Title: NONINVASIVE DETERMINATION OF CARDIAC OUTPUT DURING CESAREAN SECTION

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Introduction. Previous studies show that cardiac output (CO) increases during pregnancy and increases further during labor and the immediate postpartum period. These studies were limited by the invasiveness of their techniques, which precluded multiple measurements during gestation on the same patient or repeat determinations at a given time. Recently, Doppler determinations of CO made in critically ill patients have been shown to correlate strongly with the thermodilution method (1). This technique is noninvasive and, if applicable to pregnant patients, may overcome the technical limitation of previous work. This study, part of a large investigation of CO during pregnancy, focuses on term pregnant patients to evaluate the applicability of the Doppler method to pregnant women and to define CO changes during cesarean section with epidural and general anesthesia.

Methods. Sixteen term pregnant patients who were not in labor and were undergoing elective cesarean section under epidural (n=10) or general (n=6) anesthesia gave informed consent as required by the Institutional Review Board. CO was measured by an Ultrasonic Doppler Computer (Ultracom, Lawrence Medical Systems, Inc.). The measurements were made with the patient supine and in the left lateral tilt positions preoperatively, after anesthetic induction, and 15, 30, 60, and 90 min and 24 h after delivery. Multiple determinations of CO were made at each interval by a two phase method, which included measuring the ascending aortic root diameter by A-mode echocardiography and the ascending aortic blood velocity with a continuous wave transducer. The CO is then calculated by taking the product of systolic velocity integral, cross-sectional area of the aorta (computed from the aortic diameter), and heart rate. Statistical analysis included analysis of variance with subsequent Duncan multiple range tests; $P < 0.05$ was considered significant.

Results. CO increased after delivery in 15 of 16 patients. Compared with preoperative measurements, mean CO increased 32% (range -10% to 48%) 15 to 30 min after delivery and returned to preoperative values or less by 60 to 90 min. Mean CO at 15 and 30 min differed significantly from values at all other intervals. CO 24 h after delivery did not differ from that 90 min after delivery (Figure). This CO trend did not differ between epidural and general anesthesia. The overall mean peak in heart rate 15 to 30 min after delivery was 11% higher than preoperative levels, which is a statistically significant difference. Stroke volume did not vary significantly during the perioperative period.

Discussion. Our study shows no appreciable difference in CO between epidural and general anesthesia for cesarean section. Our findings agree with earlier studies of further increases in CO immediately after delivery (2, 3). Moreover, this increase in CO consistently occurred 15 to 30 min after delivery with rapid return to preoperative levels by 60 to 90 min after delivery. Advantages of this ultrasonic Doppler method include its noninvasiveness, minimal discomfort, and the detection of CO trends with frequent measurements. Moreover, this method can be used to further define normal trends in CO during pregnancy and to delineate hemodynamic changes in the high-risk obstetrical patient.

References

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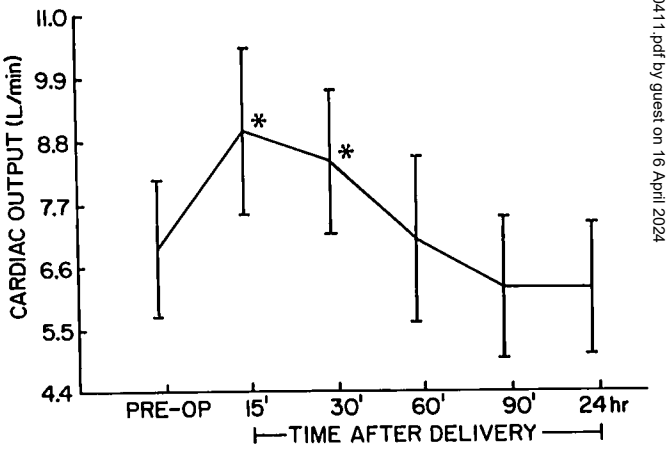

Figure. Cardiac output (CO) in all patients (n=16) during the perioperative period.
*CO at 15 and 30 min differs significantly from CO at all other intervals ($P < 0.05$).

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