OBSTETRICS

A comparison of surface acquired uterine electromyography and intrauterine pressure catheter to assess uterine activity

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OBJECTIVE: Intrauterine pressure catheter (IUPC) is the primary device used to evaluate uterine activity. In contrast to the IUPC, electrical uterine myography (EUM) enables noninvasive measurement of frequency, intensity, and tone of contractions. The aim of this study was to determine the accuracy of EUM compared to IUPC.

STUDY DESIGN: EUM measured myometrial electrical activity using a multichannel amplifier and a noninvasive position sensor. In all, 47 women in labor were monitored simultaneously with an IUPC and EUM. We compared the frequency, intensity, and tone of uterine contractions between the methods.

RESULTS: The correlation of the frequency, intensity, and tone of contractions between uterine electromyography and IUPC was strong with significant r values of 0.808-1 ($P < .0001$).

CONCLUSION: Electrical uterine electromyography yields information about uterine contractility comparable to that obtained with IUPC.

Key words: contractions, intrauterine pressure catheter, myometrial electrical activity

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Monitoring uterine activity during labor is indicated for evaluating labor progress and the diagnosis of uterine tachysystole, which poses a potential risk of fetal distress.[1-3]

Tocodynamometry has long been the most common method for assessing uterine contractility during labor. Although this method has no complications and enables measurement of the frequency and duration of contractions, its major limitation is the inability to assess the intensity of uterine contractions, which is crucial for labor management. The accuracy of tocodynamometry is limited by the thickness of the abdominal wall and by its position relative to the uterus.[4,5]

The intrauterine pressure catheter (IUPC) is considered to be the gold standard for monitoring uterine contractions as it enables assessment of both the frequency and the intensity of contractions more accurately than tocodynamometry.[6-8] However, IUPC requires ruptured membranes prior to catheter insertion; therefore, its use is limited. In addition, this invasive method carries risks of placental and fetal damage, infection, and uterine perforation.[9-11]

The American College of Obstetricians and Gynecologists and the Society of Obstetricians and Gynecologists of Canada recommend the use of IUPC in selected circumstances, such as maternal obesity or limited response to oxytocin. The theory behind these recommendations is that monitoring with IUPC might improve both maternal and fetal outcomes by allowing better adjustment of oxytocin, thus preventing uterine hyperstimulation and fetal hypoxia, or by enabling better interpretation of abnormal fetal heart rate patterns in relation to uterine activity. This hypothesis is mainly based on expert opinion, as limited clinical data are available to support it. A randomized clinical trial of internal and external monitoring did not show any difference in the rate of operative deliveries or of adverse neonatal outcomes.[12-14]

Myometrial activity resulting in contractions is the result of molecular changes that lead to increased coupling and excitability of cells.[15-19] Electrical activity of the myometrium can be monitored noninvasively by uterine electromyography (EMG).[19-21] Electrical uterine myography (EUM) monitoring uses an EMG monitor with 9 electrodes that are placed on the maternal abdominal surface to evaluate uterine contractions. Not only does EUM enable noninvasive evaluation of the beginning, time to peak, duration and frequency of uterine contractions, it also evaluates their intensity. Furthermore, since it is noninvasive and does not require ruptured membranes, it can be used as a diagnostic tool for uterine contractions in suspected preterm labor. It also allows ambulation during monitoring. EUM has been shown to correspond strongly with tocodynamometric sensor in measuring contractions and predicting preterm labor.[19,22]

The aim of this study was to compare EUM and IUPC monitoring in terms of onset, time to peak, duration, frequency, and intensity of uterine contractions.

