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Abdominal electromyography may predict the response to tocolysis in preterm labor

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ABSTRACT

Objective: To determine whether abdominal electromyography can predict the response to tocolysis in pregnant women in preterm labor.

Study design: This study was carried out at the Department of Obstetrics and Gynecology, Menofyia University Hospital in Egypt. Fifty pregnant women in preterm labor who fulfilled the inclusion criteria were enrolled. Baseline abdominal electromyography was performed. Tocolysis in the form of hexoprenaline sulphate infusion was started for all women and electromyography was repeated after 24 h in responders but only after 6 h in non responders. The receiver operating characteristics curve was drawn to calculate specificity of the electromyography at 100% sensitivity. Results were tabulated and statistically analyzed.

Results: Forty women responded to tocolysis by delaying delivery for more than 48 h. There was a significant reduction in the frequency of uterine contractions after tocolysis (3.76 ± 0.92 versus 2.32 ± 2.05 contractions per 10 min; $P < 0.001$). Similar significant reductions affected the duration and amplitude of uterine action potentials (25.08 ± 9.74 versus 14.4 ± 17.16 s; $P < 0.001$, 40.8 ± 25.89 versus 28.32 ± 29.38 mV; $P < 0.001$). At a sensitivity of 100% and using ROC curve, abdominal electromyography of amplitude of 82 mV lasting for 30 s or more had a specificity of 90%, positive and negative predictive values of 67% and 95%, and a diagnostic accuracy of 88% in predicting preterm labor.

Conclusion: Abdominal electromyography may predict the response to tocolysis in preterm labor.

1. Introduction

The prediction of the outcome of preterm delivery is a major concern in obstetric practice. There is no single method that can differentiate between preterm uterine contractions that will increase in frequency and intensity ending up in delivery and those that will spontaneously subside or respond to tocolysis [1]. The diagnostic accuracy of traditional data in predicting the outcome of preterm delivery is limited. Methods such as previous history of preterm delivery, cervical examination on admission, white blood cell counts, frequency of uterine contractions per unit time, and premature rupture of membranes all have a diagnostic accuracy ranging between 40 and 70% [2]. Presently, the best predictor for the outcome of preterm labor is a combination of cervical length measurement using transvaginal ultrasound and determination of the level of cervico-vaginal fetal fibronectin in pregnant mothers [3]. Abdominal electromyography (EMG) records the electrical activity of the uterus [2,4–6]. The increase in this activity during labor is due to the enhanced excitability of the myometrium and its subsequent ability to generate and spread action potentials [7–9], a stage at which the uterus becomes able to respond to oxytocics and progresses successfully to labor [10].

This study was designed to determine whether the non-invasive technique of abdominal electromyography can predict the response to tocolytic therapy in preterm labor and to try to establish a threshold above which cases of preterm labor do not respond to tocolysis.

2. Materials and methods

This study was carried out on a total of 50 primigravid women recruited from the labor and delivery ward, Department of Obstetrics and Gynecology, Menofyia University Hospital, from September 2009 till March 2010. Prior to starting the study, ethical committee approval was obtained and all women enrolled in the study signed an informed consent after the details of the study were explained to them. Inclusion criteria included primigravid

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women at 28–34 gestational weeks with the following criteria: (1) one or more painful uterine contractions per 10 min documented by CTG; (2) cervical dilatation of no more than 2 cm on local examination; (3) cervical length of 25 mm or less measured by transvaginal ultrasound. Gestational age was confirmed with both clinical examination and ultrasound scan. All pregnancies were uncomplicated singletons with normal fetal heart rates and intact membranes. All women enrolled were sure of the exact dates of their last menstrual period. Women unsure of dates, those with body mass index greater than 30, women with multiple gestations, polyhydramnios, malpresentations, premature rupture of membranes, antepartum hemorrhage, fetal or maternal distress were excluded from the study.

After enrollment, baseline pre-treatment abdominal electromyography was performed. Tocolysis was then started for all women. We used hexoprenaline sulphate (the Arab Drug Company, Egypt) in an infusion solution as a tocolytic for all women enrolled in the study. The drug belongs to the beta adrenergic agonist group of tocolytics and it has a greater $beta_2$-receptor affinity, and therefore side-effects such as tremors, palpitation and tachycardia of 120–140 beats/min are uncommon. Four ampoules (each is 2 ml and contains 10 μg hexoprenaline sulphate) were diluted in 500 ml. Ringer lactate solution and infused initially at a rate of 10–15 drops per minute. The rate of infusion was increased by 5 drops every 5 min until an adequate response was obtained. Effective tocolysis was considered when prolongation of pregnancy occurred for more than 48 h after initiation of tocolysis. Treatment failure was defined as progressive preterm labor in spite of tocolysis administered to the patient over a 6-h period. Women who responded to tocolysis had a post-treatment electromyography 24 h after initiating tocolysis. Non-responders had a post-treatment electromyography after the diagnosis of treatment failure was made. The technique of abdominal electromyography was performed as previously described [11] using Nihon Kohden machine, model MEB-9200/9300 (Japan). The period of recording for different patients ranged between 20 and 40 min. For every burst of action potential, we measured the amplitude, the frequency and the duration of burst. Cardiotocography was used in order to document the presence of uterine contractions prior to starting electromyographic recording. The amplitude, frequency and duration of uterine contractions were documented using BT-300 Bistos C0, 201, 2F, 239-15, Gasan-Dong, Ltd., Geumcheon-Gu (Seoul, Korea).

