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Placental site does not change background uterine electromyographic activity in middle trimester of pregnancy

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Condensation

Background uterine EMG activity measure from the abdominal surface in mid trimester of pregnancy does not depend on placental implantation site.

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Abstract

Objective: This study was performed in order to assess the potential influence of placental implantation site on transabdominal electromyographic (EMG) assessment of the uterine electrical activity in mid trimester of pregnancy.

Study design: In this prospective study 251 unselected, nulliparous asymptomatic women with singleton pregnancy underwent transabdominal uterine EMG. Uterine electrical activity was recorded using bipolar electrodes placed on the abdominal surface for 20 minutes. Regarding the placental implantation site and presence of action potentials (AP) pregnant women were divided into two groups: anterior placenta group (APG) and posterior placenta group (PPG). Outcome measures were difference between median frequency (MF) and median amplitude (MA) of AP between the two groups.

Results: Action potentials were detected in 56 women - APG 33/56 versus PPG 23/56. The analyzed parameters: MF ($p = 0.527$, Fisher exact test) and MA ($p = 0.255$, Fisher exact test) did not show any statistical significant difference between the two groups.

Conclusion: Background uterine EMG activity measured from the abdominal surface in mid trimester of pregnancy does not depend on placental implantation site.

Keywords: transabdominal electromyography (EMG), placenta, implantation site, uterine electrical activity, action potentials

Introduction

Uterine electrical activity has been an important subject of interest during last decades, particularly after development of a new, noninvasive method for electrical assessment of the pregnant uterus - transabdominal uterine electromyography (EMG); and improved filtering system that reduces the recording artifacts [1, 2]. Electrical activity originates form the depolarization and repolarisation of thousands of smooth muscle myometrial cells [3]. Myometrial cells have two forms of electric potentials: resting membrane potential and action potential (AP) [4]. Gap junctions, used for inter cell communication, develop progressively with duration of pregnancy and play an important role in the electrical evolution of the myometrium [5, 6]. Action potentials have ability to spread unchanged trough gap junctions from one to another myometrial cell, causing increased and organized electrical activity [7]. Organized and synchronized electrical activity precedes mechanical activity which results in myometrial contractions [1, 8].

Transabdominal uterine EMG can be used to assess electrical activity of pregnant uterus from mid trimester (16 - 18 week). The anterior uterine wall is the main origin of the uterine electrical activity detected trough the abdominal wall [1, 2].

So far there have been no studies investigating the relationship of transabdominally recorded EMG activity of uterus and placental implantation site in mid trimester of pregnancy. Some investigators have reported that anterior placental implantation site causes changes in the electrical activity of the human uterus during the last trimester of pregnancy and labor [9 -12]. This phenomenon is based on the local hormonal inhibitory influence of the placenta on the surrounding myometrial cells [10, 11].

The aim of this study was to test the potential influence of the placental implantation site on the electrical uterine activity measured from the abdominal surface (transabdominal EMG) in low risk asymptomatic population of pregnant women in mid trimester of pregnancy.

Materials and methods

This prospective study was performed between October 2002 and September 2004 at University Department of Obstetric and Gynecology, "Sveti Duh" Hospital, Zagreb, Croatia. The final results were based on 56 women with detected AP. Regarding the placental implantation site and presence of AP, pregnant women were divided into two groups: 33/56 in anterior placenta group (APG) and 23/56 in posterior placenta group (PPG).

In order to select them, 251 nulliparous asymptomatic women with singleton pregnancy underwent transabdominal uterine EMG. Totally 138/251 women had placenta on the anterior uterine wall and 113/251 women had placenta on the posterior uterine wall.

This prospective cohort study was a part of a research project designed to assess the efficacy of different noninvasive diagnostic methods such as sonographic assessment of cervical length, qualitative sonographic assessment of cervical glands and mucus area and transabdominal uterine EMG as potential screening tests for preterm labor (PTL) and late spontaneous miscarriage (LSM) (Croatian Ministry of Science, Project No 0129111). During the study period, 346 women were approached in order to participate in the study. All of them were booked for in-hospital antenatal care from one consultant (RM) in low risk clinic.

