



Mode of delivery has an independent impact on neonatal condition at birth



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ARTICLE INFO

Article history:

Received 29 May 2014

Received in revised form 21 July 2014

Accepted 29 July 2014

Keywords:

Apgar score

Acidosis

Fetal distress

Nonreassuring fetal status

ABSTRACT

Objective: Current intra-partum monitoring techniques are often criticized for their poor specificity, with their performance frequently evaluated using measures of the neonatal condition at birth as a surrogate marker for intra-partum fetal compromise. However, these measures may potentially be influenced by a multitude of other factors, including the mode of delivery itself. This study aimed to investigate the impact of mode of delivery on neonatal condition at birth.

Study design: This prospective observational study, undertaken at a tertiary referral maternity unit in London, UK, included 604 'low risk' women recruited prior to delivery. Commonly assessed neonatal outcome variables (Apgar score at 1 and 5 min, umbilical artery pH and base excess, neonatal unit admission, and a composite neonatal outcome score) were used to compare the condition at birth between babies born by different modes of delivery, using one-way ANOVA and chi-squared testing. **Results:** Infants born by instrumental delivery for presumed fetal compromise had the poorest condition at birth (mean composite score = 1.20), whereas those born by Cesarean section for presumed fetal compromise had a better condition at birth (mean composite score = 0.64) ($p = <0.001$). No difference in composite neonatal outcome scores was observed between babies born by instrumental delivery for a prolonged second stage (no evidence of compromise), and those born by Cesarean delivery for presumed fetal compromise.

Conclusions: Mode of delivery represents a potential confounding factor when using condition at birth as a surrogate marker of intra-partum fetal compromise. When evaluating the efficacy of intra-partum monitoring techniques, the isolated use of Apgar scores, umbilical artery acidosis and neonatal unit admission should be discouraged.

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Introduction

Intra-partum fetal hypoxia, resulting in permanent neurological impairment remains a significant source of concern for parents and healthcare professionals. Despite improvements in antenatal and intra-partum care, the incidence of cerebral palsy in term infants has not changed in the last 30 years [1]. Whilst in the majority of cases cerebral palsy results from antenatal insults [2], a significant percentage, particularly in term infants, is caused by intra-partum events [3,4]. Several techniques have been developed with the aim of identifying the compromised fetus before

permanent neurological damage ensues, thereby enabling expedited delivery and hopefully improving outcomes for the baby. The most widely used of these, the cardiotocograph (CTG), has been reported to have a high false positive rate [5], and as a result CTG monitoring does not always correlate with the neonatal condition at birth. Other parameters, including the Apgar score, umbilical artery pH and base deficit at delivery, and the requirement for neonatal unit admission, are also used to evaluate the newborn at the time of delivery and are valuable in determining the requirement for further treatment or observation. However, studies evaluating intra-partum monitoring techniques frequently use these measures as an indication of intra-partum fetal compromise [6,7]. This is perhaps inappropriate given that all these methods of assessment have the potential to be misleading. Whilst they may suggest intra-partum hypoxia, they are also influenced by a multitude of other factors. For example, Apgar scores at delivery can be significantly influenced not only by the

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presence of birth asphyxia, but also by prematurity and intra-partum narcotics used for analgesia [8]. Similarly, neonatal acidosis used in isolation is a poor predictor of birth asphyxia. Even a pH <7.00 is associated with a normal post-natal course in the majority of neonates [8]. Neonatal unit admission, as a single criterion, is also misleading, as the indication for admission, such as sepsis or hypoglycaemia, may be independent of adequate fetal oxygenation during labor [9]. Furthermore, there is potential for the mode of delivery itself, as well as the overall fetal condition throughout labor, to influence the condition of the neonate at birth. Respiratory complications, for example, are associated with elective Cesarean delivery [10], and many practicing Obstetricians will have experienced difficult instru-

mental deliveries resulting in a neonate in poor condition despite an absence of evidence of fetal compromise throughout labor. We have suggested recently that neonates delivered by emergency Cesarean delivery for presumed fetal compromise may benefit from a period of in-utero resuscitation prior to delivery, resulting in a better than anticipated condition at birth [11].

In this study, we used commonly assessed neonatal outcome variables to compare condition at birth between neonates born by different modes of delivery. We aimed to determine whether the mode of delivery itself may significantly influence the condition at birth, and as such represent a confounding factor when using these parameters to determine the presence or absence of intra-partum fetal compromise. We hypothesized that an adverse condition at birth would occur more frequently amongst babies delivered by instrumental delivery for presumed fetal compromise, than those delivered by emergency Cesarean delivery for presumed fetal compromise. Even amongst babies with no evidence of fetal compromise during labor, we hypothesized that condition at birth would show significant variation between those born by different modes of delivery.

