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Original Article

Effect of obesity on preterm delivery prediction by transabdominal recording of uterine electromyography

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ABSTRACT

Objective: It has been shown that noninvasive uterine electromyography (EMG) can identify true preterm labor more accurately than methods available to clinicians today. The objective of this study was to evaluate the effect of body mass index (BMI) on the accuracy of uterine EMG in predicting preterm delivery.

Materials and Methods: Predictive values of uterine EMG for preterm delivery were compared in obese versus overweight/normal BMI patients. Hanley–McNeil test was used to compare receiver operator characteristics curves in these groups. Previously reported EMG cutoffs were used to determine groups with false positive/false negative and true positive/true negative EMG results. BMI in these groups was compared with Student *t* test ($p < 0.05$ significant).

Results: A total of 88 patients were included: 20 obese, 64 overweight, and four with normal BMI. EMG predicted preterm delivery within 7 days with area under the curve = 0.95 in the normal/overweight group, and with area under the curve = 1.00 in the obese group ($p = 0.08$). Six patients in true preterm labor (delivering within 7 days from EMG measurement) had low EMG values (false negative group). There were no false positive results. No significant differences in patient's BMI were noted between false negative group patients and preterm labor patients with high EMG values (true positive group) and nonlabor patients with low EMG values (true negative group; $p = 0.32$).

Conclusion: Accuracy of noninvasive uterine EMG monitoring and its predictive value for preterm delivery are not affected by obesity.

Introduction

The inability of currently used methods to accurately diagnose true preterm labor remains one of the biggest unsolved obstetrical problems [1,2]. Parturition, both at term and preterm, is a complex process involving ripening of the uterine cervix and activation of the myometrium [1,3]. Assessment of the myometrial activity today mostly relies on detection of contractions through maternal perception and/or tocodynamometry (TOCO). Both have been shown to have very low sensitivity and positive predictive value for preterm delivery [4,5]. In women with high body mass index (BMI), the accuracy of TOCO in recording contractions is even lower [6]. This is important considering the current worldwide epidemic of obesity, which is also reflected in the increasing number of obese women of reproductive age [7].

Several studies have demonstrated that noninvasive measurement of uterine electromyography (EMG) from the abdominal surface detects uterine contractions as reliably as the TOCO, and even as the intrauterine pressure catheter (IUP; Figure 1) [8–11]. In addition, EMG can identify the transition from the nonlabor to the labor state of the myometrium. Different uterine EMG parameters can indicate the myometrial properties characteristic of true term and preterm labor, which is something that the other contraction monitoring devices cannot do [12–16].

One of the potential limitations of the transabdominal uterine EMG could be its low sensitivity in recording myometrial activity in patients with high BMI, as is the case with TOCO [6]. Abdominal

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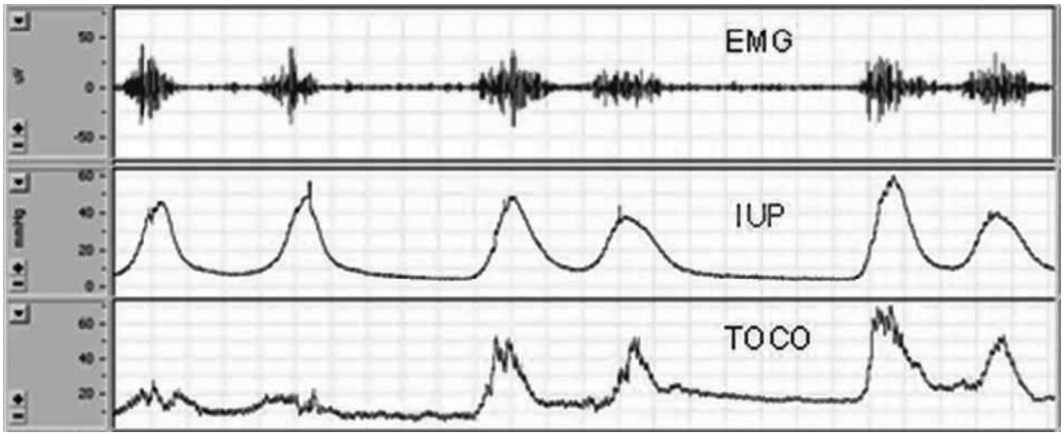

