European Journal of Obstetrics & Gynecology and Reproductive Biology 203 (2016) 297–302

Contents lists available at ScienceDirect

European Journal of Obstetrics & Gynecology and Reproductive Biology

journal homepage: www.elsevier.com/locate/ejogrb

Cardiotocographic findings in the second stage of labor among fetuses delivered with acidemia: a comparison of two classification systems

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ARTICLE INFO

Article history:
Received 24 January 2016
Received in revised form 24 June 2016
Accepted 28 June 2016

Keywords:
Cardiotocography
Labor
Fetal acidemia
Piquard
Second stage
Asphyxia

ABSTRACT

Background: The RCOG classification system of CTG trace is widely used for the analysis of the fetal heart rate during the first and second stage of labor. Other authors proposed specific classification systems for the second stage traces.
Objective: To evaluate the accuracy of RCOG and Piquard cardiotocographic patterns classification systems in predicting fetal acidemia in the second stage of labor.
Study design: This was a nested retrospective case–control study including fetuses delivered with metabolic acidemia in the second stage of labor and a matched group of non-acidemic fetuses as controls. Cases and controls were selected from the electronic medical records of the University Hospital of Bologna between 2008 and 2013. The last 60 min of the cardiotocograms recorded during the second stage of labor were independently classified by a senior consultant and a trainee according to RCOG and Piquard classifications. The inter-observer agreement and the accuracy of the two classifications in predicting fetal acidemia were evaluated.
Results: In all, 82 acidemic fetuses and 164 controls were recruited in the study period. Regarding the CTG traces assessment, the inter-observer agreement was moderate for both the categorizations (RCOG $\kappa = 0.584$). Unclassifiable CTG patterns were more frequent among acidemic fetuses vs controls either at RCOG and at Piquard evaluation (26.8% vs 7.9%, $p < 0.001$). Both systems yielded a moderate and comparable ability to predict fetal acidemia (RCOG ROC AUC = 0.731; 95% CI 0.660–0.795; Piquard ROC AUC = 0.773; 95% CI 0.704–0.833. DeLong z-test = 1.186, $p = 0.236$).
Conclusions: RCOG and Piquard systems have a moderate accuracy in identifying acidemic fetuses during the second stage of labor. The occurrence of unclassifiable findings seems significantly more common among the acidemic fetuses.

Introduction

Fetal acidemia in labor is a major cause of neonatal morbidity and mortality [1,2] and is due to an acute or progressive imbalance between an inadequate oxygen supply and an increased fetal metabolic demand. The use of electronic fetal heart rate monitoring (EFM) has been widely adopted with the aim of detecting the cardiac effects of fetal hypoxia in labor but its ability to decrease the occurrence of adverse perinatal events in the general population remains unproven [3–7].

Among the limitations of cardiotocography, which may affect its accuracy in predicting fetal acidemia, the low intra and inter-observer agreement in the trace reading is widely acknowledged [8–11]. The low reliability of this method is further enhanced during the second stage of labor when the intermittent maternal pushing efforts may alter fetal heart rate pattern, its interpretation or signal detection [12,13]. On the other hand, because of the accelerated consumption of buffer systems, the second stage of labor is the phase at highest risk for fetal acidemia [14,15]. One of the most widely used classification method for cardiotocograms (CTG) analysis is a three-tier system developed by RCOG and very recently revised by NICE [16,17]. This system does not take into

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http://dx.doi.org/10.1016/j.ejogrb.2016.06.028
0301-2115/

account the different stage of labor in the interpretation and management of CTG findings. A specific classification system for EFM adjusted for the fetal heart rate changes occurring in the second stage of labor has been proposed almost 30 years ago by Piquard et al. In the original publication the Authors have described 6 different CTG patterns in relationship to fetal pH at birth [18].

The aim of this study was to assess retrospectively the accuracy of the RCOG and the Piquard CTG classification systems in identifying a group of fetuses delivered in the second stage of labor with metabolic acidemia at birth.

Material and methods

This was a nested retrospective case–control study including a consecutive series of fetuses delivered with metabolic acidemia in the second stage of labor between 2008 and 2013 at the University Hospital of Bologna. Metabolic acidemia was defined by pH < 7.00 and base excess ≥ -12.00 mmol/l, measured on the arterial cord at birth. The first pair of non acidemic neonates delivered in the second stage immediately before and after each case and matched for sex and birthweight were selected as controls.

Exclusion criteria were multiple gestation, preterm birth (defined as delivery before 37 completed weeks of gestation), pathological CTG trace in the 1st stage, evidence of fetal structural anomalies or congenital diseases, exposure to maternal drugs which may affect fetal reactivity.