Materials and methods

Six hundred and four women were recruited to this prospective observational study over a two-year period, between March 2011 and March 2013. All participants were recruited from the delivery suite, antenatal ward, and day assessment unit at Queen Charlotte's and Chelsea Hospital. This is a tertiary referral maternity unit in London, UK. All participants had uncomplicated, term (37–42 weeks), singleton pregnancies. Exclusion criteria included, multiple pregnancy, prematurity, known fetal anomaly, evidence of intrauterine infection, or evidence of placental dysfunction, including fetal growth restriction, maternal hypertension or pre-eclampsia. All labors were managed according to local protocols and guidelines, with staff unaware of a participant's inclusion in the research study in order to limit bias. Intra-partum fetal heart rate patterns were reviewed by an Obstetrician blinded to the intra-partum/neonatal outcomes, and classified according to NICE (National Institute for Health and Care Excellence, UK) criteria as normal, suspicious, or pathological [12]. Mode of delivery was classified as Cesarean section for presumed fetal compromise, Cesarean section 'other', instrumental for presumed fetal compromise, instrumental for a prolonged second stage, and spontaneous vaginal delivery (SVD). In all cases, the indication for assisted/surgical delivery was decided contemporaneously by the obstetric team managing the labor. Following delivery, case notes

were examined and neonatal outcomes compared between the different mode of delivery groups. Neonatal outcomes evaluated included the Apgar score at 1 and 5 min, umbilical artery pH, umbilical artery base deficit, neonatal unit admission, and neonatal encephalopathy. For the Apgar score, an adverse outcome was considered to be a score <7 at 1 or 5 min. This conforms to other studies assessing neonatal outcome, in which a score of <7 is frequently used to define an adverse outcome [6,13,14]. For umbilical artery pH, an adverse outcome was defined as a pH <7.20. This level was used as a pH of <7.20 on fetal blood sampling is defined as abnormal in current intra-partum guidelines used in the UK [12], and is used to prompt immediate delivery. For umbilical artery base excess, an adverse outcome was considered a base excess of ≤ 8.0 . This level has been described as a moderate base deficit in the published literature, and associated with an increased incidence of central nervous system complications [15]. Admission to the neonatal unit was also considered an adverse outcome. In order to improve the sensitivity of the study for detecting a difference between mode of delivery groups, thresholds defining adverse neonatal outcomes were set deliberately low. A composite neonatal outcome score was also calculated incorporating all of the neonatal outcomes variables. Points were awarded dependent on the degree of deviation from normality for each neonatal outcome variable, and combined to give a composite outcome score.

Ethical approval for this study was granted by the London Research Ethics Committee (Ref No: REC 10/H0718/26).

For data analysis cases were grouped according to mode of delivery and intra-partum monitoring classification. The neonatal outcome variables were then compared amongst these groups using one-way ANOVA and chi-squared tests.

Results

All 604 women recruited to the study gave birth to live infants. The mode of delivery for all cases is documented in Table 1.

Neonatal outcome variables were compared between the different mode of delivery groups (see Table 2). Birthweight, birthweight centile, incidence of Apgar score <7 at 1 min, incidence of umbilical artery pH <7.20, incidence of umbilical artery base deficit ≤ 8.0 mmol/L, and the composite neonatal outcome score, were all found to have significant variation between the different mode of delivery groups. For each neonatal outcome variable, the poorest outcomes were observed in infants delivered by instrumental delivery for presumed fetal compromise. Whilst infants born by emergency Cesarean for presumed fetal compromise had the second highest incidence of an Apgar <7 at 1 min, a higher incidence of both umbilical artery pH <7.20 and umbilical artery base deficit ≤ 8.0 mmol/L were found in the group of infants born by SVD. Cases born by instrumental delivery for a prolonged second stage (no evidence of fetal compromise) had an incidence of umbilical artery pH <7.20 at delivery of 25.0% (24/96), and an incidence of an Apgar score <7 at 1 min of 11.5% (11/96).

Cases with normal intra-partum monitoring were then grouped according to their mode of delivery (see Table 3). Whilst no significant variation in the neonatal outcome variables was observed between the mode of delivery groups, a trend toward poorer outcomes was observed in cases delivered by instrumental delivery. These babies had the highest incidence of an Apgar <7 at

Table 1
Mode of delivery.

Cesarean—fetal compromise	Instrumental—fetal compromise	SVD	Instrumental—prolonged 2nd stage	Cesarean—other
69	110	238	96	91

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