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Towards Non-Invasive Assessment of Central Venous Pressure Variations using Real Time and Quantitative Liver Stiffness Estimation

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Objectives. The main purpose of this study was the real-time evaluation of the variation impact of central venous pressure (CVP) on liver stiffness (LS) by shear wave elastography (SWE) in a cohort of children with heart disease.

Background. SWE has been showed and used as a non-invasive, quantitative and reproducible approach to assess LS. LS has been reported to be associated with fibrosis but there is also a potential dependence of LS with the CVP.

Methods. 103 children (6.8±5.5 years) referred to our institution for diagnostic or interventional right heart catheterization (RHC) were prospectively enrolled. CVP and LS were measured simultaneously at baseline and after 15 ml/kg of volume loading. Inferior vena cava (IVC) diameter and pulsed-Doppler profile of hepatic veins were also evaluated. Plasma level of NT-pro-BNP was assayed during the RHC.

Results. At baseline RHC, mean CVP was 7.4±2.9 mm Hg [range 3–16] and mean LS was 9.0±5.8 kPa [4–46.1]. After volume loading, mean CVP increased significantly to 10±3.3 mm Hg [3-18] ($p<10^{-4}$) and mean LS increased significantly to 14.4±9.1 kPa [4.3-72] ($p<10^{-4}$).
LS significantly correlated with CVP [r=0.89, p<10−4; CVP=(ln(LS)-1)/0.145]. Optimal cut-off value of LS for detection of CVP > 10 mmHg was 10.8 kPa (Se=89.3%, Sp=86.0%), with an area under the curve of 0.946 (95% CI 0.920 to 0.971; p=0.01).
Beyond this correlation, LS is sufficient to provide an indirect and reliable measurement of quantitative CVP variations.
IVC diameter, pulsed-Doppler profile of hepatic veins and NT-pro-BNP were less robust than LS to estimate CVP.

Conclusions. Here, we show that LS measurement using SWE is a reliable surrogate of quantitative estimation of the CVP. It can also be used to measure CVP changes in real time. LS could potentially be a useful non-invasive tool for evaluation and follow-up of acute and chronic right heart failure.