Magnetic Nanoparticles Coated by Latex with Optimized Properties as Contrast Agent in Shear Wave Dispersion Magneto-motive Ultrasound Imaging

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Background, Motivation and Objective

Shear wave dispersion magneto-motive ultrasound imaging (SDMMUS) has been proposed as a novel elasticity imaging to evaluate the mechanical properties of the medium. In this modality, the induced displacement due to the interaction between the magnetic nanoparticles (MNPs) and an external magnetic field generates shear wave (SW) within the medium labelled with magnetic nanoparticles. Viscoelastic parameters including shear elasticity and shear viscosity can be achieved by propagation of SW.

Statement of Contribution/Methods

In this work, using an oscillating magnetic force induced displacements of an internal structure of a gelatin tissue mimicking phantom labelled with two magnetite nanoparticles were generated. These displacements inside the sample were detected by a linear ultrasound transducer connected to a diagnostics ultrasound device model Sonix RP. Here, two kinds of MNPs, namely bare MNPs and MNPs covered with natural rubber latex (NRL), were used. Both MNPs were synthesized by co-precipitation method. The size and saturation magnetization (M_s) of bare magnetic nanoparticle were 12±4.17 nm and 57 emu/g respectively. The covered MNPs (MNPs-800NRL) had the size 7.9±1.5 nm and M_s 119 emu/g. The gelatin tissue mimicking phantoms (4 wt. % of Bovine gelatin, Bloom 250) were homogenously labelled with 1 wt. % of aforementioned MNPs. The Levenberg–Marquardt algorithm, as a nonlinear fitting, was applied to calculate the velocity of shear waves versus excitation frequency in order to estimate the viscoelastic parameters.

Results/Discussion

According to the observed results, MNPs covered by latex, which had the higher magnetization but smaller size, enhanced the contrast of shear wave dispersion magneto-motive ultrasound imaging. Induced displacements for bare MNPs and MNPs-800 NRL were 16 ± 0.7 μm and 35.5 ± 1.56 μm respectively. The shear elasticity was 7.32 ± 0.30 kPa and shear viscosity was 3.24 ± 0.22 Pa.s for bare MNPs, and for MNPs-800NRL shear elasticity and shear viscosity were 7.16 ± 0.27 kPa and 3.64 ± 0.20 Pa.s respectively.