The entry criteria were: 1. nulliparous women with singleton pregnancies 16 0/7 – 23 6/7 gestational weeks, 2. asymptomatic pregnancy, a) without clinical and laboratory evidence of infection (WCC < 14 x 10^{12}/l, CRP < 10 mg/l), b) no evidence of infection on cervical and vaginal swabs and c) vaginal pH < 4,5. The exclusion criteria were uterine factors that could affect the distribution of electrical activity trough the myometrium, including; Műllerian duct anomalies, uterine fibromas, clinically palpable contractions, multiple pregnancy and presence of polyhydramnios. We excluded women with body mass index (BMI) > 25 kg/m^2 because the increased abdominal thickness reduces the detection of AP by transabdominal

EMG. Since spasmolytic or tocolytic drugs may decrease myometrial electrical activity, women using these drugs were also excluded.

Based on the defined entry criteria 11 women were excluded because of WCC > 14 x 10^{12}/l, 7 were excluded because of CRP > 10 mg/l, while 18 women were excluded because the findings on cervical and vaginal swabs were different than the normal vaginal flora and 27 were excluded because the vaginal pH level was above 4,5.

Prior to the entry, every woman signed informed consent form approved by hospital and national ethical committee. Totally 32 women did not give their consent for the study.

Placental implantation site was determined by transabdominal ultrasound scan (Aloka 5500, ALOKA CO. LTD, Japan). Transabdominal uterine EMG was performed on empty urinary bladder.

Uterine EMG activity was detected using two bipolar surface silver-silver chloride disc electrodes (The 2-channel TECA™ Synergy T-EP system, Oxford Instruments, UK). The electrode sites of attachment were cleaned and treated with electrode gel. The bipolar electrodes were applied to the abdominal wall with adhesive tape symmetrically on both sides of the uterus. The electrodes were placed on abdominal projections of corneal and isthmic part of the uterus, while the reference electrode was placed on the woman's right wrist. Each measurement lasted 20 minutes. The EMG activity was amplified, acquired and digitalized using TECA™ Synergy, EMG LivePlay™ software. The data were filtered in the 0.1-4 Hz frequency range and the sampling frequency was set at 20 Hz. The analyzed EMG parameters were: median frequency (MF) and median amplitude (MA) of the recorded AP. The example of detected AP is presented in Figure 1.

All women had a follow up appointment after 7 days. The results were known to principal investigators only (OG, RM and OV) and the course of pregnancy was unaltered based on the obtained results.

MaCorr software (Sample size calculator, MaCorr Inc., Toronto, Ontario, Canada) was used for sample size calculation. Confidence interval (CI) was determined using the confidence level (CL) of 95%. The program has calculated that CI is 6.5%. Using CL of 95% and CI of 6.5% the program has calculated that for population of low risk pregnant women the sample size needs to be 228.

Statistical analysis of the maternal age, gestational age at the examination and BMI was performed using the Student t - test for independent variable (SPSS v11.0, SPSS Inc., Chicago IL, USA). Because the data of frequency and amplitude of AP were skewed, 1^{st} quartile – 3^{rd} quartile and median values were reported. Comparison of MF and MA values between the two groups was made with the Fisher exact test (SPSS v11.0, SPSS Inc., Chicago IL, USA). $P < 0.05$ was considered to be statistically significant.

Results

Among 56/251 women with detected AP (APG 33/56 versus PPG 23/56) we found no statistically significant differences in MF (APG 0.022 Hz [0.014 – 0.032] vs. PPG 0.019 Hz [0.011 – 0.026], p = 0.527, Fisher exact test) and MA (APG 1500 mV [1000 – 2000] vs. PPG 1500 mV [875 – 2000], p = 0.255, Fisher exact test).

The comparison between the two groups is presented in Table 1.

The average gestational age at the time of examiation was 19.6 weeks; 95%CI [18.9 – 20.4] , the average BMI was 22.1 kg/m^2; 95%CI [21.5 – 24] and average maternal age was 29.1 years; 95%CI [26.4 – 31.4]. The differences among assessed paramaters between APG and PPG were not statistically significant.

