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Assessment of Ventricular Pressure-Volume Relations and Myocontractility by Real Time Three Dimensional Transesophageal Echocardiography Coupled with Diagnostic Catheterization

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Introduction:
In physiology, pressure-volume relations (pv-loops) are still the gold-standard for studying inotropic myocardial systolic and diastolic performance. Technical challenges for simultaneous measurement of ventricular pressures and volumes are, however, a barrier for their introduction into the clinical context. The objectives of this study were to determine the feasibility and accuracy of measuring left ventricular (LV) pressure volume relationships and derived parameters of myocontractility in a large animal model using real time three-dimensional transesophageal echocardiography (RT3DTEE) coupled with catheterization. Conductance catheter (CC) pv-loops served as gold standard.
Methods:
Six pigs (median weight 34 kg) were studied. CC (6 F, Millar, TX) were positioned in the LV apex via right carotid artery access (MPVS Ultra, Millar and PowerLab, AD Instruments). Simultaneous CC and RT3DTEE ('3D Opt' single beat mode, X7-2 X matrix, iE33, Philips) data were obtained with the animal ventilated (end-expiration), and paralyzed (vecuronium) at 3 different conditions: baseline, inferior vena caval (IVC) occlusion, and IVC occlusion during dobutamine (5 µg/kg/min). All measurements in each condition were performed thrice. CC derived LV pressures (Labchart) were integrated with RT3DTEE volumes (TMQ, QLab) on a beat-to-beat basis using an ECG trigger signal. From CC and RT3DTEE derived pressure volume loops, the end systolic pressure volume relations (Emax) were determined.
Results:
Bland-Altman analysis showed excellent agreements between the RT3DTEE and CC for parameters derived at baseline and with dobutamine. At baseline, the mean ± SD were (mmHg/mL) Emax-CC 1.86 ±1.1 and Emax-RT3DTEE 1.78 ± 1.2 (p= 0.502). On dobutamine, the means were Emax-CC 3.43 ± 1.5 and Emax-RT3DTEE 3.60 ± 1.23 (p= 0.171). Emax (mean ± SD) normalized to end diastolic volumes were 0.034 ± 0.02 for CC and 0.033 ± 0.02 for RT3DTEE at baseline (p=0.433); the respective values were 0.081 ± 0.04 and 0.084 ± 0.03 on dobutamine (p=0.133).
Conclusions:
Pv-loops and Emax can accurately be assessed by RT3DTEE and there is good agreement with CC methods. Thus, the use of RT3DTEE might facilitate the introduction of intrinsic myocardial functional parameters in the clinical context.