OBSTETRICS

The risks and benefits of internal monitors in laboring patients

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OBJECTIVE: The purpose of this study was to estimate the impact of internal monitors (fetal scalp electrode [FSE] and intrauterine pressure catheter [IUPC]) on maternal and neonatal outcomes.

STUDY DESIGN: The study comprised a retrospective cohort of all women who were admitted for labor from 2004-2008. Women with internal monitors (FSE, IUPC, or both) were compared with women without internal monitors. Maternal outcomes were maternal fever and cesarean delivery. Neonatal outcomes were a composite of 5-minute Apgar score of $\leq$3, cord pH $<$7.1, cord base excess ≤ -12, or admission to level 3 nursery. Logistic regression was performed to estimate the impact of internal monitors with adjustment for confounding variables, including time in labor.

RESULTS: Of 6445 subjects, 3944 women (61.2%) had internal monitors. Women with internal monitors were more likely to have a fever than women without internal monitors (11.7% vs 4.5%; adjusted odds ratio [AOR], 2.0; 95% confidence interval [CI], 1.6—2.5). FSE alone was not associated with an increased risk of fever (AOR, 1.5; 95% CI, 1.0—2.1), but IUPC alone was (AOR, 2.4; 95% CI, 1.8—3.2). The risk of cesarean delivery was higher in women with internal monitors (18.6% vs 9.7%; AOR, 1.3; 95% CI, 1.0—1.5). Risk of cesarean delivery was lower in women with an FSE alone (AOR, 0.5; 95% CI, 0.4—0.7) but higher in women with both an FSE and an IUPC (AOR, 1.6; 95% CI, 1.4—2.0). Risk of the composite neonatal outcome was not higher in women with internal monitors (3.3% vs 3.6%; AOR, 0.8; 95% CI, 0.6—1.1).

CONCLUSION: Routine use of an IUPC in laboring patients should be avoided because of an increased risk of maternal fever.

Key words: cesarean delivery, chorioamnionitis, endometritis, internal monitor, labor

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Intrauterine pressure catheter (IUPC) and fetal scalp electrode (FSE) are commonly used devices for intrapartum monitoring and management. Although the internal monitors that are used are packaged sterilely, they travel through the vaginal canal into the uterine cavity, which provides a potential pathway for contamination and ascending infections. Studies are conflicting on whether internal monitors are associated with maternal and neonatal infections; however, amniotic fluid specimens that have been collected after IUPC insertion have been found to be contaminated with bacteria in 50% of subjects.[1] Additionally, numerous case reports exist of scalp abscesses after monitoring with FSE; 1 case control study of infants with group B *streptococcus* sepsis suggest that monitoring with FSE may be associated with a greater risk of death.[2]

Because the IUPC can be used to calculate Montevideo units and adequacy of contractions, they frequently are placed when labor dystocia is a concern.[3] However, randomized control trials that have compared the use of internal and external monitors for labor management have not demonstrated a decrease in the risk of cesarean delivery when internal monitors are used, although they also do not demonstrate an increased risk of infectious morbidities.[4,5]

Despite this, the use of internal monitors is widespread. At some institutions, it is routine to place internal monitors at the time of membrane rupture. Several factors are at work in the continued use of internal monitoring in the face of demonstrated lack of benefit. First, the selection of a highly specific patient population (ie, labor dystocia) makes these trials less generalizable, because several indications exist for internal monitoring. Second, the statement that internal and external monitoring is equivalent inherently assumes that external monitoring is possible. As obesity, and particularly morbid obesity, becomes more prevalent, external monitoring of fetal heart rate and contractions may not be possible.

Therefore, we sought to estimate the impact of internal monitors on maternal and neonatal outcomes in a modern population of unselected women in labor.

Materials and Methods

This is a retrospective cohort study of all consecutive women who were admitted

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at a single institution from 2004-2008. Institutional review board approval was obtained from Washington University School of Medicine.

Women were included in the cohort if they carried a singleton pregnancy in vertex presentation and attempted a trial of labor. We excluded women who had a fetus with congenital anomalies or who underwent cesarean delivery without labor. For this analysis, women were excluded if their maximum temperature or the use of internal monitors was unknown. We extracted detailed information on maternal sociodemographic, obstetric and gynecologic history, medical and surgical history, prenatal history, antepartum records, and labor and delivery records. The labor and delivery records included medications, labor type, cervical examination times, dilation and station, length of labor stages, mode of delivery, maximum temperature, time of maximum temperature, postpartum record, and neonatal outcomes. All data were extracted with close-ended forms by trained research assistants who underwent regularly scheduled training.

