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Shoulder dystocia in diabetic and non-diabetic pregnancies

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Abstract

OBJECTIVES: Shoulder dystocia remains an obstetric emergency. Maternal diabetes is considered to be one of the major risk factors for shoulder dystocia. The aim of this study was to analyze antepartum and peripartum risk factors and complications of shoulder dystocia in diabetic and non-diabetic women.
DESIGN: We performed a retrospective analysis of 48 shoulder dystocia cases out of 28,485 vaginal deliveries of singleton, live-born infants over a 13 year period: 13 cases were diagnosed in diabetic women and 35 cases in non-diabetic women. Setting: The study was conducted in the 2nd Department of Obstetrics and Gynecology, Medical University of Warsaw, Poland, from January 2000 to December 2012.
RESULTS: Compared to non-diabetic women, diabetic patients had significantly higher pre-pregnancy body weight (83.4±23.8 kg vs. 62.5±10.9 kg, p=0.002), higher pre-pregnancy BMI (30.2±6.8 kg/m^2 vs. 22.9±4.3 kg/m^2, p=0.0003), and lower gestational weight gain (11.4±6.2 kg vs. 16.0±4.7 kg, p=0.01). Diabetic women with shoulder dystocia were more likely to deliver before completion of the 38th week of gestation (30.8% vs. 5.7%, p=0.02) and had a higher incidence of 1st and 2nd stage perineal tears compared with the non-diabetic group (23.1% vs. 0%, p=0.02). There were two cases of symphysis pubis dehiscence in non-diabetic women. Children of diabetic mothers had a significantly higher birth weight (4,425.4±561.6 g vs. 4,006.9±452.8 g, p=0.03). Children of diabetic mothers with dystocia were at significantly higher risk of peripartum injuries (92.3% vs. 45.7%). A significant difference was observed in the percentage of brachial plexus palsy (61.5% vs. 17.1%). Children of diabetic women experiencing shoulder dystocia were more frequently affected by Erb's brachial plexus palsy and respiratory disturbances. These children had an increased likelihood of birth weights above the 90th percentile (not necessarily reaching 4,000 g) compared to children born to non-diabetic mothers.
CONCLUSIONS: Shoulder dystocia in women with diabetes mellitus during pregnancy was associated with earlier gestational age of labor, and these women were more frequently overweight. The newborns of diabetic mothers after shoulder dystocia appeared to be at an increased risk for perinatal morbidity compared to the newborns of non-diabetic mothers experiencing this complication.

ORIGINAL ARTICLE

Abbreviations:

AC	- abdominal circumference
BPD	- biparietal diameter
BE	- base excess
BMI	- body mass index
EFW	- estimated fetal weight
FL	- femoral length
GDM	- gestational diabetes mellitus
HC	- head circumference
NICU	- neonatal intensive care unit
NS	- non-significant
PGDM	- pregestational diabetes mellitus
pCO2	- carbon dioxide pressure
PROM	- premature rupture of membranes
SD	- standard deviation

INTRODUCTION

Shoulder dystocia is an obstetric emergency. This condition is associated with an increased risk for maternal and fetal complications. Shoulder dystocia is defined as a delivery that requires additional obstetric maneuvers to release the shoulders after gentle downward traction has failed. Shoulder dystocia occurs when either the anterior or, less commonly, the posterior fetal shoulder impacts on the maternal symphysis or sacral promontory. The incidence of shoulder dystocia in different reports varies, ranging from 0.2 to 3.0% of all single cephalic vaginal deliveries (Acker *et al.* 1985; Baskett & Allen 1995; Neumann *et al.* 2001; Kwek & Leo 2006; Gupta *et al.* 2010).

Shoulder dystocia remains an unpredictable complication of vaginal delivery. Fetal macrosomia and maternal diabetes are the main independent risk factors for shoulder dystocia, but maternal obesity, shoulder dystocia in previous labor, and prolonged second stage of labor are also considered to be important risk factors (Acker *et al.* 1985; Lewis *et al.* 1995). Some authors recognize additional risk factors, such as post-term pregnancy, labor induction, operative vaginal delivery, multiparity and estimated fetal weight over 4500 grams (Baskett & Allen 1995; McFarland *et al.* 1995; Baskett 2002; Mehta *et al.* 2004; Tsur *et al.* 2012).

