A384

TITLE: CAN PULMONARY ARTERY PRESSURES BE ESTIMATED BY TRANSESOPHAGEAL ECHOCARDIOGRAPHY?

AUTHORS: IA Muhiudeen, MD, K Oken, MD, H Kuecherer, MD, N Schiller, MD and MK Cahalan, MD
AFFILIATION: Depts. Anesthesia and Cardiology, UCSF, San Francisco, CA 94143-0648

Transesophageal echocardiography is used intraoperatively to assess left ventricular function, myocardial ischemia, valvular function, preload (including mean left atrial pressure) and cardiac output.[1-3] The purpose of this study was to determine whether TEE, like precordial echocardiography,[4] could also be used to estimate pulmonary artery pressures by pulsed Doppler analysis of pulmonary artery flow. With approval from our Committee on Human Research, we studied 35 consecutive patients (34-77 yr) undergoing cardiac or vascular surgery. Anesthetic management included premedication with morphine sulfate and diazepam, induction and maintenance of anesthesia with fentanyl (30-100 µg/kg) or sufentanyl (10-15 µg/kg), and muscle relaxation with pancuronium or vecuronium. After the induction of anesthesia, tracheal intubation and insertion of a pulmonary artery catheter, TEE probes (Hewlett Packard, Inc, Andover, MA; Advanced Technology Laboratories, Inc, Bellevue, WA; Aloka, Wallingford, CT) were inserted. An observer blinded to the hemodynamic data performed 2-D color and pulsed wave Doppler imaging. The pulsed Doppler measurements were obtained from the proximal main pulmonary artery, placing the sample volume (2 mm) just above the level of the pulmonic valve where color Doppler indicated maximal flow velocities. Invasive pulmonary artery pressure measurements and Doppler recordings were obtained simultaneously. Four separate echocardiographic and hemodynamic measurements were made in each patient when the patient was hemodynamically stable. The Doppler recordings were then analyzed off-line in a random order by 2 observers blinded to the hemodynamic data. We measured the acceleration time and ejection time of flow through the pulmonary artery and calculated the ratio. Invasive pulmonary artery pressure measurements were correlated with pulmonary artery outflow acceleration and ejection time and pulmonary outflow acceleration time/ejection time ratio using linear regression analysis (based on the method of Dabestani et al.[4]). Data from 98 of the 140 possible episodes were analyzed. The rest were excluded from study: 2 for atrial fibrillation and severe dysrhythmias, 18 for inadequate tracings of Doppler signals, 6 for inadequate 2-D recordings of the pulmonary artery, 14 when access to the TEE probe was denied for logistic or clinical considerations, and 2 for inadequate invasive hemodynamic signals.

Doppler indices of pulmonary arterial flow did not correlate with invasive measurements of pulmonary arterial pressure. We were unable to reproduce the reported close correlation[4] between precordially measured acceleration time/ejection time (Act/Et) ratio and mean pulmonary artery pressure. Correlation coefficients for the mean, systolic and diastolic pulmonary artery pressures correlated poorly with the acceleration time: (r= 0.03, 0.01, 0.04), ejection time: (r= -0.48, -0.37, -0.49), and with the Act/Et ratio: (r= 0.29, 0.23, 0.29). Constraints in this technique include reliance on 2-D echocardiography for placement of the Doppler sample volume in the center of the 3-D pulmonary artery. Our attempts to investigate the region of maximal laminar flow may have been hindered by inconsistency in interrogating the true center of the pulmonary artery from a perspective parallel to flow. With TEE the main pulmonary artery is relatively parallel to the angle of Doppler interrogation (rendering pulmonary artery flow amenable to Doppler evaluation), but its orientation is different from that obtained with/imaged by precordial echocardiography. This difference may explain why our TEE findings correlated poorly with invasive measurements and the discrepancy between our findings and those of Dabestani et al. Alternatively, positive pressure ventilation may alter pulmonary flow dynamics (or invasive hemodynamic measurements) sufficiently to explain the discrepancy. Unlike our patients, those participating in the precordial echocardiographic studies were breathing spontaneously. We conclude that transesophageal echocardiography is not a reliable intraoperative tool for estimating/monitoring pulmonary artery pressure in patients undergoing cardiac and vascular surgery.

References:
1. Anesth Analg 66:249-261, 1987
2. Circulation 85:1127-1139, 1990
3. Anesthesiology 74:9-14, 1991
4. Am J Cardiol 59:662-668, 1987

A385

Title: AUTOMATED REAL-TIME ANALYSIS OF TRANSESOPHAGEAL ECHOCARDIOGRAMS

Authors: M.K. Cahalan, M.D., P. Ionescu, M.D., H. Melton, PhD.
Affiliations: Anes. Dept, University of California, SF CA 94143; and HP Labs, Palo Alto, CA

Quantitative evaluation of transesophageal echocardiographic images has been too time consuming for intraoperative use. However, we now report our initial results using an automated border detection device (ABD) which continuously computes the cross-sectional area of the LV cavity.

Methods. With approval of our committee on human experimentation, we performed 47 sets of measurements in 30 randomly selected patients during surgery. Nearly simultaneous recordings were made of the LV short-axis cross section with and without ABD. The LV end-diastolic area (EDA in cm^2) and end-systolic area (ESA) of the images without ABD were independently measured by standard laboratory methods.

Results. ABD operation was simple to learn and easy to perform. The linear correlation between ABD and Lab estimates was quite good (see figure). However, the limits of agreement (mean difference between estimates ±2SD) were EDA±2.29 cm^2 and ESA±2.51 cm^2. But, if the studies with obvious artifact or poor ABD tracking were eliminated (5 studies for EDA and 11 for ESA), the limits in the remaining studies were ±1.45 and ±1.24 cm^2 respectively. When the comparison was confined to high resolution studies only (20 for EDA and ESA), the limits were ±1.07 and ±0.82 cm^2.

Discussion. ABD is an automated method for continuous, real-time measurement of EDA and ESA. Poor resolution images defeat ABD, but when adequate endocardial tracking is apparent, it reliably estimates LV filling and ejection.