Research Open

Integrative Gynecology and Obstetrics Journal

Volume 2 Issue 1

Research Article

Neonatal Outcomes of Macrosomic New-Borns (4,000g +) of Diabetic and Non Diabetic Mothers: A Study of 1,391 Singleton New-Borns

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Received: December 21, 2018; **Accepted:** January 17, 2019; **Published:** January 29, 2019;

Abstract

Objective: To explore the association between diabetic status of the mother and subsequent pregnancy outcomes in a cohort of macrosomic births (birth weight ≥ 4000 grams).

Design: Historical cohort study of macrosomic births comparing delivery method, newborn injury, and newborn morphology between diabetic and non-diabetic women.

Setting: Centre Hospitalier Universitaire Sud-Reunion's maternity (island of La Reunion, French overseas department, Indian Ocean)

Population: All consecutive singleton live macrosomic births delivered from 2009–2017.

Methods: Macrosomic births were identified from the hospital and the medical records of the mother and newborn were abstracted. Pregnancy outcomes (method of delivery, newborn injury, and newborn morphology) were contrasted between diabetic and non-diabetic women. Among those delivered vaginally, we compared newborn injury between groups.

Results: Newborns from diabetic mothers (cases: 206) were slightly heavier while being younger in gestational ages than controls. There were more caesarean deliveries in the diabetic group (48.8% vs 22.5%, p< 0.001). Among diabetic newborns with vaginal deliveries (ap. half of all diabetic), there were more newborn injuries (brachial plexus, clavicle fractures) in the diabetic group (OR 2.5, p = 0.01) than in controls. A logistic regression model taking into account maternal pre-pregnancy BMI and fetal BW gave an adjusted Odds Ratio for newborn injuries of 2.29 (p = 0.03) in diabetic deliveries.

Conclusion: Among macrosomic deliveries (BW ≥ 4000g), newborns from diabetic mothers have more injuries than controls. This risk remains after controlling for pre-pregnant BMI and newborn birth weight. These data confirm that diabetic-macrosomic newborns may present a different truncular obesity than non-diabetics.

Keywords: *Cesarean Delivery, Overweight, Shoulder dystocia, Pre-pregnancy Adiposity, gestational diabetes, Fetal macrosomia.*

Introduction

This historical cohort study was conducted to test the hypothesis that pregnancy outcomes of macrosomic newborns (≥ 4000g) might be different according to the diabetic status of parturients. This information may have important implications for clinical management of these pregnancies. Some authors have reported a different morphology in heavy babies according to the diabetic status of the mother. In diabetic pregnancies, as compared to non-diabetic pregnancies, repartition of fetal adiposity may be predominant in the upper part of the body (fetal truncular obesity), inducing a greater risk of shoulder dystocia in these cases [1–6]. This may be particularity so in gestational diabetes and is therefore of paramount importance in clinical management with respect to mode of delivery. The data for this investigation were obtained from the computerized perinatal data base of more than 35,000 deliveries from nine years of practice at the Centre Hospitalier Universitaire Sud-Reunion's maternity.

Material and Methods

From January 1st, 2009, to December 31st, 2017, the hospital records of all women delivered at the Centre Hospitalier Universitaire Sud-Reunion's maternity were abstracted in standardized fashion. All data were entered into an epidemiological perinatal data base which contained information on obstetrical risk factors, description of deliveries and neonatal outcomes. As participants in the French

national health care system, all pregnant women in Reunion Island have their prenatal visits, biological and echographical examinations, and anthropological characteristics recorded in their maternity booklet. Maternal pre-pregnant body mass index (BMI) was defined as the ratio of pre-pregnancy weight in kilograms divided by height in meters squared (kg/m²).

Screening for gestational diabetes was performed by the O'Sullivan test between 24 and 28 weeks gestation (ingestion of 50g glucose, followed one hour later by a glycaemia, the cut-off value being 1.4 g/l). The diagnostic test was then the oral glucose tolerance test (OGTT, ingestion of 100g glucose, followed by measurements of glycaemia 1, 2 and 3 hours after ingestion (cut-off values respectively being 0.95 g/l, 1.8 g/l, 1.55 g/l and 1.40 g/l). Diagnosis of gestational diabetes was performed when at least 2 glycemic measurements were above the cut-off values during the OGTT.

