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## International Journal of Gynecology and Obstetrics

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



## CLINICAL ARTICLE

Mode of delivery and outcomes by birth weight among spontaneous and induced singleton cephalic nulliparous labors<sup>☆</sup>Jennifer M. Walsh<sup>\*</sup>, Mark P. Hehir, Michael S. Robson, Rhona M. Mahony

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## ARTICLE INFO

## Article history:

Received 3 June 2014

Received in revised form 7 October 2014

Accepted 15 December 2014

## Keywords:

Birth weight

Cesarean delivery

Labor

## ABSTRACT

**Objective:** To assess the effect of birth weight on mode of delivery among nulliparous women in a setting with no policy of elective induction for suspected macrosomia. **Methods:** In an observational study, data were assessed from nulliparous women with a single cephalic pregnancy of at least 37 weeks in spontaneous (Robson group 1) and induced (Robson group 2a) labor attending a hospital in Dublin, Ireland, between January 1, 2008, and December 31, 2009. The primary outcome measure was mode of delivery. **Results:** A total of 7528 nulliparous labors were included (4989 in group 1 and 2539 in group 2a). The cesarean section rate was 15.1% overall (n = 1139), with 411 (8.2%) in group 1, and 728 (28.7%) in group 2a. Cesarean delivery rates rose with increasing birth weight in group 1, from 119 (6.3%) of 1886 infants weighing 3000–3499 g and 160 (8.5%) of 1892 weighing 3500–3999 g, to 19 (26.8%) of 71 weighing 4500–4999 g. Rates of cesarean delivery were significantly higher in induced labor (group 2a) for each birth-weight category, ranging from 202 (25.9%) of 781 weighing 3000–3499 g and 243 (27.0%) of 899 weighing 3500–3999 g, to 38 (48.1%) of 79 weighing 4500–4999 g (P < 0.01 for all). **Conclusion:** In a setting with standardized management of labor, birth weight remains a significant determinant of mode of delivery.

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## 1. Introduction

Birth weight is an important determinant of mode of delivery [1]. Neonates at the higher end of the weight range are significantly more likely to be delivered by cesarean, and are more prone to birth trauma than are neonates of normal birth weight [2,3]. Delivery of a macroscopic newborn also confers excess risk for the mother, including an increased risk of operative vaginal delivery (OVD), obstetric anal sphincter injury (OASIS), and postpartum hemorrhage (PPH) [3,4].

This association with birth injury, and in particular with shoulder dystocia and brachial plexus injury, has led to an increasing trend toward a planned delivery when fetal macrosomia is suspected, either by induction or an elective cesarean delivery [5,6]. However, the appropriate management in such cases remains unclear. Observational studies have failed to show a reduction in cesarean delivery rates, or indeed neonatal morbidity, when labor is induced on the basis of suspected macrosomia [7]. The issue is further complicated by the limitations of prenatal detection of macrosomia by either clinical or ultrasonographic methods [8,9].

In many centers, there is a policy of elective induction of labor, or indeed cesarean delivery, for cases of suspected fetal macrosomia [10]. In addition, the knowledge that a fetus could be large for its gestational age could introduce a degree of physician bias in the management of labor, leading to a lower threshold to deliver by cesarean in cases of slow progress than in labors in which the estimated fetal weight (EFW) is within the normal range.

At the National Maternity Hospital, Dublin, Ireland—a large institution where more than 9000 women deliver annually—there is no policy of elective induction of labor or elective cesarean in cases of suspected fetal macrosomia. In addition, all nulliparous labors are managed in accordance with a standard active management of labor protocol [11], which minimizes any potential physician bias in relation to estimated birth weight. Lastly, all labor outcomes are continuously audited according to the Robson 10-group classification [12], which facilitates clear, reproducible auditable standards.

