A comparison study between three different magnetic nanoparticles for Magneto Motive Ultrasound Imaging

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There is a well-known modality called Elastography to obtain information about tissues stiffness, while this method has a dominant limitation which is the dependency on the operator. Currently, various types of US elastography are in use, for instance, transient elastography (TE), sonoeelasticity, acoustic-radiation-force-induced (ARFI) elastography, and Shear Wave Dispersion Magneto Motive Ultrasound (SDMMUS). This last one is a branch of magneto motive ultrasound imaging that investigates shear waves generated magnetically by an alternating magnetic field in order to assess the elasticity and viscosity of a medium labeled with magnetic nanoparticles (Fe3O4). In this work, three different magnetite nanoparticles, synthesized by co-precipitation method, were used as a contrast agent in SDMMUS to evaluate the viscoelasticity properties of gelatin phantom. In this study, we are using an oscillating remote magnetic force to induce a deformation into the structure of the sample labeling with three magnetite nanoparticles, naming A (14 nm), B (20 nm), C (14nm with latex-coated). A linear ultrasound transducer connected to a diagnostics ultrasound system (Sonix RP) was used to detect the microdisplacement induced into the sample. To perform SDMMUS, we used gelatin tissue mimicking phantoms of agar (1 wt. % of Bovine gelatin, Bloom 250) homogenously labeled with 1 wt. % of nanoparticles as inclusions. The SDMMUS setup was consisted of a coil inner and outer diameters of 45 mm and 89 mm, respectively, with a ferrite core of 1 cm of diameter, to generate the magnetic field which was driven by a function generator connected to a power amplifier. The tone bursts of 10 cycles of sinusoidal voltage with different range of frequencies from 50 to 250 Hz were used. Voigt model was applied to evaluate the viscoelastic properties of gelatin phantoms. Displacements in the range of micro were observed in phantoms after processing by a code developed in Matlab. The displacement oscillation frequency is the double of the magnetic field. According to the results among these three kinds of nanoparticles, sample A induced the larger displacement. This method will be useful to detect pathologies in early stages using appropriate magnetic nanoparticles.