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The impact of acoustic radiation force impulse sonoelastography to assess the liver stiffness in patients after Fontan procedure

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Introduction
Although late hepatic dysfunction and cirrhotic change were often seen in Fontan patients, not only the prevalence and progression of cirrhotic changes but also the non-invasive diagnostic tools for hepatic fibrosis have not been clearly clarified. In this study, we aim to clarify the clinical impact of the novel echographic imaging: sonoelastography using acoustic radiation force impulse (ARFI) to assess the liver stiffness in Fontan patients.
Methods
The study subjects were 20 patients with Fontan procedure (age: 12.7 +/- 5.3 years) and 75 patients either with minor cardiac anomalies or after uncomplicated definitive surgeries, having no hemodynamic compromise, (age: 11.4 +/- 6.2 years) as a control. The imaging apparatus was Acuson S-2000 (Siemens AG, USA) with 9L4 and 4C1 probe. The liver stiffness was measured and estimated by shear propagation velocity (m/s) (Vs) by Virtual Touch TM tissue quantification (VTTQ) which provided accurate numerical measurements related tissue stiffness at user-defined location using ARFI. The value of Vs was proportional to the degree of tissue stiffness (Young elastic modulus). The patients were in prone position and Vs at the 2-3cm inner portion of the right lobe of liver was measured at 5 times consecutively and averaged.
Results
Vs of Fontan patients (2.52 +/- 0.63 m/s) was significantly higher than those of the control patients (1.25 +/- 0.23 m/s) ($p<0.001$). In Fontan patients, Vs was weakly proportional to the ratio of mean pulmonary artery and aortic pressure : PA/AO ($r2=0.29$), the ratio of pulmonary and systemic vascular resistance: Rp/Rs ($r2=0.31$), and the multiplication of central venous pressure(CVP) and interval from Fontan ($r2=0.27$), but not associated with age at measurement, the interval from Fontan procedure, CVP, cardiac index, and biomarkers (BNP, r-GTP, platelet). Vs of Fontan patients were lower than those of patients with end-staged liver cirrhosis (> 4.0).
Conclusion:
The liver stiffness after Fontan patients measured as Vs by VTTQTM is higher than control from shortly after Fontan operation and weakly associated with PA/Ao, Rp/Rs, and CVP*Interval. The Vs by VTTQTM could be a powerful tool for early non-invasive detection of liver fibrosis and cirrhosis in Fontan patients.