These characteristics provide an opportunity to perform an objective analysis of obstetric outcomes according to birth weight. The primary aim of the present study was to examine the role of neonatal birth weight on mode of delivery among nulliparous women by performing a comparison of cesarean delivery rates in each of seven different birth-weight categories. Secondary aims were to clarify rates of maternal and neonatal morbidity associated with birth-weight category, and to compare these rates between spontaneous and induced labors.

<sup>☆</sup> Presented at the Society for Maternal–Fetal Medicine Annual Meeting; February 6–11, 2012; Dallas, TX, USA. Am J Obstet Gynecol 2012; 206(Suppl 1):S294.

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## 2. Materials and methods

In the present observational study, data were reviewed from all nulliparous deliveries at the National Maternity Hospital, Dublin, Ireland, between January 1, 2008, and December 31, 2009. The study population comprised all nulliparous women with a single cephalic pregnancy of at least 37 weeks whose labor was spontaneous (Robson group 1) or induced (Robson group 2a). Preterm labors ( $\leq 37$  weeks), prelabor cesarean deliveries, and stillbirths were excluded from the study. The data were compiled as part of a continuous audit of practice and outcomes at the institution; therefore, the study was deemed exempt from requiring institutional ethics board approval and informed consent was not obtained.

At the study institute, all first-time mothers who present in spontaneous labor at term ( $\geq 37$  weeks) with a singleton vertex presentation are managed in accordance with a standard intrapartum active management protocol [11]. This protocol includes early amniotomy after diagnosis of labor, regular (2-hourly) assessment of cervical dilatation, oxytocin augmentation if labor does not progress at a rate of 1 cm per hour in the absence of fetal distress, and a cesarean section when delivery is not imminent after 12 hours on the labor ward. Fetal blood sampling is used to confirm fetal distress suspected by cardiotocographic monitoring; cesarean is performed in cases of a fetal scalp pH of less than 7.20 before full dilatation.

Labor was induced when women had completed at least 42 weeks of pregnancy or had prolonged rupture of membranes ( $>18$ – $24$  h), pre-eclampsia/hypertension, fetal interest, or oligohydramnios. The method of labor induction is determined via a modified Bishop score [13] as either dinoprostone gel or amniotomy, followed by intravenous oxytocin if labor has not commenced within 20–24 hours. Once labor is established, it is managed as above in accordance with active management principles.

When required, oxytocin is administered at a concentration of 10 IU/L, starting at a rate of 5 mU/min and increasing by 5 mU/min every 15 minutes to a maximum of 30 mU/min, unless the frequency of contractions is more than seven in 15 minutes.

All labor events are recorded by the attending midwife on standardized partograms. Before discharge from the labor ward, these data are entered into a computerized database and counter-checked by the supervising midwife. This prospective database is subject to continuous audit.

For the present study, the primary outcome measure was mode of delivery, which was classified as spontaneous vaginal delivery (SVD), OVD, or cesarean delivery. The incidence of maternal PPH greater than 1000 mL, OASIS, and shoulder dystocia was also determined for each birth-weight category. Shoulder dystocia was defined as failure to deliver the shoulders at the first attempt in singleton cephalic vaginal deliveries. At the study institution, all incidences of shoulder dystocia are reported to the hospital's risk management committee and outcomes are continuously audited. A diagrammatic report form is completed immediately after each case of shoulder dystocia, and these forms are crossreferenced by hand to ensure accurate rates of shoulder dystocia are reported.

Neonatal birth weight was subdivided into seven categories of 500 g, ranging from less than 2500 g to more than 5000 g. The incidence of labor complications (PPH, shoulder dystocia, and OASIS) and mode of delivery (SVD, OVD, or cesarean delivery) were determined for each birth-weight category, and the values were compared between spontaneous and induced labor.

Statistical analysis was performed with SPSS version 21.0 (IBM, Armonk, NY, USA). Data are reported as mean  $\pm$  SD or number (percentage), and odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Groups were compared via the  $\chi^2$  test and Fisher exact test. A two-tailed *P* value of less than 0.05 was considered significant.