Because maternal diabetes is considered to be a major risk factor of shoulder dystocia, we compared a group of diabetic women who experienced shoulder dystocia with non-diabetic women who presented with this complication. The aim of our study was to analyze antepartum and peripartum risk factors and complications of shoulder dystocia in diabetic and non-diabetic women delivering at University Hospital of Warsaw.

MATERIAL AND METHODS

We performed a retrospective analysis of cases of shoulder dystocia during vaginal deliveries of singleton, live-born infants at the Hospital of Medical University of Warsaw, Poland, from January 1, 2000, to December 31, 2012. During the analyzed period, 40,250 deliveries took place. Of these deliveries, 11,765 (29.2%) were cesarean sections and 28,485 (70.8%) were vaginal deliveries. Shoulder dystocia was diagnosed when the progress of labor stopped after head delivery and difficulties with shoulder delivery occurred.

Shoulder dystocia complicated 48 (0.119%) out of 40,250 deliveries. A total of 48 cases of shoulder dystocia, accounting for 0.169% of all vaginal deliveries, were subjected to the analysis. Thirteen patients (27.1%) were diabetic: 3 women suffered from pre-gestational diabetes mellitus (PGDM), while 10 women were diagnosed with gestational diabetes mellitus (GDM). Five GDM patients achieved proper glycemic control with an appropriate diet, while the remaining 5 patients required insulin treatment. Five hundred fifty-three PGDM patients and 4,291 GDM patients gave birth in the 13-year observation period, compared to 35,406 non-diabetic patients. The incidence of shoulder dystocia in non-diabetic patients was 0.099%, 0.542% in PGDM patients and 0.233% in GDM patients.

Maternal socioeconomic status, i.e. educational background, type of occupation and residence, was analyzed. History of tobacco use was determined. Maternal age and anthropometric parameters at delivery (height, pre-pregnancy body weight and BMI, gestational weight gain, pre-partum abdominal circumference and pelvic bone size) were obtained. Obstetric history was assessed, including parity, number of previous deliveries of live-born children, incidence of prenatal and postnatal deaths by the 7th day of life and deliveries of children with birth weight greater than 4,000 grams.

The course of the pregnancy was also subjected to analysis, particularly including gestational age at delivery, pregnancy complications such as arterial hypertension, cholestasis, anemia, threatened miscarriage or premature birth, abnormal quantity of amniotic fluid – polyhydroamnion, infections of the genital or urinary tract and thyroid disorders.Biparietal diameter (BPD), femoral length (FL), head circumference (HC), abdominal circumference (AC) and fetal mass (EFW) were estimated from analysis of prepartum fetal biometry ultrasound scans.

Data taken from delivery, including the delivery method (spontaneous or assisted – vacuum/forceps), duration of first and second stage of labor, amniotic fluid leak time (PROM), the need to induce delivery or stimulate contractions, the use of epidural anesthesia, episiotomy, peripartum injuries of the genital tract (cervical tears, perineal tears), symphysis pubis dehiscence, peripartum blood loss, labor stage at admission to the delivery room, maneuvers undertaken to resolve shoulder dystocia and maternal hospitalization time, were also included in the analysis.

Finally, we analyzed neonatal sex, birth weight and length, head, abdominal and chest circumference, shoulder width, and 1-minute and 5-minute Apgar scores. The incidence of peripartum neonatal injuries, such as clavicular fracture, brachial plexus palsy, pericranial hemorrhage, soft tissues injuries and intraventricular hemorrhage, was assessed. The incidence of early neonatal complications, such as hyperbilirubinemia (bilirubin levels of more than 15 mg/dL), abnormal neurological symptoms, respiratory disorders, and infections were analyzed. Cases requiring admission to the neonatal intensive care unit and infant hospitalization time were also analyzed. Neonatal hypoxia was established based on a 5-minute Apgar score of less than 8 and abnormal umbilical blood gases.

Statistics

Statistical analyses were performed using the Chi-squared test and comparison of means. Multifactoral analysis of variance was used as appropriate to evaluate differences between continuous variables between groups. A p-value less than 0.05 was accepted as indicating statistical significance.

