

Correlation between fetal movement revealed in actography and fetal-neonatal well-being: observational study on 3,805 pregnancies followed in a Northern Italy tertiary care hospital

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Summary

Purpose of investigation: To evaluate the correlation between fetal movement revealed in cardiotocography and fetal-neonatal well-being as well as to assess the value of cardiotocography in our clinical practice. **Methods:** Retrospective analysis of 3,805 pregnancies followed at Parma General Hospital. Exclusion criteria were cesarean section, preterm delivery, and stillbirth. We analyzed the predictive power of actography during the dilating and expulsive phases of labor by establishing a correlation between number of fetal movements and our neonatal indexes of well being, i.e., cardiotocographic score, Apgar index and neonatal pH value. Statistical tests used were Fisher's test, chi-square test (X^2), Pearson correlation and Spearman Rho; p value was considered significant if it was less than 0.05. **Results:** We considered 2,389 vaginal deliveries. Analyzing the correlation between fetal movement and cardiotocographic score in the two different phases of labor, the comparison among subpopulations identified by different cardiotocograph scores revealed no statistical difference. **Conclusion:** Cardiotocography is reconfirmed as a good instrument to evaluate neonatal outcome, while actigraphy cannot be used alone to define fetal well-being, mainly due to the inability to standardize assessment of the actographic study.

Key words: Actigraphy; Cardiotocography; Fetal well-being; Neonatal well-being; Mode of delivery; Medico-legal implications.

Introduction

To reduce perinatal morbidity and mortality rates it is necessary to have an adequate control system of fetal well-being. In the 70s this attempt was discharged by the introduction of cardiotocography, a technique of monitoring fetal well-being able to identify impromptu conditions of fetal distress. Since its introduction in obstetric clinical practice cardiotocography has achieved a fundamental role in obstetric *decision making* in the delivery room, thus it has a crucial role in defining timing and mode of delivery. Up to date cardiotocography is the gold standard technique for fetal well-being surveillance in the third trimester of pregnancy, in particular by the 28th gestational week, and more during labor [1]. As a screening test its aim is to identify early acute intrapartum hypoxia in order to prevent fetal consequences with an early intervention by obstetricians [2]. Since its routine introduction in the clinical evaluation of fetal well-being, cardiotocography has been an important instrument even under legal and medico-legal aspects. There is a direct correlation between a low reassuring cardiotocogram and the modality of delivery, vaginal or abdominal mode [3]. Thus an

accurate analysis of the cardiotocogram makes it possible to evaluate the clinical evolution of labor in the medico-legal area, even post partum [4]. Indeed in the literature it is well known that there is a close correlation between pathologic cardiotocogram and unfavorable fetal outcome, and also the correlation between a non reactive cardiotocography (CTG) and increased fetal morbidity and mortality, especially in high-risk pregnancies [5].

The primary endpoint of our study was to evaluate the correlation between fetal movement revealed in the CTG (echocardiography) and fetal-neonatal well-being. The secondary endpoint was to assess the value of CTG in our clinical practice.

Patients and Methods

Our study was a retrospective analysis of 3,805 pregnancies followed in the Obstetric and Gynecological Clinic of the University of Parma from 1 January 2008 to 30 June 2009. The selection of patients was done based on mode of delivery, gestational age and fetal condition. Exclusion criteria were:

- Delivery by cesarean section (urgent or elective)
- Preterm delivery (before 38 gw)
- Fetal endouterine death before labor

For each pregnancy we considered gestational and maternal age, but our attention was focused on the CTG during dilation and expulsive phases of labor. We used a scoring system for the

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CTG to systematize the analysis; in particular we used the Arduini *et al.* scoring system [6], still used in practical obstetric management in our institute. The score was called Score D for the dilation period and Score E for the expulsive phase. The cardiotocographic track was compared with the value of zero in absence of fetal movement, 1 point if one-two movements were revealed in 30 minutes, and 2 points if more than two fetal movements were seen in 30 minutes. For neonatal well-being we considered the physiologic pH value more or equal to 7.25 and the pathologic pH value less than 7.25 [7, 8]. Neonatal weight was considered normal in a range from 2,500 to 3,200 kg [9], as we took into account term pregnancies. We analyzed the predictive power of actigraphy during the dilation and expulsive phases of labor by establishing a correlation between number of fetal movements and our neonatal indexes of well-being, i.e., CTG score, Apgar index and neonatal pH value. The other part of our study was the evaluation of the cardiotocographic track during the two different phases of labor, dilation and expulsive periods, considering correlations of the cardiotocographic score [6] and Apgar index and neonatal pH value, and weight in each of the two considered periods.

