Title: Comparing Left Ventricular Contractility Assessments: TEE dp/dt vs Arterial Pressure dp/dt
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Student's Role: Assisted with data acquisition, collaborated on data analysis, drafted and collaborated on data presentation.

Background
Left ventricular (LV) contractility is used to describe cardiac function and guide intraoperative management. Contractility can be characterized by dp/dt, which represents the change in LV pressure during isovolumetric contraction. Direct measurement requires an invasive LV catheter. There is no established standard for noninvasive measurement of dp/dt. Current options include transesophageal echocardiography (TEE) and arterial pressure waveform analysis.

Methods
Following Human Subjects Research Committee approval, data was collected from sequential elective cardiac surgery patients, over age 18, with planned arterial pressure, Swan Ganz, and intraoperative TEE monitoring. Data was collected at five intraoperative timepoints: post-induction, pre-incision; post-incision, pre-sternotomy; post-heparin, pre-bypass; post- bypass, pre-sternal closure; and post-sternal closure, pre-incision closure. The TEE dp/dt was obtained with the Philips Epiq CVx from the continuous wave Doppler tracing of the mitral regurgitation (MR) jet. Arterial pressure dp/dt was obtained with the Edwards Acumen transducer and HemoSphere monitor with Hypotension Prediction Index software. TEE dp/dt was calculated from the slope of the MR jet between flow rates of 100 and 300 mmHg/s. Five consecutive dp/dt values from the HemoSphere centered at the time of the MR jet image were averaged to determine the Arterial Pressure dp/dt value. Cardiac output (CO) was obtained with a Swan Ganz CCOmbo V catheter. Systemic vascular resistance (SVR) was calculated with the equation $\text{SVR} = \frac{\text{MAP-CVP}}{\text{CO}} \times 80$. Statistical evaluations utilized GraphPad Prism.

Results
Data were collected from 43 patients: average age 66.8±12 years, average weight 83.76±17 kg, average height 174±9 cm, 33 males, 10 females, 34 ASA class 4. 51% of the patients underwent coronary artery bypass grafts; other procedures included aortic or mitral valve repairs/replacements and aortic aneurysm repairs Patient care, unstable waveforms, and technical malfunctions precluded complete data collection. Of 215 possible measurements, 138 TEE and 142 arterial pressure dp/dt points were available with 79 paired data sets. The arterial pressure dp/dt did not have a significant correlation with the TEE dp/dt (p=0.336, Spearman rank correlation coefficient 0.097). The concordance rate in a four-quadrant plot for these two dp/dt values (0% exclusion zone) was 55%, or moderately concordant, and did not increase with a larger exclusion zone.

Conclusions

In this study, TEE and arterial pressure dp/dt measurements were not interchangeable. The correlation was not significant and the Spearman coefficient demonstrated only a weak relationship. The concordance was of moderate strength. Previous reports have demonstrated a significant relationship between TEE and arterial pressure dp/dt measurements especially with greater SVR and lower CO.[1] In our study, the relationship between the two dp/dt values only in patients with high SVR did not improve. We also considered the potential confounding impact of the increased variability of TEE dp/dt measurements in patients with high dp/dt values, and repeated the data analysis for TEE dp/dt ≤ 2000 mmHg/s. There was no significant change in the relationship between dp/dt measurements ($p=0.145$, Spearman rank correlation coefficient 0.157). Though TEE and arterial pressure waveform analysis are two ways of obtaining the same measure of left ventricular contractility (dp/dt), these measurements are not interchangeable in this clinical setting.

References

1. Ostadal P, Vondrakova D, Krüger A, Janotka M, Naar J: Continual measurement of arterial dP/dt_{max} enables minimally invasive monitoring of left ventricular contractility in patients with acute heart failure. *Critical Care* 2019; 23(1):364