RESULTS

No significant differences were observed in educational background, occupation, residence or smoking frequency between the groups of diabetic and non-diabetic patients with shoulder dystocia (Table 1). Average maternal age was similar between the groups. Diabetic patients had significantly higher pre-pregnancy body weights (83.4±23.8 kg vs. 62.5±10.9 kg, p=0.002), higher pre-pregnancy BMIs (30.2±6.8 kg/m^2 vs. 22.9±4.3 kg/m^2, p=0.0003), lower gestational weight gains (11.4±6.2 kg vs. 16.0±4.7 kg, p=0.01), and larger pre-partum abdominal circumferences (115.8±12.3 cm vs. 107.0±9.1 cm, p=0.04). Significantly more diabetic patients had pre-pregnancy BMIs over 25 kg/m^2. No differences were observed in outer pelvic bone dimensions (interspinous, intercristal, and intertrochanteric diameters and external conjugate) (Table 2). Both groups were similar regarding parity, number of previous live-born deliveries, history of perinatal and postnatal deaths and history of high birth weight of previous (above 4,000 g) (Table 3).

Diabetic women with shoulder dystocia were more likely to deliver before completion of the 38th week of gestation (30.8% vs. 5.7%, p=0.02). No differences were observed in the incidence of pregnancy complications (Table 4). Fetal biometric parameters resulting from a prepartum ultrasound scan are presented in Table 5. No significant differences were observed in the average estimated fetal weight (3,756±406.5 g vs. 3,715±389.2 g).

No differences were observed between groups in terms of duration of the first and second stage of labor, duration of membrane rupture, frequency of labor induction and stimulation and use of epidural anesthesia, labor stage at admission to the delivery room, episiotomy and peripartum blood loss. There was a trend towards significance when comparing the percentage of assisted deliveries between groups, with

Tab. 1. Maternal socioeconomic and smoking status in dystocia cases.

Maternal socioeconomic and smoking status	Diabetic n (%) n=13	Non-diabetic n (%) n=35	All n (%) n=48	p-value
Education				
Elementary	2 (15.4%)	2 (5.7%)	4 (8.3%)	NS
Medium	6 (46.1%)	8 (22.9%)	14 (29.2%)	
High	4 (30.8%)	20 (57.1%)	24 (50.0%)	
Basic occupational	1 (7.7%)	5 (14.3%)	6 (12.5%)	
Occupation				
Blue-collar worker	2 (15.4%)	4 (11.4%)	6 (12.5%)	NS
White-collar worker	7 (53.8%)	26 (74.3%)	33 (68.7%)	
Unemployed	4 (30.8%)	3 (8.6%)	7 (14.6%)	
Pension	0	2 (5.7%)	2 (4.2%)	
Residence place				
City	6 (46.1%)	23 (64.7%)	29 (60.4%)	NS
Urban	4 (30.8%)	10 (29.4%)	14 (29.2%)	
Rural	3 (23.1%)	2 (5.9%)	5 (10.4%)	
Tobacco use				
Non-smoking	10 (76.9%)	29 (82.9%)	39 (81.3%)	NS
Smoking	3 (23.1%)	6 (17.1%)	9 (18.8%)	

Tab. 2. Maternal age and anthropometric parameters in dystocia cases.

Maternal age and anthropometric parameters	Diabetic mean±SD n=13	Non-diabetic mean±SD n=35	All mean±SD n=48	*p*-value
Maternal age (years)	30.4±7.1	30.0±4.8	30.1±5.5	NS
Height (cm)	165.2±6.4	165.3±4.6	165.3±5.1	NS
Pre-pregnancy body weight (kg)	83.4±23.8	62.5±10.9	68.2±17.8	0.002
Pre-pregnancy BMI (kg/m^2)	30.2±6.8	22.9±4.3	24.9±6.0	0.0003
Gestational weight gain (kg)	11.4±6.2	16.0±4.7	14.7±5.5	0.01
Pre-pregnancy BMI>25 kg/m^2	9 (69.2%)	10 (28.6%)	19 (39.6%)	0.02
Abdominal circumference (cm)	115.8±12.3	107.0±9.1	109.7±10.8	0.04
Interspinous diameter (cm)	26.3±1.4	25.6±1.2	25.8±1.3	NS
Intercristal diameter (cm)	29.6±2.5	28.2±1.6	28.6±2.0	NS
Intertrochanteric diameter (cm)	33.1±2.8	32.0±1.5	32.3±2.0	NS
External conjugate (cm)	22.0±2.4	21.0±1.7	21.0±1.9	NS

Tab. 3. Obstetric history in dystocia cases.

