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Horizontal shear wave scattering from a nonwelded interface observed by magnetic resonance elastography

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Abstract

A method based on magnetic resonance elastography is presented that allows measuring the weldedness of interfaces between soft tissue layers. The technique exploits the dependence of shear wave scattering at elastic interfaces on the frequency of vibration. Experiments were performed on gel phantoms including differently welded interfaces. Plane wave excitation parallel to the planar interface with corresponding motion sensitization enabled the observation of only shear-horizontal (SH) wave scattering. Spatio-temporal filtering was applied to calculate scattering coefficients from the amplitudes of the incident, transmitted and reflected SH-waves in the vicinity of the interface. The results illustrate that acoustic wave scattering in soft tissues is largely dependent on the connectivity of interfaces, which is potentially interesting for imaging tissue mechanics in medicine and biology.

1. Introduction

The scattering of plane elastic waves by interfaces is of fundamental interest in seismology (Aki and Richards 2002) and medical imaging (Tribikram 2004). For example, the exploration of fractures and cracks in the Earth's upper crust is based on the scattering effects of seismic waves. In ultrasonic imaging, the scattering of elastic waves is directly related to the image contrast. In shear wave-based elastography as well (Lerner *et al* 1990, Muthupillai *et al* 1995, Sandrin *et al* 1999, Park and Maniatty 2006), the observation of scattering effects was reported in the context of MR elastography of the brain (Sack *et al* 2005, 2006). The analysis of elastic wave scattering in complex media suffers from multiple unknowns influencing the degree of wave reflection and transmission from elastic discontinuities. Particularly, in the presence of imperfectly bounded tissue layers, the degree of scattering is a function of

