

The Incidence of Maternal Artefact During Intrapartum Fetal Heart Rate Monitoring

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Abstract

Objective: To determine the incidence of maternal heart rate artefact (MHRA) when monitoring fetal heart rate (FHR) in labour and to determine obstetrical factors associated with MHRA.

Methods: In a prospective observational study, maternal and fetal heart rates were displayed simultaneously to document the superimposition of the maternal heart rate (MHR) on FHR tracings. All women in labour who were undergoing external fetal monitoring (EFM) at the Ottawa Hospital from October 2011 to March 2012 were eligible. Every episode of MHRA was documented and classified according to its clinical significance. Wilcoxon test, *t* tests, and chi-square tests were used to identify time-related differences and obstetrical factors (epidural analgesia, fetal presentation, multiple gestation, maternal BMI, umbilical cord arterial pH, five-minute Apgar scores) that were associated with a potential adverse outcome.

Results: We assessed 1313 tracings with simultaneous displays of the MHR and FHR in labour. MHRA was present at least once in 721 tracings (55%). Of these tracings, 35 were classified as having one or more episodes that might have led to an adverse outcome (either false positive or false negative), giving an incidence of 2.7% of all women in labour. In 33 tracings, the MHRA masked an abnormal FHR tracing. In two tracings, the MHRA masked a normal FHR, which might have resulted in misinterpretation of the tracing (i.e., false positive), leading to unnecessary intervention.

Conclusion: The incidence of MHRA is higher than currently thought, and in more than 2% of women in labour may lead to adverse outcomes. We propose routine use of simultaneous maternal and FHR monitoring for women undergoing EFM, especially during the second stage of labour.

Résumé

Objectif : Déterminer l'incidence des artéfacts de fréquence cardiaque maternelle (AFCM) dans le cadre du monitoring de la fréquence cardiaque fœtale (FCF) pendant le travail et identifier les facteurs obstétricaux associés aux AFCM.

Méthodes : Dans le cadre d'une étude observationnelle prospective, les fréquences cardiaques maternelles et fœtales ont été affichées de façon simultanée afin de documenter la superposition de la fréquence cardiaque maternelle (FCM) sur les tracés de FCF. Toutes les femmes en travail qui, entre octobre 2011 et mars 2012, ont fait l'objet d'un monitoring fœtal externe (MFE) à l'Hôpital d'Ottawa étaient admissibles à l'étude. Chaque épisode d'AFCM a été documenté et classé en fonction de sa signification clinique. Le test de Wilcoxon, des tests *t* et des tests de chi carré ont été utilisés pour identifier les différences liées au temps et les facteurs obstétricaux (analgésie péridurale, présentation fœtale, gestation multiple, IMC maternel, pH du sang artériel issu du cordon ombilical, indices d'Apgar à cinq minutes) qui ont été associés à une issue indésirable potentielle.

Résultats : Nous avons évalué 1 313 tracés ayant affiché de façon simultanée la FCM et la FCF pendant le travail. Des AFCM ont été présents à au moins une reprise dans 721 tracés (55 %). Parmi ces tracés, 35 ont été classés comme présentant un épisode ou plus qui aurait pu mener à une issue indésirable (faux positif ou faux négatif), ce qui équivaut à une incidence de 2,7 % de toutes les femmes en travail. Dans 33 tracés, les AFCM ont masqué un tracé anormal de FCF. Dans deux tracés, les AFCM ont masqué un tracé normal de FCF, ce qui aurait pu mener à une interprétation erronée du tracé (c.-à-d. faux positif) et à la mise en œuvre d'une intervention inutile.

Conclusion : L'incidence des AFCM est supérieure aux estimations actuelles; chez plus de 2 % des femmes en travail, ils pourraient mener à des issues indésirables. Nous proposons l'utilisation systématique du monitoring simultané de la FCM et de la FCF pour ce qui est des femmes faisant l'objet d'un MFE, particulièrement au cours du deuxième stade du travail.