Epidemiological data have been recorded and analysed with the software EPI-INFO 7.1.5 (2008, CDC Atlanta, OMS), EPIDATA 3.0 and EPIDATA Analysis V2.2.2.183. and statistical analysis by Stata 7.

Results

During the nine year study period, there were 35,459 singleton live births of which 1,391 (3.9%) newborns weighing 4000g or more.

Table 1 compares macrosome newborns (BW ≥ 4000g) according the diabetes status of their mothers during pregnancy. In diabetic pregnancies, 88% (182/206) were gestational diabetes while 24 presented a preexisting diabetes mellitus. Newborns from diabetic mothers were slightly heavier than controls (44g in average, p = 0.002) but with a lower gestational age at birth (38.6 weeks vs 39.7 weeks, p < 0,001).

Table 1. Diabetic and non diabetic macrosomes (≥ 4000g). Singleton live births

	Macrosomes ≥ 4000g Diabetic mothers N=206 (%)	Macrosomes ≥ 4000g Non-Diabetic mothers N=1,185 (%)	Odds Ratio [95% CI]	p
Mean Birthweight (g) ± SD	4247 ± 235	4203 ± 187	_	0.002
Mean Gestational Age (Weeks) ± SD	38.6 ± 1.2	39.7 ± 1.2	_	<0,001
Caesarian sections (%)	101 (49.0)	266 (22.4)	3.3 [2.4–4.5]	<0.001
Induced deliveries	70 (33.9)	307 (25.9)	1.46 [1.05–2.0]	0.02
% of induced deliveries with a C-section issue	17/70 (24.3)	86/307 (28.0)	_	NS
Abnormal fetal monitoring*	18 (8.7)	157 (13.2)	_	NS
Fluid or thick meconium staining	36 (17.4)	279 (23.5)	0.68 [0.45–1.0]	0.05
APGAR ≤ 6	15 (7.3)	41 (3.4)	2.2 [1.1–4.2]	0.01
Transfers in neonatology	11 (5.3)	44 (3.7)	_	NS
Gestational diabetes	182	0	_	_
Preexisting Diabetes	24	0	_	_
Pre-pregnancy maternal BMI, Kg/m² ± SD	30.1 ± 6,8 n= 200	26.1 ± 5.6 N= 1140		< 0.001

* Abnormal fetal monitoring: Dip2, fetal bradycardia 10 minutes minimum, flat line.

There were significantly (incidence almost doubled) more Cesarean sections in diabetics (48.8% vs 22.5%, OR 3.3, p<0.001). There were more induced deliveries in diabetics than in controls (33.8% vs 25.9%, OR 1.4, p = 0.02), but in both groups, failures of induction (leading to a C-section) were similar. There was less meconium staining in diabetics (OR 0.68, p = 0.05) and a greater incidence of Apgar 3 mn scores less than 7, (7.2% vs 3.4% OR 2.2, p = 0.01) than in controls. There were no differences in transfers of newborns to a neonatal intensive care unit (NICU) or abnormal fetal monitoring during labour.

Table 2 analyzes vaginal deliveries (N = 1,024) in both groups of macrosomes. Instrumental extractions (vacuum, forceps) and transfers of newborns to the NICU were not statistically significant in both groups. There was significantly more fetal trauma (clavicle fractures and/or brachial plexus) in diabetics (OR 2.5, p = 0.02) and Apgar 3 mn scores less than 7 (OR 3.7, P< 0.001). In non-diabetic

macrosomes, two infants presented with both clavicle fractures and brachial plexus.

Table 2. Obstetrical traumatisms in vaginal deliveries. Diabetic and non-diabetic macrosomes (≥ 4000g). Singleton live births

	Macrosomes ≥ 4000g Diabetic mothers N= 106 (%)	Macrosomes ≥ 4000g Nondiabetic mothers N= 918 (%)	Odds Ratio [95% IC]	p-value
Instrumental Extractions (vacuum, forceps)	9 (8.5)	102 (11.1)	_	NS
Obstetrical Traumatisms (Clavicles and/or brachial plexus)	11 (10.4)	40 (4.4)	2.5 [1.2–5.3]	0.01
Clavicle fractures	8 (7.5)	26 (2.8)	2.8 [1.1–6.8]	0.02#
Brachial Plexus	3 (2.8)	16 (1.7)	_	NS
APGAR ≤ 6	11 (10.4)	28 (3.1)	3.7 [1.7–8.0]	<0.001
Transfers in neonatology	4 (5.7)	14 (3.2)		NS
Pre-pregnancy maternal BMI Kg/m² ± SD.	30.0 ± 6,6 n= 105	25.8 ± 5,6 n= 885		< 0.001

