Transesophageal Magnetic Resonance Imaging of Thoracic Aorta Using an Esophageal Loopless Antenna

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Purpose
The purpose of this study was to develop a non-invasive method of imaging the thoracic aorta which would provide both morphological detail within the aortic wall as well as information about regional aortic wall motion.

Introduction
Current standard techniques for imaging the thoracic aorta include CT, standard body-coil MRI, transesophageal echocardiography (TEE), and contrast aortography. Each of these techniques suffers some limitation in its ability to allow detailed mapping of the aortic wall and its anatomic and functional lesions. Body-coil MRI and CT lack adequate resolution of the aortic wall for precise characterization of aortic atheroma, and are not able to provide aortic wall tissue tagging information. TEE allows real time imaging, but suffers from both an inability to image clearly the quadrant of the aortic wall which is directly against the esophagus, and from an inability to register images to a fixed frame of reference. Contrast aortography is lumenography; the tissues which make up the aorta are not seen directly.

Previously a loopless catheter antenna has been used for in vivo intravascular imaging of rabbit aortae [1]. To address the need for a less invasive method of aortic imaging we exploited the fact that the esophagus and the aorta are directly juxtaposed throughout the length of the descending thoracic aorta. Our goal was to design and animal-test a device which, in principle, could be passed down the esophagus of a non-sedated human patient and provide information not obtainable by other non-invasive methods.

Methods
The design and construction of the MRI-compatible loopless coil RF receiver antenna are described previously [1]. The current device is such an antenna, designed inside a modified 12 Fr. Levin gastric tube (Sherwood Medical, St. Louis, MO, USA).

Domestic pigs were endotracheally intubated and ventilated, using inhaled halothane (≤2%) as anesthetic. Esophageal placement of the antenna device was confirmed by fluoroscopy. At the end of each study, the pig was sacrificed and the aorta and esophagus harvested en bloc for gross and microscopic histopathologic examination for evidence of tissue injury.

Tagged and non-tagged cine images were obtained as described previously [2]. Imaging parameters are listed under figure 1.

Results
Images of the thoracic aorta, with and without tissue-tagging, obtained by trans-esophageal MRI (TEMRI) in a live, anesthetized domestic pig are shown in Figure 1.

Histopathologic examination of aorta and esophageal tissues from the sacrificed animals revealed no evidence of injury.

Discussion
We have demonstrated the feasibility and safety of imaging the thoracic aorta using an esophageal loopless MR antenna. This technique has direct application to studies of aortic atheroma size, morphology and composition. These properties cannot be measured as well, or at all, by competing techniques. Non-invasive studies of, for example, changes in atherosclerotic plaques in response to pharmacologic interventions, could be considered using this technique. In addition, with the addition of ECG-gated cine tissue tagging, this technique offers the first means of direct observation of regional stress/strain relationships in the aortic wall throughout the cardiac cycle.

References

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