Figure 1. Electrical activity of the myometrium [electromyography (EMG) activity – top trace] is responsible for uterine contractions. Note the excellent temporal correspondence between EMG and mechanical contractile events [measured by intrauterine pressure catheter (IUP) – middle trace, and tocodynanometry (TOCO) – bottom trace].

adipose tissue could insulate and weaken electrical signals coming from the uterus. The purpose of this study was to evaluate the effect of patient's BMI on the accuracy of uterine EMG in predicting preterm delivery. We have also assessed the effect of impedance between the skin and the electrodes on the accuracy of uterine EMG, as well as the association between BMI and skin–electrode impedance.

Materials and methods

This study is a secondary analysis of the recently reported study on 88 consecutive patients admitted with the diagnosis of preterm labor with or without ruptured membranes at less than 34 weeks of gestational age at a single institution (St. Joseph's Hospital and Medical Center, Department of Obstetrics and Gynecology, Phoenix, AZ, USA) between September 2009 and February 2010 [17]. All included women provided written informed consent for study participation. The St. Joseph's Hospital and Medical Center Institutional Review Board approved the study.

Propagation velocity (PV) of EMG signals, power spectrum (PS) peak frequency, and the combination (rescaled sum) of these two parameters were significantly higher in patients delivering within 7 days from the EMG measurement compared to those who delivered after 7 days. Both EMG PV and PS peak frequency more accurately identified true preterm labor than today's clinical methods [17].

Skin–electrode impedance was measured prior to each EMG recording in this study. The results of these measurements have not been reported yet.

In order to determine to what extent high patient's BMI can affect the accuracy of EMG in predicting preterm delivery, we constructed the receiver operator characteristics (ROC) curve for patients with BMI in the obese range (≥ 30.0) and compared it with the ROC curve for patients whose BMI was in one of the three remaining categories: underweight (≤ 18.5), normal (18.5–24.9) or overweight (25–29.9). Positive likelihood ratio (sensitivity/1 – specificity) and negative likelihood ratio (1 – sensitivity/specificity) have also been calculated for uterine EMG in all patients included, as well as in the obese, and the nonobese groups.

In addition, we performed a comparison between BMI and impedance values in true negative and true positive versus false negative and false positive patients (as determined by best cutoff value of PV and PS frequency reported). We also analyzed the correlation between patient's BMI and skin–electrode impedance.

Statistical analysis

Hanley–McNeil test was used to compare ROC curves in the obese versus other BMI groups. Data on patients' BMI and skin–electrode impedance were analyzed by Student *t* test to determine whether there were statistically significant ($p < 0.05$) differences between the group with false positive or false negative results, and the group with true positive or true negative results. The Pearson correlation test was used to determine whether there was a correlation between patient's BMI and skin–electrode impedance overall. A p value < 0.05 was considered statistically significant.

Results

Table 1 shows the BMI distribution of patients included in the study. There were 20 obese, 64 overweight, and four normal BMI patients. None had a BMI in the underweight range. EMG recordings were of sufficient quality for analysis in all women included in the study. Patients were included in the study at a median of 28 5/7 weeks of gestational age (range, from 21 5/7 weeks to 33 6/7 weeks). Nine (10%) patients were < 24 weeks, 31 (35%) patients were 24–28 weeks, 33 (38%) patients were 28–32 weeks, and 15 (17%) patients were >32 weeks. Delivery within 7 days from the EMG measurement occurred in 23% (20/88) of the cases. Out of 68 patients who did not deliver within 7 days from admission, 23 delivered at term (after 37 weeks), and 45 delivered before 37 weeks of gestation.

Predictive values of EMG PV, PS peak frequency, and the combination (rescaled sum) of these parameters for predicting preterm delivery within 7 days from the EMG measurement were calculated. PV and PS peak frequency were combined by looking at the sum of their rescaled values. Specifically, PS peak frequency was multiplied by 100 and added to the corresponding PV value. The

Table 1
Body mass index (BMI) of patients included.

BMI category	*N*	Median	Range
Obese	20	31.5	30.1–47.5
Overweight	64	27.0	25.0–29.8
Normal	4	24.3	19.8–24.8
Underweight	0	N/A	N/A

N/A = not available.