Magnetic resonance thermography

see Laser interstitial thermotherapy

see Magnetic resonance guided laser induced thermal therapy

Regional hyperthermia is a non-invasive technique in which cancer tissue is exposed to moderately high temperatures of approximately 43-45 degrees C. The clinical delivery of hyperthermia requires control of the temperatures applied. This is typically done using catheters with temperature probes, which is an interventional procedure. Additionally, a catheter allows temperature monitoring only at discrete positions. These limitations can be overcome by magnetic resonance (MR) thermometry, which allows non-invasive mapping of the entire treatment area during hyperthermia application. Various temperature-sensitive MRI parameters exist and can be exploited for MR temperature mapping. The most popular parameters are proton resonance frequency shift (PRFS) (Delta phi corresponding to a frequency shift of 0.011 ppm, i.e. 0.7 Hz per degrees C at 1.5 Tesla), diffusion coefficient D (Delta D/D = 2-3 % per degrees C), longitudinal relaxation time T(1) (Delta T1/T1 approximately 1% per degrees C), and equilibrium magnetisation M(0) (Delta M(0)/M=0.3% per degrees C). Additionally, MRI temperature mapping based on temperature-sensitive contrast media is applied. The different techniques of MRI thermometry were developed to serve different purposes. The PRFS method is the most sensitive proton imaging technique. A sensitivity of +/-0.5 degrees C is possible in vivo but use of PRFS imaging remains challenging because of a high sensitivity to susceptibility effects, especially when field homogeneity is poor, e.g. on interventional MR scanners or because of distortions caused by an inserted applicator. Diffusion-based MR temperature mapping has an excellent correlation with actual temperatures in tissues. Correct MR temperature measurement without rescaling is achieved using the T(1) method, if the scaling factor is known. MR temperature imaging methods using exogenous temperature indicators are chemical shift and 3D phase sensitive imaging. TmDOTMA(-) appears to be the most promising lanthanide complex because it showed a temperature imaging accuracy of <0.3 degrees C [1].

[1]

Lüdemann L, Wlodarczyk W, Nadobny J, Weihrauch M, Gellermann J, Wust P. Non-invasive magnetic resonance thermography during regional hyperthermia. Int J Hyperthermia. 2010;26(3):273-82. doi: 10.3109/02656731003596242. PubMed PMID: 20345269.