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<http://dx.doi.org/10.1016/j.nhtm.2014.11.024>

Satellite symposium: Emerging role of microwave imaging technology (organized by the biomedicine and molecular biosciences COST action TD1301) Microwave Imaging for Breast Cancer Detection

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Abstract

Breast cancer is the most common cancer in women worldwide, with nearly 1.7 million new cases diagnosed in 2012. This represents about 12% of all new cancer cases and 25% of all cancers in women. The current standard method for detecting non-palpable early stage breast cancer is X-ray mammography. Despite the fact that X-rays provide high-resolution images at low radiation doses, its limitations are well documented. In the U.S., up to 75% of all malignancies identified by X-ray mammography are later found to be benign after biopsies. These false positive conclusions result in unnecessary biopsies, causing considerable distress to the patient and an unnecessary financial burden on the health service. Much more worryingly, up to 15% of all breast cancers present at the time of screening are missed by conventional mammography, often delaying treatment to the point where it's no longer effective. One of the most promising alternative imaging modalities is Microwave Imaging. Microwave Imaging is based on the dielectric contrast between healthy and cancerous breast tissue at microwave frequencies. Microwave imaging is non-ionising, non-invasive, does not require uncomfortable breast compression, and is potentially low cost.

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Microwaves for medical imaging: Some possible pathways for an accelerated progress towards clinical practice

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Abstract

The talk will start from a brief review of the physical basis of microwave imaging for medical diagnostics and of the challenges that have to be faced in this technology, to present three areas which are possibly the most promising ones for a fruitful application of microwave imaging in the medical arena. The first one is the monitoring of brain injuries, which is a topic of increasing importance for its impact on the European health system in the ageing society. In particular, it will be discussed how microwave imaging can play a role both in the detection of the diseases in the early stage and in their clinical follow-up, by filling the gap between current diagnostic modalities and the need of continuous monitoring at the patient's bed. The second one is the potential of enhancing the capabilities of microwave imaging by means of contrast agents. Indeed, while contrast enhancement is a common practice to improve performances in medical imaging, it presents even some remarkable and specific advantages in microwave imaging, provided suitable contrast agents are adopted. Third, and not last, the intrinsically dual nature of microwaves, which are not only a diagnostic tool, but also a therapeutic

means (hyperthermia, thermo-ablation), makes them a suitable candidate to address the emerging paradigm of theranostics, wherein the imaging capability provide the basis for truly patient specific treatments.

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Hyperthermia applications at microwave frequencies

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Abstract

Short introduction to microwave hyperthermia from the point of view of biology and physics will be given firstly. The physical basis of microwave thermotherapy for cancer treatment and for other medical microwave therapeutic purposes (e.g. in cardiology, urology, surgery, physiotherapy, etc.) will be described in this talk. Different kinds of hyperthermia clinical applications will be mentioned (i.e. local, deep local, regional and intracavitary treatment). Different physical and technological approach to describe these above given different cases will be discussed. For each of these mentioned cases a different type of electromagnetic (EM) wave should be used: EM plane wave for local treatment, converging cylindrical EM wave for regional treatment and finally diverging cylindrical EM wave for intracavitary treatment. Then different types of applicators (resp. antennas) for microwave hyperthermia clinical applications will be discussed (e.g. waveguide, waveguide horn, evanescent mode, planar, array, lens, metamaterial etc. applicators). Each of these microwave technologies has its specific advantages in creation of the optimal SAR and temperature distribution in the area to be treated. It is given by its specific EM field distribution in the aperture of these applicators. And the importance of the so called treatment planning will be discussed. It is based on several different numerical methods (e.g. FDTD, FEM, MOM etc.) for calculation of the SAR in the treated area firstly and afterwards for calculation of the temperature distribution in the treated area with respect to the time, blood perfusion, etc. Last part of this presentation will be dedicated to description of clinical results of hyperthermia in cancer treatment. Importance of possibility to combine effectively hyperthermia with e.g. radiotherapy and/or chemotherapy will be underlined.

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Other applications of medical microwaves – Breast tumour classification

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Abstract

This talk addresses the development of imaging techniques for the early detection of breast cancer, based on Ultra Wideband (UWB) radar, a promising emerging technology that exploits the dielectric contrast between normal and tumour tissues at microwave frequencies. Of particular interest in this work are issues related to techniques for classification of potential breast tumours into benign and malignant. This is particularly important given the results from recent studies of the dielectric properties of breast and tumour tissue, which have found that strong similarities exist between the dielectric properties of malignant, benign and normal fibroglandular breast tissue. This creates a more challenging imaging scenario and motivates the development of enhanced signal processing techniques for UWB imaging systems.

Tumour growth and development patterns are modelled using Gaussian Random Spheres, using four discrete sizes and four different shapes.