity and conductivity values compare to white matter and spinal cord, while dura has values in between the two groups. In the case of skull, the permittivity and conductivity data obtained were significantly higher than the corresponding data available in the literature. In order to investigate and explore the properties of pig skull further, the surface of the skull has been divided into three regions. Results show that position C (the top of the skull) has the highest dielectric values, while the other two regions (Mandible and Zygomatic bones) have somewhat lower values. An initial visual inspection of the skull bone depicts a pink tissue, pitted and moist to the touch, rather different from the smooth dry surface of cortical bone. It is important to determine whether or not

these properties pertain to porcine skull bone tissue or if these are more general properties of animal head bone.

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