Key Words: Artefact, fetal monitoring, heart rate, maternal

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INTRODUCTION

Assessment of fetal well-being during labour is routinely accomplished by use of electronic external fetal heart rate monitors.¹ External fetal monitoring is the most widely used screening tool for fetal distress during labour in women with high-risk pregnancies. However, it is a poor predictor of fetal acidosis and has demonstrated a high false-positive rate that may lead to an increase in unnecessary interventions including emergency Caesarean sections.²

It is well established that EFM technology can monitor and record the maternal heart rate, which may mimic FHR patterns and result in maternal heart rate artefact. There are many reports of misinterpretation of tracings due to MHRA,³ and Nageotte describes this misinterpretation as one of the five most common FHR monitoring errors.⁴ Despite the increased risk of misinterpretation of fetal parameters resulting from MHRA, only a few selected reports of unexpected adverse outcomes attributable to maternal artefact have been published.⁵⁻⁷ Neilson et al. estimated that in approximately 5:10 000 deliveries examples of unexpected adverse fetal outcomes attributable to signal ambiguity may be encountered.⁷

To date, three retrospective studies examining the presence of signal ambiguity have been published. Reinhard et al. reviewed 144 simultaneous cardiotocograms, abdominal fetal electrocardiograms, and maternal electrocardiograms to investigate the presence of signal ambiguity in intrapartum FHR monitoring during delivery and found significantly less MHR/FHR ambiguity with the abdominal fetal ECG than with the CTG in both the first stage of labour (0.70% vs. 1.22%, $P < 0.001$) and the second stage (mean 3.30% vs. 6.20%, $P < 0.001$).⁸ Another study by Stampalija et al.⁹ examined 41 traces of simultaneous monitoring with transabdominal ECG and Doppler telemetry to compare their performance and found a significantly higher rate of confusion between the fetal and maternal heart rates for Doppler telemetry ($4.5 \pm 4.5\%$) than with transabdominal ECG ($1.3 \pm 1.9\%$). Finally, Nurani et al.¹⁰ specifically examined the presence of FHR accelerations in the second stage of labour and the role of the fetal ECG in avoiding misidentification of MHR as FHR. They reported

accelerations indicating possible recording of FHR or MHR in 28.1% of cases recorded by an external transducer and 10.9% of cases recorded by internal scalp electrodes.¹⁰ To date, however, there has been no published prospective study of the incidence of MHRA, and this ambiguity in clinical monitoring remains to be addressed.⁵

METHODS

All women in labour and undergoing EFM at the Ottawa Hospital from October 2011 to March 2012 were invited to participate in a prospective observational study. Upon admission, each woman's labour and delivery nurse presented the study details, and consent to participate was obtained. All recruitment nurses were educated regarding the study procedures. If a consenting patient underwent external FHR monitoring (Series 50XM Fetal Monitor, Philips, Boeblingen, Germany), according to the usual hospital protocol, the MHR was then simultaneously monitored and recorded on the FHR tracing by placing a heart rate monitor (pulse oximeter) on the patient's finger. MHR monitoring could be discontinued at a patient's request, if there was any discomfort, or to allow the patient to be mobile. If MHRA was observed during the labour, the nurses were asked to take corrective action by repositioning the abdominal transducer; this is standard practice at our institution and routine in a non-study situation. All tracings in which there was simultaneous MHR recording for any period of time greater than one page of trace (i.e., 8 minutes of tracing time) were reviewed, and every episode of MHRA was documented and classified into one of five types according to clinical significance (Figure 1). We designed this classification to assist in the description of the specific features of MHRA, since a number of different patterns were observed. Only type 5 was considered to be a potential clinical problem in labour. This classification of tracings may assist other investigators examining the subject.

We determined the incidence of type 5A MHRA (MHRA that could potentially mask an abnormal FHR), the most clinically significant type. Additionally, we examined whether the presence of obstetrical factors such as multiple gestation, fetal presentation, epidural anaesthesia, stage of labour, or maternal BMI were significantly related to type 5 MHRA in the tracings. Finally, we assessed neonatal outcome, including fetal arterial pH, base excess, and five-minute Apgar scores in the pregnancies associated with type 5 MHRA. The Birth and Childhood Registry Network database was used to identify the obstetrical factors in patients for whom the tracings were reviewed. The Birth and Childhood Registry Network database is a perinatal database that collects

ABBREVIATIONS

CTG	cardiotocogram
ECG	electrocardiogram
EFM	electronic fetal monitoring
FHR	fetal heart rate
MHR	maternal heart rate
MHRA	maternal heart rate artefact

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