Statistical analysis was done by SPSS software for Windows 18. Statistical tests used were Fisher's exact test, chi-square test, Pearson's correlation and Spearman rho.

A *p* value was considered significant if it was less than 0.05 and highly significant if less than 0.01.

Results

We considered 2,389 vaginal deliveries of which 2,166 (94.9%) were spontaneous vaginal deliveries and 223 (5.1%) operative vaginal deliveries (using a disposable vacuum extractor and/or forceps). Median maternal age was 32 years (interquartile range 28-35 years). Median gestational age was 278 days (interquartile range 272.25-283). From the analysis of the CTG during the dilation phase a median value of Score D was 8 (interquartile distance equal to one), while median value of Score E was 7 (interquartile distance equal to one).

From the analysis of correlations between fetal movement and cardiotocographic score in the two different phases of labor, in the dilation period among cases with a high rate of fetal movement (1,503), 86 cases (5.7%) had a Score D less or equal to 6, 808 cases (53.8%) had a Score D equal to 7, and 609 cases (40.5%) had a Score D equal to 8. Among cases with a low rate of fetal movements (886), 151 case (17.04%) had a Score D less or equal to 6, 135 cases (15.2%) had a Score D equal to 7, and 600 cases (67.7%) had a Score D equal to 8. Comparison among subpopulations identified by different CTG scores revealed no statistical difference. Analyzing the correlation between fetal movements and Score E, among cases with a high movement rate (2,365), 347 cases (14.7%) had a Score E less or equal to 6, 903 cases (38.2%) had a Score E equal to 7, and 1,115 cases (47.1%) had a Score E equal to 8. All fetuses with a low movement rate (22) or absence of movement (2) had a Score D less or equal to 6. Comparison among subpopulations identified by different CTG scores revealed no statistical difference.

We also considered the correlation between fetal move-

ment from the CTG during the two phases of labor and neonatal outcome by evaluation of the Apgar index. During the dilation period among cases with a high fetal movement rate (1,434), 60 cases (4.2%) had an Apgar index equal to 8, 1,302 cases (90.8%) had an Apgar index equal to 9 and 72 cases (5.2%) had an Apgar index equal to 10, whereas among cases with an ante-partum low fetal movement rate (825), 39 cases (4.7%) had an Apgar index equal to 8, 783 cases (94.9%) had an Apgar index equal to 9 and three cases (0.3%) had an Apgar index equal to 10. Comparison among subpopulations identified by Apgar index values revealed no statistical differences.

From our analyses during the expulsive phase of labor in cases with a high fetal movement rate (2,245), 96 cases (4.3%) had an Apgar index equal to 8, 2,075 cases (92.4%) had an Apgar index equal to 9 and 74 cases (3.3%) had an Apgar index equal to 10, while in cases with an ante-partum low fetal movement rate (12), three cases (25%) had an Apgar index equal to 8, eight cases (66.7%) had an Apgar index equal to 9 and one case (8.3%) had an Apgar index equal to 10. All cases with no fetal movement (2 fetuses), had an Apgar index equal to 9 at birth. Comparison among subpopulations identified by the Apgar index value revealed no statistical differences.

We then considered the correlation between fetal movement from the cardiotocographic track during the two phases of labor and neonatal outcome by evaluation of the neonatal pH value by blood gases on cord blood immediately after the delivery. During the dilation period in cases with a low fetal movement rate (886), 54 cases (6.1%) had a pH value less than 7.25 and 832 cases (93.9%) had a pH value more or equal to 7.25, whereas in cases with a high fetal movement rate (1,503), 82 cases (5.5%) had a pH value less than 7.25 and 1,421 cases (94.5%) had a pH value more or equal to 7.25. Comparison among subpopulations identified by neonatal pH value revealed no statistical differences.

From our analyses during the expulsive period, considering the correlation between fetal movement from the cardiotocographic track and neonatal outcome by evaluation of neonatal pH value, among cases with no ante-partum fetal movements (2 fetuses), all had a pH value less than 7.25 and none had a pH value more or equal to 7.25. Among cases with a low fetal movement rate (22), six cases (27.3%) had a pH value less than 7.25 and 16 cases (72.7%) had a pH value more or equal to 7.25, whereas among cases with a high fetal movement rate (2,365), 130 cases (5.5%) had a pH value less than 7.25 and 2,235 cases (94.5%) had a pH value more or equal to 7.25. Comparison among subpopulations identified by neonatal pH value revealed no statistical differences.

