

Effects of Maternal Anesthesia on Fetal Cardiovascular Physiology in Fetuses undergoing Fetal Myelomeningocele Repair

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Fetal surgery has evolved as a surgical therapeutic option that may offer some survival and therapeutic benefit to fetuses that otherwise would undergo demise or have major congenital abnormalities. The anesthetic care of the mother and fetus during such procedures is challenging, as it is essential to prevent the onset of premature labor by tocolysis, minimize the fetal stress response and maintain fetal cardiovascular stability.

Methods:

In this IRB approved study, we extracted data from the charts of 43 fetuses undergoing myelomeningocele repair at 22-26 weeks of gestation. Fetal cardiovascular system was assessed by fetal echocardiography performed before, during and after fetal surgery. The procedure was performed via a low uterine hysterotomy in mothers under deep general anesthesia with tocolytic therapy. The anesthesia technique was standardized, with intravenous induction, endotracheal intubation facilitated by neuromuscular blockade, and inhalational agents at 1.5 to 2 MAC concentrations for maintenance of anesthesia. All fetuses received an intramuscular injection of fentanyl, atropine, and vecuronium prior to fetal incision.

Results:

All subjects had a structurally normal heart. At the time of fetal incision, the fetal heart rate increased and the combined RV + LV cardiac output decreased. Ventricular dysfunction (16/43), valvular regurgitation (22/43) and ductal constriction (8/43) were observed during fetal surgery, though all findings normalized in the post-operative period. The end-tidal anesthetic gas concentration did not correlate with the incidence of ductal constriction, with 32/43 having no evidence of ductal constriction despite maternal MAC values >1.5, and 2 fetuses having severe ductal constriction at MAC values <1.5. Maternal diastolic blood pressure (DBP) <60 mm Hg was a predictor of fetal ventricular dysfunction, with a significant depressant effect noted in both LV (11/16) and RV (11/15) function, with 3 having severe dysfunction. Two fetuses had severe valvular regurgitation but maternal diastolic BP was >60 mmHg. However, maternal MAC values >1.5 did not have a significant effect on maternal DBP/SBP.

Discussion:

Significant changes in the fetal circulation occur during fetal myelomeningocele repair, but we could not determine if the fetal changes were related to maternal hemodynamics, direct effects of the anesthetic, surgical manipulation or other unknown factors. Maternal anesthesia and tocolytic techniques impact maternal hemodynamics, and the levels of anesthesia sufficient to produce the desired maternal tocolysis may also be sufficient to cross the placenta and cause direct fetal myocardial depression. The relatively small number of subjects in this study may explain the lack of statistical significance in the association between maternal BP and fetal ductal constriction. More prospective studies with a standardized protocol need to be performed in this unique patient population to ascertain the influence of maternal anesthesia and hemodynamics on the fetal cardiovascular system.