TITLE: ATELECTASIS AND PLEURAL FLUID EXAMINED BY TRANSESOPHAGEAL ECHOCARDIOGRAPHY DURING CORONARY ARTERY BYPASS GRAFTING

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INTRODUCTION: Due to the increased use of the internal mammary artery (IMA) graft, the left pleural space is often exposed. It is a commonly accepted notion that, when the pleura is opened during cardiac surgery, postoperative pulmonary complications are high. We have recently applied transesophageal echocardiography (TEE) for detecting atelectasis (AT) and pleural fluid (PF)[1]. The present study was designed to evaluate the clinical significance of AT and PF in patients undergoing IMA grafting. SUBJECTS AND METHODS: Sixteen patients (11 males and 5 females, ranging from 47 to 75 years old) were studied. After approval of institutional research committee, informed consent was obtained from all patients. A TEE probe (3.75MHz, ESB-37LR, Toshiba) and an echo system (SSH-65A, Toshiba) were used. The probe was rotated counterclockwise from four-chamber view to obtain short-axis view of the descending aorta, and then the left pleural space adjacent to the aorta was examined. When an echo-free space was seen in the pleural space, it was determined as presence of PF, and when it was not, as absence of PF. When the surface of lung adjacent to the aorta was strongly echogenic and the lung parenchyma was not visualized, it was determined as absence of AT, and when it was visualized, as presence of AT. AT was classified into three grades: grade 1 - the lung parenchyma contains diffuse and dense dots of strong echo; grade 2 - it is less echogenic but contains strong echo in the dorsal side; grade 3 - it contains no strong echo in the dorsal side. Arterial blood gases were analyzed with 288 Blood Gas System (CIBA-CORNING). Examinations were done at stage 1 (after induction of anesthesia) and stage 3 (post-bypass period). RESULTS: AT was detected in 68.8% (11/16) at stage 1 and 93.8% (15/16) in stage 3 and grade of AT progressed significantly from stage 1 to stage 3 ($p<0.005$, Chi-square test). PF was detected in 6.3% (1/16) at stage 1 and 62.5% (10/16) at stage 3. The incidence increased significantly in stage 3 compared with stage 1 ($p<0.005$, Chi-square test). Grade of AT at stage 3 was significantly higher when PF coexisted ($p<0.05$, Chi-square test) than that without PF. PaO_2 in stage 3 significantly decreased compared to stage 1 in 10 patients in whom PF was newly detected and also in 11 patients in whom AT progressed from grade 0-1 to 2-3 ($p<0.01$ in both, paired t-test). DISCUSSION AND CONCLUSION: These results suggest: 1) AT progresses during the course of operation associated with increased incidence of PF; 2) TEE is useful for detecting AT and PF in the dorsal side of the left thorax (a blind zone).

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TITLE: A NEW METHOD FOR THE MEASUREMENT OF CONTINUOUS CARDIAC OUTPUT: PULSE CONTOUR

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INTRODUCTION: Historically, analysis of the area under the aortic pressure waveform has been utilized to derive cardiac output (CO)[1]. However, as a result of changes occuring within the arterial system (i.e. summation), the contour of the peripheral waveform does not accurately reflect cardiac output[2]. To alleviate errors associated with peripheral arterial waveform analysis, a new model (pulse contour) describing the fluid and wall motion of the arterial system has been developed. Using this technique, the peripheral arterial waveform is processed to calculate CO[3]. This study was designed to assess the correlation between continuous cardiac outputs (CCO) derived from the pulse contour method with thermodilution (TD) CO measurements.

METHODS: Following guidelines approved by the Human Investigation Committee, 11 patients (334 data points) undergoing elective cardiac surgery were studied. Patients were premedicated with morphine (0.1 mg/kg IM) and scopolamine (0.4 mg). All patients were anesthetized with fentanyl (50-100 µg/kg) or sufentanil (10-20 µg/kg). Intubation of the trachea was accomplished using pancuronium (0.10-0.15 mg/kg) and ventilation maintained with an FiO_2 between 0.4 and 1.0. Arterial blood pressure was measured via cannulation under local anesthesia of the radial artery with a 20 gauge Jelco indwelling arterial catheter. In addition a 7.5 French balloon-tipped flow-directed TD pulmonary artery catheter was inserted in the internal jugular vein for determination of thermodilution cardiac outputs. TD measurements were obtained using a 10 cc volume of room temperature injectate and a Baxter Edwards CO computer (model COM-2). CCO was measured with a COM-3 Alpha (Baxter-Edwards) system. This system is comprised of a bank of instruments consisting of a COM-2 CO computer, an analog/digital interface and control box (ICB), and a desktop computer. This system utilizes an algorithm to process the area under the arterial waveform based on impedance (Z_{ao}) along the arterial tree. Output from the arterial pressure amplifier was processed by the analog digital interface, and CCO was then displayed. Sets of four TD COs were determined at numerous points throughout the surgical procedure. The results of these TD COs were then used to recalculate the impedance, Zao, resulting in a recalibrated continuous pulse contour CO. Pulse contour COs were correlated with TD outputs at each study interval.Statistical analysis was performed using linear regression analysis with $p<0.05$ considered significant.

RESULTS: Data were analyzed for all patients in the pre-cardiopulmonary bypass (CPB) period, in the post-CPB period, and for the combined pre-CPB and post-CPB periods. In the pre-CPB period (213 data points), the correlation coefficient $R=0.62$ ($p< 0.0001$); in the post-CPB period (121 data points), $R=0.50$ ($p< 0.0001$). Data from the combined periods (334 data points) revealed an R of 0.59 ($p< 0.0001$).

DISCUSSION: The pulse contour method for determination of CCO provides a reliable method for the measurement of CO. When this method is compared to TD, this correlation is strongest in the pre-CPB period ($R=0.62$) when there is less potential for hemodynamic instability and fewer vasoactive interventions. In the post-CPB period when patient lability may require active pharmacologic support, R becomes 0.50. Furthermore, calibration of the continuous cardiac output method during dynamic periods of cardiovascular change (i.e. following CPB) may detract from the accuracy of subsequent measurements.

CCO determined by the pulse contour method appear to be valuable for monitoring intraoperative fluctuations in COs. However further investigation needs to be done to determine the optimal timing for recalibration of this system, particularly in situations requiring vasoactive interventions.

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