Considering the correlation between Score D and Score E, among 237 fetuses with Score D less or equal to 6 (93.2%), 221 cases had the same score even in the expulsive period, while 16 cases had a SCORE E equal to 7, and none had a Score E equal to 8. Of 943 fetuses with Score D equal to 7, 150 cases (15.9%) had a Score E less

or equal to 6, 789 cases (83.6%) had a Score E equal to 7 and four cases (0.4%) had a Score E equal to 8. Among 1209 fetuses with Score D equal to 8, none had a Score E less or equal to 6, 98 cases (8.1%) had a Score E equal to 7 and 1111 cases (91.9%) had a Score E equal to 8.

On completion of the analysis on actography, a possible correlation was considered between cardiotocographic score and neonatal outcome defined by neonatal weight, Apgar index and neonatal pH value. A proportional correlation was noticed between cardiotocographic score values and neonatal Apgar index in the dilation period and the expulsive period of labor, respectively with $p < 0.0001$ (Spearman $p = 0.175$) and $p < 0.0001$ (Spearman $p = 0.126$).

There was also a proportional correlation between values of the cardiotocographic score and neonatal pH values in both the dilation and expulsive phases of labor, respectively with $p < 0.0001$ (Spearman $p = 0.112$) in the dilating period and $p < 0.0001$ (Spearman $p = 0.115$) in the expulsive period.

A statistically significant correlation was noted between Score E and neonatal weight with $p < 0.0001$ (Spearman $p = 0.74$). Finally a proportional correlation between neonatal pH values and Apgar index was seen with $p < 0.0001$ (Pearson $p = 0.140$).

Discussion

Since CTG can evaluate fetal heart rate and its relation with uterine tone, it plays an important role in the evaluation of fetal well-being during labor and in identifying fetal suffering due to hypoxia. Thus it is a fundamental step in *obstetric decision making* to define a quick delivery in cases at risk of fetal suffering. In the literature the role of actigraphy is still described as an instrument to better evaluate fetal well-being together with cardiotocography. Actography is able to reduce false-positive non reassuring the CTG, increasing predictive value and specificity of the latter in determining neonatal outcome in the ante-partum period [10-13]. A close correlation between fetal heart rate and fetal movement has been described as a highly significant index of fetal well-being. Accelerations often precede or coincide with fetal movement from the 26th-28th gestational weeks [14]. This finding supports the hypothesis of a coordinated control of acceleration and fetal movement by the autonomous nervous system and negates the idea that acceleration happens as consequence of fetal movement [14]. In a non reassuring CTG, with absence of acceleration and low variability, low or absent fetal movements suggest fetal hypoxia thus establishing fetal distress [12, 13]. Finally actigraphy and CTG can be used together in a diagnostic algorithm to predict a sudden and imminent fetal distress [12, 13]. In the literature fetal movements have been described in the presence of big accelerations in the CTG since there is a close association between fetal movements and big accelerations in 99.6% of cases [15].

The endpoint of our study was to evaluate if actography alone could be a useful parameter of good neonatal

outcome in the prenatal period. We considered a correlation between fetal movement revealed in actography and cardiotocographic score also during labor. The aim was to define if actigraphy could help cardiotocography in defining *modus operandi* in the delivery room, since today obstetric management in the delivery room is based on evaluation of the cardiotocographic track. We analyzed the prognostic power of actography, establishing a relation between fetal movement and common fetal well-being indexes, such as neonatal pH, Apgar index, and neonatal weight. As a control we also compared CTG scores with the same indexes of neonatal outcome in both periods of labor, dilation and expulsion. The results demonstrated that there is no correlation between absence of fetal movements and low Apgar score, or low neonatal pH value or neonatal weight out of physiologic range, in either the dilating or expulsive phase of labor. These findings support the idea that actography is not useful in monitoring fetal well-being during labor, while it has an important role in monitoring fetuses during the last weeks of gestation. This is in accord with results of studies conducted by Mangesi and Hofmeyr [16], but not by the results of Maeda and Zhao [13, 14]. As widely described in the literature [3, 4, 11, 17, 18], it has been the correspondence between progressively higher CTG scores and better fetal well-being indexes during labor has been reconfirmed. Particularly, in our study during dilation the cardiotocographic score correlated with a good Apgar index and neonatal pH value, whereas in the expulsive period the cardiotocographic score was also correlated with neonatal weight in the optimal range with a good Apgar index and a good neonatal pH value.

Thus CTG is reconfirmed as a good instrument to evaluate neonatal outcome, while actigraphy alone cannot be used to define fetal well-being, mainly due to the inability to standardize assessment of the actographic study.

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