Obstetric history	Diabetic n (%) n=13	Non-diabetic n (%) n=35	All n (%) n=48	*p*-value
Parity				
Primiparas	5 (38.5%)	13 (37.1%)	18 (37.5%)	NS
Multiparas	8 (61.5%)	22 (62.9%)	30 (62.5%)	
Number of deliveries				
0	6 (46.2%)	14 (40.0%)	20 (41.7%)	NS
1	6 (46.2%)	13 (37.1%)	19 (39.6%)	
2	1 (7.6%)	5 (14.3%)	6 (12.5%)	
3 or more	0	3 (8.6%)	3 (6.2%)	
Previous perinatal death	0	1 (2.9%)	1 (2.1%)	NS
Previous postnatal death*	0	1 (2.9%)	1 (2.1%)	NS
Previous children with high birth weight#-	2 (15.4%)	3 (8.6%)	5 (10.4%)	NS

*postnatal death by the 7th day of life, # children with birth weight of more than 4,000 g

Tab. 4. Current pregnancy data in dystocia cases.

Current pregnancy data	Diabetic n (%) or n=13	Non-diabetic n (%) or n=35	All n (%) or n=48	*p*-value
Mean gestational age (weeks')	38±1.8	40±1.3	39.2±1.5	NS 0.054
Gestational age (weeks')				
35 – 37.6 weeks	4 (30.8%)	2 (5.7%)	6 (12.5%)	0.02
38 – 39.6 weeks	9 (69.2%)	25 (71.4%)	34 (70.8%)	
>40 weeks	0	8 (22.9%)	8 (16.7%)	
Hypertension	3 (23.1%)	3 (8.6%)	6 (12.5%)	NS
Cholestasis	1 (7.7%)	2 (5.7%)	3 (6.3%)	NS
Anemia	3 (23.1%)	7 (20.0%)	10 (20.8%)	NS
Threatened miscarriage	2 (15.4%)	3 (8.6%)	5 10.4%)	NS
Threatened preterm birth	0	4 (11.4%)	4 (8.3%)	NS
Polihydroamnion	1 (7.7%)	0	1 (2.1%)	NS
Genital tract infection	2 (15.4%)	11 (31.4%)	13 (27.1%)	NS
Urinary tract infection	2 (15.4%)	4 (11.4%)	6 (12.5%)	NS
Thyroid disorders	1 (7.7%)	3 (8.6%)	4 (8.3%)	NS

labor completed with forceps or vacuum in 15.4% of diabetic patients and no assisted deliveries in non-diabetic women (p=0.07). Diabetic women had a significantly higher incidence of 1st and 2nd stage perineal tears compared with the non-diabetic group (23.1% vs. 0%, p=0.02). There were two cases of symphysis pubis dehiscence in non-diabetic women. The overall duration of hospitalization of diabetic mothers was significantly longer compared to the non-diabetic group (7 days vs. 4 days, p=0.003) (Table 6).

Tab. 5. Data of fetal measurements in ultrasound of dystocia cases.

Data of fetal measurements in ultrasound	Diabetic mean±SD n=13	Non-diabetic mean±SD n=35	All mean±SD n=48	*p*-value
BPD (mm)*	92.7±4.8	88.5±26.6	88.9±19.4	NS
FL(mm)**	73.7±3.6	76.6±4.1	75.0±4.0	NS
HC (mm)***	333.4±13.0	341.7±12.3	337.6±13.0	NS
AC (mm)****	360.8±16.8	360.2±13.8	360.5±14.9	NS
EFW (g)*****	3756±406.5	3715±389.2	3730±388.3	NS

*BPD – biparietal diameter, ** FL – femoral length,
***HC – head circumference, ****AC – abdominal circumference,
***** – estimated fetal weight

Neonatal anthropometric parameters are presented in Table 7. Children of diabetic mothers had significantly higher birth weights (4,425.4±561.6 g vs. 4,006.9±452.8 g, p=0.03), abdominal circumferences and shoulder widths. There were no significant differences in sex distribution between groups. The observed differences in the 1-minute Apgar scores were borderline significant (p=0.089), with neonates born of diabetic mothers having lower 1-minute Apgar scores. The 5-minute Apgar scores of children in both groups were similar (Table 7).

