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Magnetic nanoparticle heating in an AC magnetic field; an ex vivo approach

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Abstract:

Magnetic fluid hyperthermia (MFH) is the ever-promising "fourth leg" of cancer treatment. This thermotherapy is based on the fact that magnetic nanoparticles can transform electromagnetic energy from an external high-frequency field to heat, thus affecting the viability of malignant cells. In this work, in order to address the current challenges in clinical magnetic hyperthermia and due to the lack of tissue heat dissipation in *in vitro* studies, hyperthermia experiments were performed in phantom systems and eventually in *ex vivo* environment. For this purpose, iron oxide nanoparticles were chosen as hyperthermia magnetic carriers, and injected in tissue mimicking phantom models (by using appropriate dispersion medium such as agarose), while various substances (e.g. albumin) were utilized as a tool for visualisation of the heating area. For *ex vivo* systems magnetic carriers injected in bovine liver and sausage pork. All prepared samples were subjected in hyperthermia experiment, with magnetic field amplitude of 30 mT and frequency of 760 kHz (Fig.a). Heat diffusion of our studies was illustrated using an infrared digital camera while optical images revealed the final heating effect in each case. More specifically, our results revealed thermal denaturation of albumin protein as well as color changes in irradiated liver (Fig.b-e) at highest recorded temperatures of 70°C and 100°C respectively. Moreover, heat dissipation results of the computational analysis developed using COMSOL Multiphysics®, showing good agreement with available experimental findings, are also discussed.

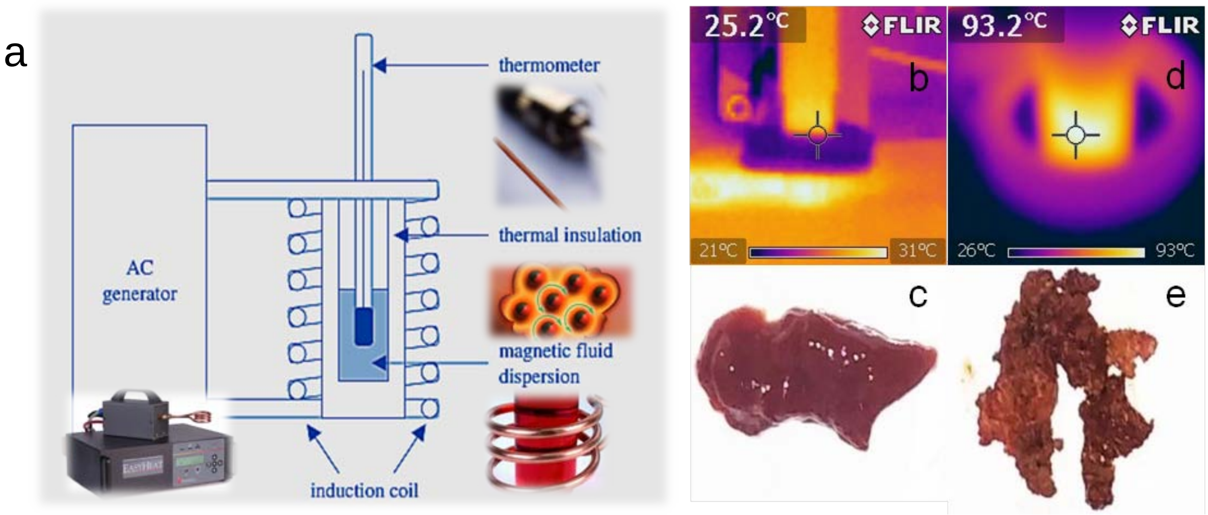

Figure: Scheme of magnetic hyperthermia setup (a). Heat map and bovine liver image without (-b,c) and with (d,e) magnetic nanoparticles after the application of AC magnetic field. It is obvious that the sample with injected magnetic nanoparticles was successfully submitted to heating treatment.