## 3. Results

During the study period, there were 7528 eligible nulliparous labors, with 4989 in Robson group 1 and 2539 in group 2a. Among women in group 2a, labor had been induced because the pregnancy had lasted at least 42 weeks in 714 (28.1%); induction was indicated for prolonged rupture of membranes in 650 (25.6%), pre-eclampsia/hypertension in 302 (11.9%), fetal interest in 264 (10.4%), oligohydramnios in 185 (7.3%), and other reasons in 424 (16.7%). Delivery was by cesarean for 1139 (15.1%) women overall, 411 (8.2%) in group 1, and 728 (28.7%) in group 2a.

The mean maternal age was  $29.4 \pm 5.3$  years and the mean body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters) was  $24.8 \pm 4.6$ . The mean birth weight was  $3539 \pm 463$  g; 1197 (15.9%) neonates weighed more than 4000 g.

Generally, the proportion of deliveries that were SVDs decreased with increasing birth-weight category for both groups (Table 1). Only 12.0% of neonates with birth weights of 3000–3499 g were delivered by cesarean, compared with half of those weighing more than 5000 g (Table 1). For each birth-weight category, the number of women who delivered by cesarean was higher in group 2a than in group 1 (Table 1). In group 1, 315 (7.3%) of 4322 neonates with a birth weight of less than 4000 g were delivered by cesarean, compared with 96 (14.4%) of 667 weighing at least 4000 g (OR 2.14; 95% CI 1.67–2.73;  $P < 0.001$ ). In group 2a, 535 (26.6%) of 2009 neonates weighing less than 4000 g were delivered by cesarean, compared with 193 (36.4%) of 530 weighing more than 4000 g (OR 1.58; 95% CI 1.29–1.93;  $P < 0.001$ ). For birth weights of 4500–4999 g, 27% of women laboring spontaneously delivered by cesarean delivery as compared with 48% of those who were induced. No significant overall trend in the incidence of OVD was noted in terms of either birth-weight category or mode of onset of labor (Table 1).

Maternal PPH of greater than 1000 mL complicated 82 (1.1%) deliveries. The proportion of women affected by PPH of greater than 1000 mL increased with birth-weight category (Table 2). The frequency of PPH was higher in every birth-weight category of group 2a than group 1, although the differences were significant for only the birth-weight categories of 3000–3499 g and 3500–3999 g ( $P = 0.003$  for both) (Table 2).

Overall, 217 (2.9%) women had OASIS: 141 (2.8%) women in group 1 and 76 (3.0%) in group 2 were affected (OR 1.04; 95% CI 0.79–1.20;  $P = 0.7$ ). Generally, the frequency of OASIS increased with birth weight (Table 2). OASIS affected 166 (2.6%) of 6331 women who delivered neonates weighing less than 4000 g, compared with 51 (4.3%) of 1197 who delivered neonates weighing at least 4000 g (OR 1.65; 95% CI 1.17–1.91;  $P = 0.013$ ).

There were 90 (1.2%) cases of shoulder dystocia during the study period: 58 (1.2%) labors in group 1 and 32 (1.3%) labors in group 2a were affected. There were no cases of shoulder dystocia among neonates weighing less than 3000 g, but one in 8 of those weighing more than 5000 g were affected (Table 2).

## 4. Discussion

The present study confirms the significant influence of neonatal birth weight on delivery outcomes in nulliparous labor. In a setting where the management of labor is standardized and there is no policy of elective induction or cesarean delivery in cases of suspected macrosomia, the frequency of cesarean delivery increased steadily and consistently with each 500-g increase in neonatal size above 3000 g. The present study also highlights the difference in cesarean delivery rates when spontaneous and induced labors are compared. For birth weights of 4500–4999 g, women laboring spontaneously had a 27% risk of cesarean delivery as compared with 48% for those who were induced.

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