At our institution, sterile vaginal examinations are performed in labor approximately every 2 hours in active labor or more frequently as indicated by patient symptoms or fetal heart rate tracing. Artificial rupture of membranes is performed typically to augment labor when the fetal vertex is engaged. Internal monitors are not placed routinely at the time of rupture but are typically placed for indications such as an inability to externally monitor, oxytocin dosage >20 milliunits/minute, and labor dystocia. Umbilical cord blood gases are obtained routinely at all deliveries when possible.

For this study, women with internal monitors were compared with women without internal monitors. In the primary analysis, women were considered to have internal monitors if they had either an FSE or an IUPC or both. The primary maternal outcomes were maternal temperature $\geq$38.1°C at any point in hospitalization and cesarean delivery. Secondary outcomes considered maternal temperature $\geq$38.1°C before delivery and maternal temperature $\geq$38.1°C at least 12 hours after delivery. The primary neonatal outcome was a composite outcome of 5-minute Apgar score of $\leq$3, cord blood pH <7.1, cord blood base excess ≤ -12, and admission to level 3 nursery.

Secondary analyses were performed to assess the individual impact of FSE vs IUPC use on maternal and neonatal outcomes. Women with an FSE alone were compared with women with no internal monitors; women with an IUPC alone were compared with women with no internal monitors. The impact of internal monitors on cesarean delivery was assessed by indication of cesarean delivery. Women were classified as having a cesarean delivery for an arrest of labor if the indication for cesarean delivery was listed as arrest of dilation, arrest of descent, labor dystocia, failed induction, or failure to progress. Women were classified as having a cesarean delivery for nonreassuring fetal status if the indication for cesarean delivery was listed as nonreassuring fetal status, category 3 tracing, fetal bradycardia, or decelerations.

Data for patients with and without internal monitors were summarized and compared with descriptive and bivariate statistics with the use of the unpaired Student *t* test or Mann-Whitney *U* test for continuous variables and χ^2 or Fisher exact test for categoric variables, as appropriate. Normality was tested with the use of the Kolmogorov-Smirnov test. Potentially confounding variables of the exposure-outcome association were identified in stratified analyses. Multivariable logistic regression models for the primary and secondary outcomes were developed to better estimate the effect of internal monitors when we adjusted for potentially confounding effects. Clinically relevant covariates for initial inclusion in multivariable statistical models were selected with the use of the results of the stratified analyses, and factors were removed in a backward stepwise fashion, based on significant changes (>10%) in the exposure adjusted odds ratio (AOR) or significant differences between hierarchic models with the use of the likelihood ratio test. Covariates that were considered included maternal age, race, parity, body mass index, time in labor, induction of labor, maternal medical comorbidities, regional anesthesia, mode of delivery (for endometritis and neonatal outcomes), maternal fever (for neonatal outcomes), and gestational age at delivery (for cesarean delivery and neonatal outcomes). As the number of examinations correlated strongly with time in labor, only time in labor was used in the analysis to avoid colinearity. Time in labor was considered as both a continuous and categoric variable. The statistical analysis was performed with STATA software (version 11, Special Edition; StataCorp, College Station, TX).

RESULTS

Of 8390 women in the cohort, 6445 women (76.8%) were included. Reasons for exclusion were 1496 women had cesarean delivery without attempt at labor, 144 women had delivery before arrival on the labor unit, 68 women had unknown maximum temperature, 9 women had unknown status regarding the use of internal monitors, and 228 women had incomplete date and time information. Of the 6445 women who were included in the study, 3944 women (61.2%) had internal monitors. Of these, 625 women (15.9%) had an FSE only; 789 women (20.0%) had an IUPC only, and 2530 women (64.2%) had both. Women with internal monitors were more likely to be primiparous, black, and obese, to have chronic hypertension, preeclampsia, or diabetes mellitus, to have their labor induced or augmented, to receive regional anesthesia, and to receive antibiotics for group B *streptococcus* prophylaxis (Table 1). Women with internal monitors had longer times from admission to delivery, rupture of membranes to delivery, and more vaginal examinations.

Women with internal monitors were more likely to experience a maternal fever than women with no internal monitors (11.7% vs 4.5%; AOR, 2.8; 95% confidence interval [CI], 2.3–3.5; Table 2). After adjustment for confounding variables (time from rupture to delivery $\geq$12 hours, black race, primiparity, group B *streptococcus* status, and regional anesthesia), the risk of any maternal fever remained elevated (AOR, 2.0; 95% CI,