Increase in the Arterial-to-end-tidal Gradient (Intraabdominal Carbon Dioxide Insufflation in the Pregnant Ewe)

To the Editor:—In their recently published study on the pregnant ewe, Cruz et al. noted a significant increase in the arterial-to-end-tidal gradient for PCO₂ during intraabdominal CO₂ insufflation. They appropriately caution against underestimation of arterial PCO₂ based on end-tidal CO₂ monitoring, however, we disagree with their implicit suggestion that arterial blood gas sampling is necessary for laparoscopic surgery during pregnancy. In our clinical experience with laparoscopic cholecystectomy in 10 pregnant patients, monitoring ventilation and circulation with capnography and other customary noninvasive monitors (electrocardiography [ECG], pulse oximetry, noninvasive blood pressure, airway pressures, and expired volumes), we noted no adverse maternal or fetal outcomes. Laparoscopic cholecystectomy can be performed safely and effectively during pregnancy, without invasive monitoring.

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References

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Arterial to End-tidal Gradients in Pregnant Subjects

To the Editor:—Cruz et al. provide interesting data on the physiologic consequences of carbon dioxide (CO₂) insufflation in pregnant ewes, but their conclusion, capnography may be an inadequate guide to ventilation during carbon dioxide pneumoperitoneum in the pregnant patient, merits reexamination.

Three issues we believe deserve attention. First, CO₂ pneumoperitoneum has been shown (two separate studies; see fig. 1. Cruz et al. ; Hunter et al. ) to increase arterial to end-tidal CO₂ gradient (PaCO₂ - PETCO₂) in pregnant ewes by approximately 10 mmHg. Thus, it seems that capnographic data might be useful in adjusting minute ventilation during pneumoperitoneum, allowing for PETCO₂ to be maintained at a level 10 mmHg lower than preinsufflation ETCO₂.

Second, Cruz et al. attributed increases in PaCO₂ - PETCO₂ (the gradient) to increases in alveolar deadspace without addressing other potentially important factors. The relation between PaCO₂ and PETCO₂ for example, is altered by changes in the pattern of ventilation and by effects of pneumoperitoneum on the alveolar plateau (slope of phase III) of the capnogram. Changes in the gradient correlate with changes in alveolar deadspace when phase III is nearly horizontal (minimal slope). However, when phase III shows a steeper slope, the gradient also depends on factors that influence the slope of phase III, such as ventilatory characteristics of alveoli. For example, a lowering of total thoracic compliance (as in pregnancy and pneumoperitoneum) can alter the dynamics of alveolar emptying, causing a flattening of the initial portion of phase III and elevation of the terminal portion of the expiratory capnogram. If, however, rate of ventilation is increased (method of Cruz et al. to prevent pneumoperitoneum induced hypercarbia) when thoracic compliance is low, there may be insufficient time for gases of alveoli with the highest CO₂ (responsible for terminal increase in alveolar plateau) to reach the CO₂ sensor at end-expiration. This creates PETCO₂ samples with lower PCO₂ than end-expiratory alveolar gases. Cruz et al. could have tested the adequacy of PETCO₂ sampling by intermittently administering large volume breaths (syringe POCO₂) to determine whether values of PETCO₂ higher than those reported in their study could be obtained.

Finally, one should be cautious about using capnographic data from gravid ewes to draw inferences about parturients. During general anesthesia, for example, the PaCO₂ - PETCO₂ in pregnant ewes ranges from 6 to 15 mmHg, whereas the gradient in pregnant humans varies from -1 to 0.75 mmHg in PETCO₂ often exceeds PaCO₂ in anesthetized pregnant women, which may relate in part to a steeper slope of phase III in capnograms of pregnant versus nonpregnant subjects. Thus, it seems

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