* Cephalic vaginal deliveries : breeches (N= 1) and deliveries « en route » (N= 3) excluded
# Fisher exact test

Table 3 depicts the logistic regression model for fetal trauma (brachial plexus and/or clavicle fracture) in cephalic vaginal deliveries, controlling for maternal pre-pregnancy body mass index and fetal birthweight in diabetic and nondiabetic mothers. Out of 1,024 vaginal deliveries, breech presentation (N = 1) and "en route" deliveries (N = 3) were excluded. Pre-pregnancy maternal body mass index were recorded in 990 mothers (96.5%). In this cohort, the crude odds ratio for fetal trauma was slightly different than the entire cohort of 1,024 women, see Table 2 (2.37 [1.14–4.91], p = 0.02 vs 2.5 [1.2–5.3], p = 0.01, respectively).

Controlling for fetal birthweight and maternal pre-pregnancy BMI, the adjusted odds ratio in diabetic mothers for fetal trauma was similar to the crude OR: 2.29 vs 2.37, p = 0.03.

The risk for fetal trauma was predominantly in newborns over 4750g as compared with the group 4000–4250g as well as a strong tendency for newborns 4500–4750g, see Table 3. Association with maternal BMI was less specific (notably in women over 35 kg/m²).

Discussion

The Centre Hospitalier Universitaire Sud-Reunion's maternity (European standards of care) is the only public hospital in the southern part of Reunion Island (Indian Ocean, French overseas department). It serves the whole population of the area, and with 4,300 births per year, represents 80% of all births in the South. Results of the present study suggest that knowledge of macrosomia prior to delivery may affect obstetrical management between diabetic and non-diabetic mothers with respect to the risk of shoulder dystocia and possible consequences for the newborn. In our experience, macrosomes present more obstetrical trauma in vaginal delivery, even though the incidence of Cesareans is almost double that in non-diabetic mothers (OR 3.3, p< 0.001, Table 1), as already previously described in our population [7].

Table 3. Logistic regression model: Obstetrical trauma (brachial plexus and/or clavicle fracture) in vaginal birth of newborns ≥ 4000g BW.

Controlling for pre-pregnancy maternal Body Mass Index (BMI) and fetal birth weight.

There were 1,024 vaginal deliveries in our cohort, of which 990 (96.5%) record of pre-pregnancy maternal BMI.

Logistic model	Odds Ratio [95% CI]	P-value
BW 4250–4499g	0.67 [0.29–1.6]	0.36
BW 4500–4749g	2.5 [0.99–6.5]	0.053
BW ≥ 4750g	6.7 [1.9–23.0]	0.002
Maternal BMI < 18.5 kg/m²	5.4 [1.6–18.2]	0.006
Maternal BMI 25.0–29.9 kg/m²	2.48 [1.17–5.2]	0.02
Maternal BMI 30.0–34.9 kg/m²	2.56 [1.08–6.08]	0.03
Maternal BMI ≥ 35.0 kg/m²	0.58 [0.12–2.9]	0.51
Diabetic mothers	**2.29 [1.05–4.98]**	**0.03**

BW= Birthweight. 4000–4249g as reference

Maternal BMI: Pre-pregnancy Body mass index (kg/m²). 18.5–24.9 kg/m² as reference