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TABLE
Demographic and clinical characteristics of participants

Parameter	Range	Average ± SD
Maternal BMI	20.2–41.6	30.31 ± 4.626
Gravity	1–11	3 ± 2.77
Parity	0–8	2 ± 2.26
Gestation	32 wk + 4 d–42 wk + 6 d	39 wk + 4 d ± 2 wk + 2 d
Initial cervical dilatation, cm	1–9.5	4.7 ± 1.9
Fetal weight, g	1490–4300	3261 ± 584

Mode of delivery	No. of parturients	Percentage
Normal vaginal delivery	22	46.8
Cesarean section	18	38.3
Vacuum-assisted vaginal delivery	7	14.9
Augmentation of labor with oxytocin	40	

BMI, body mass index.

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MATERIALS AND METHODS

This prospective observational study was carried out in a single institution, Meir Medical Center, Kfar Saba, Israel.

The inclusion criteria were singleton pregnancy without evidence of significant fetal malformations, patients >24 gestational weeks, in any stage of labor. All participants required IUPC for accepted obstetrical indications such as protracted labor or augmentation of labor for a multipara, or had an amnioinfusion catheter inserted for repeated variable decelerations. The catheter enabled evaluation of the contractions by IUPC without further intervention.

Power analysis calculation for correlation between the 2 methods indicated that 41 participants were required to achieve an α error of 0.05 and a β error of 0.9. Equivalence of the measurements was defined as a difference of up to 5 seconds between the 2 methods (EUM and IUPC) regarding the onset and the duration of the contraction, and <5% difference in the intensity of the contraction. These values are based on the assumptions that the differences in the measures have no clinical significance.

The use of an IUPC can present technical challenges; therefore, for the sake of better comparison between IUPC and EUM, only patients without technical difficulties with recording contractions by the IUPC or after resolving the technical difficulties were included in the study.

The study was approved by the national Israel Ministry of Health Ethical Committee (approval no. 116-09) and registered in the National Institutes of Health Clinical Trials Registry (NCT1165879). All participants signed an informed consent form.

Equipment

The EUM monitor is a novel technology software and device developed by OB-Tools (Migdal Ha'emek, Israel). The device measures the electrical activity of the uterus by using 9 surface EMG electrodes and a multichannel amplifier. The electrodes are placed in a square surrounding the umbilicus, forming 3 rows and columns. The location of the electrodes is determined using a noninvasive position sensor. The energy of the contractions is presented in units of microwatts (μW). The 9 electrodes enable precise measurements of the EMG from different areas of the uterus and the software enables incorporation of the data and analyzing them into a contraction wave.

In the current study, each participant was monitored for 30 minutes simultaneously by EUM and by IUPC and the measurements of the contractions were compared. The data evaluator was blinded to the stage of labor that was recorded, as well as to the outcome of the labor.

IUPC was measured using millimeters of mercury (mm Hg) and EUM, in μW.

Evaluated parameters were the onset of the contraction, its peak, time to nadir, the duration, and intensity of each contraction. As accepted while using IUPC, we also calculated the total elevation of mm Hg above baseline in all contractions during 10 minutes (known as Montevideo units) and the total μW during the 10 minutes measured by the EUM. The novel software of the tested device created the waveform of the contractions and enabled us to calculate the area under the curve of the contractions that were detected by the new method in a similar way to the accepted evaluation of Montevideo while using IUPC. We compared the ratios of these measurements in each participant. Since the units used to evaluate the contractions are different, we also calculated the area under the curve of the contractions and compared the correlation between the methods for that term, as well.

Statistical analysis

The statistical analysis was performed using software (SAS, version 9.2; SAS Institute, Cary, NC). Student *t* test was used to evaluate the differences between the contraction parameters: the onset of the contraction, its peak, the time to nadir, the duration, and the intensity as measured by the IUPC and EUM methods. Pearson analysis of coefficient was used for correlations.

RESULTS

The study population included 47 parturients in various stages of labor. The demographic and clinical characteristics of the participants are presented in the Table. Uterine contractions were evaluated simultaneously by EUM and IUPC.

We faced technical difficulties in monitoring contractions with IUPC in 7 patients, all of which were resolved after some maneuvers such as washing or replacing the catheter. No technical difficulties were encountered with EUM. The