

Title: INCIDENCE OF VENOUS AIR EMBOLISM DURING CESAREAN SECTION

Authors: Jill Fong, M.D., Farida Gadalla, M.D., Mary Kathryn Pierri, M.D., Howard Koff, M.D.
and Joseph F. Artusio, Jr., M.D.

Affiliation: Department of Anesthesiology, The New York Hospital-Cornell Medical Center,
New York, New York 10021

Introduction. Venous air embolism has been reported to occur during cesarean section with regional anesthesia using precordial ultrasonic Doppler monitoring. The incidence of venous air embolism during cesarean section with lumbar epidural and general anesthesia was studied. The correlation between precordial ultrasonic Doppler monitoring and precordial two-dimensional echocardiography detection of these venous air emboli and the changes in oxygen saturation using finger pulse oximetry were also investigated.

Methods. 143 consecutive parturients undergoing cesarean section with lumbar epidural or general anesthesia were monitored with routine intraoperative monitors including finger pulse oximetry (Nellcor) and precordial ultrasonic Doppler (Medasonics Versatone D8). The correct placement of the precordial ultrasonic Doppler transducer was confirmed by a bolus of intravenous fluid through the patient's peripheral intravenous line. (1) With approval from the institution's Human Rights Committee and informed consent, 18 parturients were also monitored intraoperatively with precordial two-dimensional echocardiography (IREX 118 of Johnson & Johnson) obtaining a four chamber view of the heart. After maternal pre-hydration with 2 liters of Ringer's lactate and while the parturient breathed room air, lumbar epidural anesthesia was induced and maintained at a fourth thoracic dermatome level of sensory blockade to pin prick. General anesthesia included a 50% oxygen: 50% nitrous oxide mixture prior to the delivery of the baby and a 30% oxygen: 70% nitrous oxide mixture thereafter. Cesarean sections were performed with the parturients supine with left uterine displacement. The incidence of venous air emboli detected by Doppler versus echocardiographic monitoring was simultaneously, but independently, assessed by different investigators. All unsolicited complaints of chest pain and/or dyspnea and changes in oxygen saturation were recorded. Data was analyzed using chi-square analysis with Yates' correction or Fisher exact test.

Results. Using precordial ultrasonic Doppler monitoring, there was a 71% (10 of 14 parturients) incidence of venous air embolism versus a 39% (50 of 129 parturients) incidence during general and lumbar epidural anesthesia, respectively ($P < 0.025$). There was a 100% correlation between the incidence of venous air embolism with Doppler and echocardiographic monitoring regardless of the investigator. Furthermore, there was no statistical difference between the overall incidence of venous air embolism detected by Doppler (50 of 129 with lumbar epidural anesthesia and 10 of 14 with general anesthesia) versus echocardiography (4 of 16 and 1 of 2 parturients with lumbar epidural and general anesthesia, respectively).

Embolism sometimes occurred more than once during a cesarean section. Of these venous air emboli occurring during lumbar epidural anesthesia, 26% occurred before uterine incision, 20% with uterine incision, 6% with delivery of the baby, 26% with placenta removal, 34% with uterine closure and 8% after uterine closure. Oxygen desaturation ($< 95\%$) was associated with these

emboli in 8% of the parturients ($P < 0.05$), but chest pain and/or dyspnea were not associated with these emboli. There was a 0.78% (1 of 129 parturients) incidence of hemodynamically significant venous air embolism. This was manifested as chest pain, dyspnea, ventricular tachycardia, hypotension and a marked decrease in oxygen saturation by pulse oximetry and arterial blood gas measurements. With general anesthesia, 10% of the emboli occurred prior to uterine incision, 10% with uterine incision, 30% with placenta removal, 90% with uterine closure and 10% after uterine closure. Although there was a decrease in oxygen saturation in 20% of the parturients undergoing cesarean section with general anesthesia, it was not statistically significant.

No statistically significant difference between manual extraction or passive separation of the placenta was found. Placenta previa (1 of 5 parturients) was not associated with an increased risk of venous air embolism.

Discussion. In this preliminary study, a high incidence of venous air embolism was observed during both general (71%) and lumbar epidural (39%) anesthesia. The higher incidence of venous air embolism during general anesthesia may reflect the lack of pre-hydration in these parturients offsetting the advantageous effect of positive pressure ventilation.

We found an excellent correlation between the echocardiographic and Doppler incidence of venous air embolism as did Sato et al. (2) This data suggests that the Doppler detected emboli are echo-lucent air emboli not echo-dense amniotic fluid or thromboemboli.

Unlike the Malinow et al. study, we found that venous air emboli could occur at any time during any cesarean section regardless of the anesthetic technique used and that these emboli were not associated with chest pain and/or dyspnea. (3) In addition, during lumbar epidural anesthesia, air embolism may result in oxygen desaturation without subjective symptomatology. Overall, there was a 0.7% incidence of hemodynamically significant venous air embolism.

Further attempts to delineate the incidence and distribution of venous air embolism during cesarean section under lumbar epidural and general anesthesia are needed. Additionally, the correlation between precordial ultrasonic Doppler monitoring, echocardiography and/or mass spectrophotometry detection of these air emboli, their hemodynamic consequences and the ways to diminish their occurrence require further investigation.

References.

1. Naulty JS, Ostheimer GW, Datta S, Knapp R, Weiss JB: Incidence of venous air embolism during epidural catheter insertion. *Anesthesiology* 57:410-412, 1982
2. Sato S, Taya S, Ohira T, Mine T, Greig N: Echocardiographic detection and treatment of intra-operative air embolism. *J Neurosurg* 64(3):440-444, 1986
3. Malinow AM, Naulty JS, Hunt CO, Datta S, Ostheimer GW: Precordial ultrasonic Doppler monitoring during cesarean delivery. *Anesthesiology*. 66:816-819, 1987