Endoleak and Thrombus Characterization with Dynamic Elastography after Endoleak Embolization following Aneurysm Endovascular Repair.

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Introduction. The Supersonic Shear Imaging (SSI) technique measures tissue elasticity in real-time and produces a quantitative map of tissue stiffness. The purpose of this study was to investigate if SSI can characterize thrombus organization, the mechanical properties of embolization agents (Chi and Chi STS) and the healing of AAAs over time after endoleak embolization in a canine model of EVAR. We hypothesized that SSI can assess the fibrous organization of the thrombus, detect area of endoleak or fresh thrombus associated with endotension and the mechanical properties of embolization agents over time.

Methods. EVAR was done with creation of type I endoleak in eighteen aneurysms created in nine dogs (common iliacs arteries). Two embolization gels (Chitosan (Chi) or Chitosan-Sodium-Tetradecyl-Sulfate (Chi-STS)) were injected in the sac to seal the endoleak and promote healing. SSI and Doppler Ultrasound were performed at baseline (implantation, 1-week, 1-month, 3-months) whereas angiography and CT-scan were performed at sacrifice. Macroscopic and histopathological analyses were processed to identify and segment five different regions of interest (ROIs) (endoleak, fresh or organized thrombus, Chi or Chi-STS). Elasticity modulus values were compared in these ROIs.

Results. At sacrifice, ten aneurysms had endoleaks, nine had fresh thrombus, fifteen had organized thrombus and three were completely sealed. At 3 months, elasticity modulus (in kPa) of 0.1±0.2, 9.2±3.5, 47.3±25.7, 55.9±21.7 and 69.6±29.0 were respectively found in endoleak, fresh and organized thrombus, Chi and Chi-STS regions. Elasticity values of endoleak and fresh thrombus areas were significantly lower than organized thrombus, Chi and Chi-STS areas (p<0.001). Elasticity values of fresh thrombus ranged between 3 and 19 kPa (8.7±3.6 kPa) at 1-week and 30.2±13.8 kPa at 3-months indicating that SSI can evaluate thrombus maturation. Aneurysm with fresh thrombus did not shrink as fast as aneurysm with only organized thrombus.

Discussion. This project confirms that SSI was able to characterize thrombus organization and embolization agents after endoleak embolization following EVAR. It can monitor thrombus organization over time. A lower elastic modulus value corresponds to fresh thrombus whereas a higher value corresponds to organized thrombus. This technique could also be useful to characterize the mechanical properties of embolization agent. In addition, this real-time ultrasound modality can complement conventional DUS which is already used in a clinical setting for EVAR follow up and endoleak detection. The next objective is to evaluate the feasibility and efficacy of this approach in a clinical study compared to CT-scan.

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Aucuns conflits d'intérêts à déclarer.
Project funding: FRQ-S-ARQ and IRSC.