Several studies have reported higher neonatal morbidity and mortality risks in macrosomes delivered to diabetics as compared to non-diabetics [8–12]. Christoffersson et al describe a perinatal mortality of 1.2% in non-diabetic patients with shoulder dystocia versus 6.4% in diabetic mothers [12]. Nesbitt et al in a study of 175,886 births of newborns weighing more than 3,500g report a 3% incidence of shoulder dystocia (6,238 patients) [13]. Again, the incidence of shoulder dystocia was higher in diabetic mothers as compared with non-diabetics and directly correlated with the degree of macrosomia, diabetes (OR = 1.7), instumental extraction (OR 1.9) and induced delivery (OR = 1.3) being independently associated with shoulder dystocia. Saleh et al also describe a higher incidence of trauma (1.9% vs 0.2%) in macrosomes from diabetic mothers [14]. In studies comparing the incidence of fetal trauma, Casey *et al* [15] compared 61,209 non-diabetic patients with 874 diabetics and found that, among the diabetics, there was more shoulder dystocia and a significantly higher incidence of clavicle fractures while the incidence brachial was not significantly different. For Ecker *et al* , in 80 newborns having a plexus brachial injury at birth, 10 were from diabetic mothers (OR 2.84, p< 0.01) [16]. Conversely, in a study by Das et al, in the USA, reported a higher incidence of trauma in macrososmes of non-diabetic mothers. Vaginal deliveries occurred in 70% of cases in non-diabetic mothers with macrosomia while it was 34% in diabetic macrosomes [17]. In a recent study of 899 mothers whose babies weighed 3,500g or more, Mansor et al argue that macrosomia is the only reliable predictor of shoulder dystocia, while in their logistic model diabetes and instrumental deliveries were independently associated with that shoulder dystocia [18]. Recently,

authors from Sweden however could not find an association between diabetes and shoulder dystocia (but their definition of macrosomia was ≥ 4500g) [19]

Our results are consistent with the hypothesis that foetuses weighing more than 4000g present a different anthropometry (adiposity) in diabetic and nondiabetic mothers. In our perinatal database the variable « shoulder dystocia » is not individualized as such. That is why in this study we used indirect measures of obstetrical complications (Apgar 3mn < 7, brachial plexus and/or clavicle fractures) in women having delivered vaginally. This finding could be interpreted as primarily associated with a higher rate of maternal obesity (see Table 2) which could influence negatively the obstetrical mechanics for maternal pre-pregnancy corpulence and babies' birthweights. Results from the logistic regression (Table 3) on the 990 macrosomic vaginal births depicted similar odds ratios adjusting for BMI and birthweight: adjusted OR = 2.29 as compared to a unadjusted OR = 2.37, (p = 0.02 crude OR, p = 0.03 aOR), with a predominant risk for babies weighing more than 4,750g, and a strong tendency for those of 4,500–4,750g .

Other authors have described that diabetes by itself may be an independent risk factor responsible for a particular fetal morphology in macrosomes [1–3,5,20]. Macrosomes from diabetic mothers present an increase of the scapular diameter and a four centimeter average difference between the shoulder width and upper biparietal diameter as compared with macrosomes from non-diabetic mothers [5]. However, measurement of the shoulder width has low predictive value for shoulder dystocia, even if it can be evaluted by MRI [6]. For ultrasonographies, based one two-dimensional ultrasound formulae, accuracy is low, particularly at advanced gestation [21,22]. Three-dimensional ultrasound could be useful to monitor soft tissues [21]. Besides these problems, adiposity is well known to be more important in diabetic macrosomes. The fat mass evaluated by absorptiometry represents 30% of the body mass in newborns from diabetic mothers while it represents 15% in non-newborns of diabetic mothers [23–24]. Nasrat et al report a significant increase of sub-cutaneous fat thickness in 51 newborns from diabetic mothers, while height or biparietal diameter are similar in both groups, suggesting a disproportionate development of these fetuses [2]. McFarland et al report an increase of the shoulder width, a decrease of the head/shoulder ratio, an increase of the adipose tissue, and larger extremities in newborns of diabetic mothers [1]. Also Acker et al explain the higher risk of shoulder dystocia in newborns of diabetic mothers by a different composition of tissues and fat repartition than in controls [9].

Conclusion

Obstetricians or midwives face the dilemma of decisions on mode of delivery for women with preexisting or gestational diabetes mellitus. In these deliveries, the risk for shoulder dystocia is well-known. Our study suggests that diabetes by itself is an independent risk factor of fetal trauma in case of macrosomia. When a macrosomia is detected in the maternity ward, diabetes is a major contributor in the obstetrical decision for the mode of delivery.

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Citation:
Pierre-Yves Robillard, Malik Boukerrou, Francesco Bonsante, Thomas C. Hulsey, Jean-Bernard Gouyon and Silvia Iacobelli (2019) Neonatal Outcomes of Macrosomic New-Borns (4,000g +) of Diabetic and Non Diabetic Mothers: A Study of 1,391 Singleton New-Borns. *Integr Gyn Obstet J* Volume 2(1): 1–4.