Results were tabulated and statistically analyzed using Epi Info, version 6, a word-processing database and statistics program. Descriptive statistics were expressed as mean (X) and standard deviation (SD) using the unpaired Student's test. A statistical level was considered significant if the P value was less than 0.05. We used the receiver operating characteristics (ROC) curve [12] to select a threshold able to identify cases which will progress to active labor and delivery and will not respond to tocolytic therapy and therefore, we considered the ROC curve at a threshold sensitivity of 100%.

3. Results

According to the results of ROC curve, women enrolled in the study were divided into two groups: (A) Group I (responders to tocolysis) included 40 women who responded to tocolysis by prolonging pregnancy for at least 48 h and (B) Group II (non responders) included women who failed to respond to tocolysis and delivered within 48 h of initiating tocolysis. The demographic characteristics of women in both groups are shown in Table 1. Table 2 shows the uterine electromyographic characteristics of the ten women who failed to respond to tocolysis (Group II). The pre-treatment values given in the table were taken before initiating tocolysis. Post-treatment values were those taken after the maximum infusion rate was administered for 6 h with no response, but progression of active labor.

Table 1
Clinical characteristics of women enrolled in the study.

	Group I	Group II	P value
[a]Maternal age (years)	25.3 ± 4.0	24.5 ± 4.9	0.637
[a]Maternal BMI	28.4 ± 2.2	28.1 ± 1.8	0.669
[a]GA at delivery (weeks)	35.4 ± 1.5	32.3 ± 1.1	<0.001

GA: gestational age; BMI: body mass index.
Group I: women who responded to tocolysis by prolonging pregnancy for at least 48 h.
Group II: women who failed to respond to tocolysis.

Table 2
EMG parameters in the 10 women who failed to respond to tocolysis.

	Pre-treatment	Post-treatment	P value
Gestational age (weeks)	30.9 ± 1.03	31.04 ± 1.0	>0.05
Frequency (contractions per 10 min)	4.8 ± 0.42	6.2 ± 0.79	<0.001
Amplitude (mV)	87.8 ± 4.49	80.4 ± 28.41	>0.05
Duration (s)	38.0 ± 5.37	44.0 ± 18.68	>0.05

Among the 40 responders (Group I), there was a significant reduction in the frequency of uterine contractions after tocolysis (3.76 ± 0.92 versus 2.32 ± 2.05 contractions per 10 min; $P < 0.001$). Similar significant reductions affected the duration and amplitude of uterine action potentials (25.08 ± 9.74 versus 14.4 ± 17.16 s; $P < 0.001$, 40.8 ± 25.89 versus 28.32 ± 29.38 mV; $P < 0.001$). Further analysis of responders (Group I) showed that 16 women delivered 2–14 days after initiation of tocolysis (Group Ia) and 24 delivered more than 2 weeks after initiating tocolysis (Group Ib). Table 3 illustrates a significant post-treatment reduction in the frequency of uterine contractions, amplitude and duration of uterine contraction action potentials compared to pre-treatment values among responders in Group Ia. Similar findings were noted among responders in Group Ib (Table 4).

Women who responded to tocolysis; both Groups Ia and Ib, had pre-treatment irregular electromyographic activity of low amplitude ranging between 19.1 and 53.4 mV, a frequency of uterine contractions between 2 and 4 every 10 min and a duration ranging

Table 3
EMG parameters in the 16 women delivered 2–14 days after initiating tocolysis, before and after treatment.

	Pre-treatment	Post-treatment	P value
Gestational age (weeks)	30.13 ± 1.18	32.76 ± 2.55	<0.001
Frequency (contractions per 10 min)	3.87 ± 0.62	1.75 ± 0.68	<0.001
Amplitude (mV)	41.13 ± 6.62	19.38 ± 6.53	<0.001
Duration (s)	27.75 ± 5.39	9.38 ± 3.09	<0.001

Table 4
EMG parameters in the 24 women delivered >14 days after initiating tocolysis, before and after treatment.

	Pre-treatment	Post-treatment	P value
Gestational age (weeks)	30.15 ± 1.38	36.85 ± 1.29	<0.001
Frequency (contractions per 10 min)	3.25 ± 0.85	1.08 ± 0.28	<0.001
Amplitude (mV)	21.0 ± 4.77	12.58 ± 1.41	<0.001
Duration (s)	17.92 ± 6.06	5.42 ± 1.41	<0.001