Children of diabetic mothers with dystocia were at significantly higher risk of peripartum injuries (92.3% vs. 45.7%). A significant difference was observed in the percentage of brachial plexus palsy (61.5% vs. 17.1%). No significant differences were observed in the frequency of clavicular fractures, pericranial hemorrhages or soft tissue injuries. No differences were observed between groups in umbilical cord blood gases analyses. With respect to early neonatal complications, children of diabetic mothers more frequently presented with hyperbilirubinemia, respiratory disorders and infections. Hospitalization times were much longer for these babies (Table 8).

DISCUSSION

Diabetic patients are five times more likely to have shoulder dystocia, mainly due to higher rates of fetal macrosomia, larger shoulder and extremity circumferences and increased body fat. The purpose of our retrospective study was to compare diabetic and non-diabetic women who experienced shoulder dystocia. Shoulder dystocia remains an unpreventable complication in obstetrics despite improvements in perinatal care. The availability of ultrasound estimation of birth weight is growing together with the cesarean section rate, but shoulder dystocia and Erb's palsy still cannot be avoided.

Tab. 6. Delivery data in dystocia cases.

Delivery data	Diabetic n (%) or med [Q1–Q3] n=13	Non-diabetic n (%) or med [Q1–Q3] n=35	All n (%) or med [Q1–Q3] n=48	*p*-value
Mode of delivery				
Spontaneous	11 (84.6%)	35 (100%)	46 (95.8%)	0.07
Vacuum/forceps	2 (15.4%)	0	2 (4.2%)	
First stage (min)	435 [230–570]	325 [245–420]	345 [230–570]	NS
Second stage (min)	26 [16–71]	25 [12–43.5]	25 [12–71]	NS
Duration of PROM (min)	232.5 [142.5–526.5]	246 [70.0–496]	240 [70.0–526.5]	NS
Labor induction	4 (30.8%)	5 (14.3%)	9 (18.8%)	NS
Oxytocin use	5 (38.5%)	6 (17.1%)	11 (22.9%)	NS
Epidural use	4 (30.8%)	16 (45.7%)	20 (41.7%)	NS
Episiotomy	12 (92.3%)	27 (77.1%)	39 (81.3%)	NS
Cervical tears	1 (7.7%)	5 (14.3%)	6 (12.5%)	NS
1st and 2nd perineal tears	3 (23.1%)	0	3 (6.3%)	0.02
Symphis pubis dehiscence	0	2 (5.7%)	2 (4.2%)	NS
Blood loss (mL)	375 [350–425]	350 [350–400]	350 [350–425]	NS
Labor stage at admission				
No dilatation	10 (76.9%)	26 (74.3%)	36 (75%)	
2–3 cm dilatation	1 (7.7%)	4 (11.4%)	5 (10.4%)	NS
4–8 cm dilatation	1 97.7%)	3 (8.6%)	4 (8.4%)	
8–0 cm dilatation	1 (7.7.%)	2 (5.7%)	3 (6.2%)	
Type of intervention				
– McRoberts maneuvre	6 (46.1%)	22 (62.9%)	28 (58.3%)	NS
– McRoberts maneuvre and pressure	7 (53.9%)	13 (37.1%)	20 (41.7%)	
Maternal hospitalization time (days)	7 [6–10]	4 [3–5]	6 [3–10]	0.003

Tab. 7. Neonatal data in dystocia cases.

Neonatal data	Diabetic mean±SD n (%) n=13	Non-diabetic mean±SD n (%) n=35	All mean±SD n (%) n=48	*p*-value
Sex				
Male	5 (38.5%)	17 (48.6%)	22 (45.8%)	NS
Female	8 (61.5%)	18 (51.4%)	26 (54.2%)	
Birth weight (grams)	4,425.4±561.6	4,006.9±452.8	4,120.2±524.1	0.03
Birth weight >4,000 grams	9 (69.2%)	15 (42.9%)	24 (50.0%)	NS
Birth weight >90 pc	11 (84.6%)	16 (45.7%)	27 (56.2%)	0.04
Length (cm)	58.0±.9.0	57.0±2.8	57.0±2.9	NS
Head circumference (cm)	35.3±1.7	34.7±1.4	34.9±1.5	NS
Abdominal circumference (cm)	35.1±2.8	33.0±2.2	33.6±2.5	0.02
Chest circumference (cm)	36.0±1.9	35.0±1.6	35.2±1.8	NS
Shoulder width (cm)	14.6±1.4	12.7±1.0	13.2±1.4	0.0002
Apgar 1 min <7	8 (61.5%)	10 (28.6%)	18 (37.3%)	0.089
Apgar 5 min <7	2 (15.4%)	2 (5.7%)	4 (8.3%)	NS

Tab. 8. Neonatal injuries and complications in early neonatal period in dystocia cases.