Comment

In this study we analyzed the EMG activity in low risk population of pregnant women in mid trimester of pregnancy. We are aware that majority of studies that investigated the effect of placental location on uterine electrical activity were performed in later gestation, particularly during the labor [2, 10]. However, our intention was to analyze potential difference in uterine electrical activity regarding the placental implantation site in mid trimester of pregnancy. Such difference in EMG measured parameters may potentially be used as a screening test for LSM and PTL.

Transabdominal uterine EMG technique is simple, providing ethically acceptable method for better understanding of uterine physiology. As there is still an open question about artifacts resulting from muscular activity of the abdominal wall and internal organs we opted for MF measurements. Median frequency was considered to be a better assessment parameter than MA, as it is not so dependent on the type and quality of the tissue [10]. Furthermore, MF is simple, relatively easy to obtain and widely used in studies assessing uterine electrical activity [8, 10].

The anterior uterine wall is the major origin of the EMG activity detected trough the abdominal wall during pregnancy [10, 11]. In pregnant women with no contractions EMG activity represents the background uterine electrical activity [1, 11]. In some studies it was reported that anterior placental implantation could reduce the EMG uterine activity due to the placental hormonal inhibitory influence on the surrounding myometrial cells [10, 11].

Several decades ago, Jung tested the electrical activity of the uterus above the placental implantational site and he was unable to detect it [12]. Marque et al. found a difference in the EMG uterine activity during the labor regarding anterior or posterior placental implantation, pointing out that the local placental hormones could decrease the EMG activity [11]. Gondry

et al. monitored 8 patients, 4 with anterior and 4 with posterior placental implantation, and found no significant difference in the recorded EMG activity between the two groups [9]. Kavsek et al. found no significant difference in the EMG activity of the uterus in last trimester of pregnancy in patients without contraction, regarding the placental implantation site. However, comparing women with contractions, they found a significant difference in the EMG activity in women with anterior compared to posterior placental implantation. The patients with anterior placental implantational site had higher MF value [10].

In our study we found that placental implantation site alone does not change the uterine EMG activity in asymptomatic women, registered trough the abdominal wall in mid trimester. This may support the theory that in the presence of contractions, particularly during labor, hormonal changes in the placenta influence the electrical activity of myometrial cells above the placental implantation site [10, 11]. Again, it should be kept in mind that our results were obtained in the mid trimester when basic uterine activity is lower compared to later gestation. Pregnant women included in the study had no contractions during examination as well as at the follow up examination 7 days later. Since there was no statistically significant difference in MF and MA between two investigated groups, it can be suspected that relationship between uterine contractions and hormonal inhibitory influence of the placenta on the surrounding myometrial cells exists. This observation may have implications for better understanding of uterine physiology in pregnancy, and could be used in designing study protocols for further investigations.

Although this was a relatively small study with negative conclusions, we believe placental implantation site has no effect on EMG results. Therefore, placental implantation site should not be considered while designing protocols for detection of potential “risk” group for PTL and LSM using transabdominal EMG.

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Table 1.

The comparison between groups with positive action potentials regarding the placental implantation site

	Anterior placenta group	Posterior placenta group	p
n	33/56	23/56	
Age (years)*	29.8 [27.1 - 32.6]	28.5 [25.8 - 30.2]	0.574
GAE (weeks)*	19.9 [19.2 – 20.6]	19.3 [18.6 – 20.1]	0.301
BMI (kg/m^2)*	22 [21.4 – 23.8]	22.2 [21.7 – 24.1]	0.471
MF (Hz)**	0.022 [0.014 - 0.032]	0.019 [0.011 - 0.026]	0.527
MA (mV)**	1500 [1000 - 2000]	1500 [875 – 2000]	0.255

Abbreviations: n – number of patients, GAE – gestational age at examination, BMI – body mass index, MF – median frequency, MA – median amplitude

Numbers are: *mean [95% confidence interval]
**median [1^{st} quartile – 3^{rd} quartile]

Statistical significance was obtained by Student t-test * or Fisher exact test ** as appropriate for given variable.

Figure 1.

Uterine action potential detected by transabdominal EMG