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Thermal analysis of cancerous breast model.

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Abstract

Breast cancer is one of the most common and dangerous cancers. Subsurface breast cancer lesions generate more heat and have increased blood supply when compared to healthy tissue, and this temperature rise is mirrored in the skin surface temperature. The rise in temperature on the skin surface, caused by the cancerous lesion, can be measured noninvasively using infrared thermography, which can be used as a diagnostic tool to detect the presence of a lesion. However, its diagnostic ability is limited when image interpretation relies on qualitative principles. In this study, we present a quantitative thermal analysis of breast cancer using a 3D computational model of the breast. The COMSOL FEM software was used to carry out the analysis. The effect of various parameters (tumor size, location, metabolic heat generation and blood perfusion rate) on the surface temperature distribution (which can be measured with infrared thermography) has been analyzed. Key defining features of the surface temperature profile have been identified, which can be used to estimate the size and location of the tumor based on (measured) surface temperature data. In addition, we employed a dynamic cooling process, to analyze surface temperature distributions during cooling and thermal recovery as a function of time. In this study, the effect of the cooling temperature on the enhancement of the temperature differences between normal tissue and cancerous lesions is evaluated. This study demonstrates that a quantification of temperature distributions by computational modeling, combined with thermographic imaging and dynamic cooling can be an important tool in the early detection of breast cancer.

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