In our setting, women during the second stage of labor are commonly submitted to continuous electronic fetal monitoring by mean of external cardiotocography with the speed of the chart set at 1 cm/min. The use of internal CTG by mean of a scalp electrode is not used on a routine basis and was added to the exclusion criteria.

The study protocol was approved by our local Ethics Committee before starting the follow up research. The study protocol was found compatible with the ethical guidelines of the "World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human subjects".

The last 60 min of the CTG traces recorded in the 2nd stage for cases and controls were mixed up and assigned for review to a senior consultant (with more than ten years of experience in labor ward) and a junior trainee (with less than three years of experience). Both the examiners were blinded to the woman's clinical circumstances and to the neonatal outcome. The traces were independently classified by the two examiners, according to RCOG and Piquard classification systems.

According to RCOG guidelines, the CTG were classified as normal (all four features classified as reassuring), suspicious (one feature classified as non-reassuring and the remaining features classified as reassuring) and pathological (two or more features classified as non-reassuring or one or more classified as abnormal) [17].

According to Piquard classification, the traces were categorised as type 0 (all CTG features were normal), type 1 (early decelerations with a normal baseline), type 2a (baseline 90–120 beats per minute, with early decelerations often present), type 2b (baseline 90 bpm with decreased variability), type 3 (baseline under 90 bpm with marked accelerations occurring during the contractions) and type 4 (baseline under 90 bpm but occurring much later, at the extreme end of labor) [18].

The CTG was labeled as "unclassifiable" by either classification system if the trace of the fetal heart rate was lost or discontinued for more than 10 min ("points cloud trace", Fig. 1). Furthermore the Piquard classification system was judged "not applicable" if none of the six patterns described were compatible with the actual CTG findings.

The inter-observer agreement between the two operators in classifying the tracings was assessed by mean of Cohen's kappa (κ) coefficient.

In assessing the predictive value of each classification system for fetal acidemia, the pathologic pattern for the RCOG and the types 2a, 2b and type 3 for Piquard were considered a positive test whereas normal and suspicious patterns for RCOG and types 0, 1 and 4 Piquard were scored as negative. The decision to include the 2a CTG pattern of Piquard among the positive tests was based upon

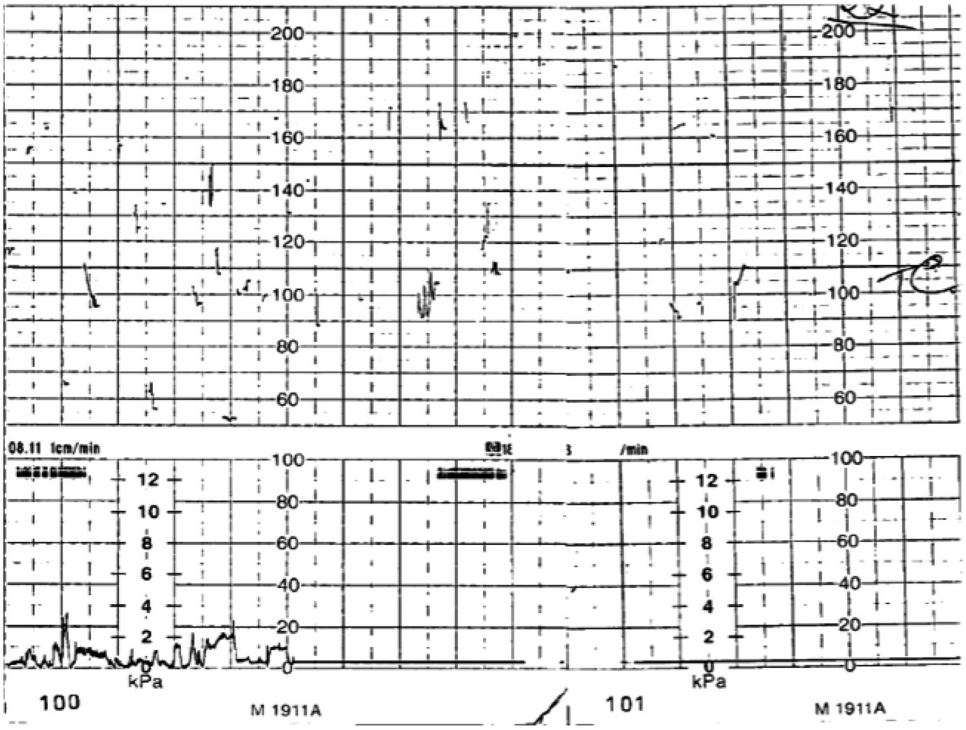

Fig. 1. Sample of a "points cloud" CTG trace.