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Research paper

In vivo feasibility case study for evaluating abdominal aortic aneurysm tissue properties and rupture potential using acoustic radiation force impulse imaging

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ABSTRACT

An abdominal aortic aneurysm (AAA) is defined as a permanent and irreversible localized dilatation of the abdominal aorta. A reliable, non-invasive method to assess the wall mechanics of an aneurysm may provide additional information regarding their susceptibility to rupture. Acoustic radiation force impulse (ARFI) imaging is a phenomenon associated with the propagation of acoustic waves in attenuating media. This study was a preliminary evaluation to explore the feasibility of using ARFI imaging to examine an AAA *in vivo*. A previously diagnosed *in vivo* aneurysm case study was imaged to demonstrate the viability of excitation of the abdominal aorta using ARFI imaging. *Ex vivo* experiments were used to assess an artificially induced aneurysm to establish its development and whether ARFI was able to capture the mechanical changes during artificial aneurysm formation. A combination of *in vivo* and *ex vivo* results demonstrated a proposed hypothesis of estimation of the tissue's stiffness properties. The study details a method for non-invasive rupture potential prediction of AAAs using patient-specific moduli to generate a physiological stiffness rupture potential index (PSRPI) of the AAA. Clinical feasibility of ARFI imaging as an additional surgical tool to interrogate AAAs was verified and methods to utilize this data as a diagnostic tool was demonstrated with the PSRPI.

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1. Introduction

For many years, clinicians have been aware of the correlation between the mechanical properties of a soft tissue and its state of health. An abdominal aortic aneurysm (AAA) is defined as a permanent localized dilation of the aorta

constituting at least a 50% increase in normal diameter (Xiong et al., 2008). There are approximately 200,000 patients in the United States and 500,000 patients worldwide diagnosed with an AAA every year (Vande Geest et al., 2004). The development of AAAs is associated with alterations of the connective tissue in the aortic wall. It is characterized by a destruction of elastin

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