Neonatal injuries and complications in early neonatal period	Diabetic mean±SD n (%) n=13	Non-diabetic mean±SD n (%) n=35	All mean±SD n (%) n=48	*p*-value
Neonatal injury	12 (92.3%)	16 (45.7%)	28 (58.3%)	0.008
Clavicular fracture	2 (15.4%)	4 (11.5)	6 (12.5%)	NS
Erb's pulsy	8 (61.5%)	6 (17.1%)	14 (29.2%)	0.002
Pericranial hemorrhage	0	2 (5.7%)	2 (4.2%)	NS
Soft tissues	2 (15.4%)	7 (20%)	9 (18.8%)	NS
Intracranial hemorrhage	1 (7.7%)	0	1 (2.1%)	NS
Intraventricular hemorrhage	0	0	0	NS
Hypoxia	4 (30.8%)	5 (14.3%)	9 (18.8%)	NS
Hiperbilirubinemia	8 (61.5%)	9 (25.7%)	17 (35.4%)	0.04
Abnormal neurological symptoms	0	1 (2.9%)	1 (2.1%)	NS
Respiratory disorders	5 (38.5%)	2 (5.7%)	7 (14.6%)	0.02
Infection	6 (46.2%)	3 (8.6%)	9 (18.8%)	0.007
Admission to NICU	2 (5.4%)	1 (2.9%)	3 (6.3%)	NS
Neonatal hospitalization time	8.5 [4.5–9.0]	3.0 [3.0–4.0]	5.0 [3.0–9.0]	0.0005
Umbilical cord blood				
pH	7.30 ±0.08	7.31±0.11	7.3±±0.1	NS
concentration of lactate acid	44.5 [34–53]	33.0 [27–36]	42.1±[27–53]	NS
BE	−2.05 [−5.7 to −0.6]	−4.1 [−6.9 to −2.6]	−4.4 [6.9 to −0.6]	NS
pCO2	42.7±8.9	41.8±9.8	41.4 [9.1]	NS

In a population-based study of singleton, vertex, and term deliveries, Sheiner *et al.* (Sheiner *et al.* 2004) showed a 0.2% incidence of shoulder dystocia. In a multivariate analysis of cases with and without this complication, the following independent risk factors for shoulder dystocia were found: neonatal birth weight of 4000 grams or more (OR=24.3), vacuum delivery (OR=5.7), diabetes mellitus (OR=1.7) and lack of prenatal care (OR=1.5). The risk of shoulder dystocia for diabetic patients was 0.6% (OR=2.8). At our site, the incidence of shoulder dystocia was low in comparison to that presented in previous literature, amounting to 0.12% of live births. During 13 years of observation, only 13 diabetic women had labor complicated with shoulder dystocia, but the risk of shoulder dystocia in women with GDM was doubled in comparison to non-diabetic women and was 5 times higher for women with PGDM. Diabetic women presented at the gynecologist's office for the first time in their pregnancies significantly later than non-diabetic women, which might indirectly suggest worse perinatal care in the former group.

In a retrospective analysis of 80,953 singleton deliveries in Hong Kong (Cheng *et al.* 2013), risk factors identified for shoulder dystocia independent of birth weight included instrumental delivery (OR 12,1), short stature (OR 2,16), maternal diabetes mellitus (OR 1,78) and obesity (OR 1,58). The incidence of shoulder dystocia rose with increasing birth weight. The odds ratio for birth weights of 4,000–4,199 g was 22.4, while for birth weights of 4,200 g or above was 76.1.

In a case-controlled study, Robinson *et al.* (Robinson *et al.* 2003) found that diabetes mellitus increased the risk for shoulder dystocia 3.5 times, but that the single most powerful predictor was fetal macrosomia. Ouzonian and Gherman (2005) did not demonstrate a significant impact of maternal diabetes on the occurrence of shoulder dystocia, but the authors showed an increasing risk for shoulder dystocia rising almost linearly with increasing birth weight and operative delivery. Birth weight over 4,000 grams and spontaneous delivery increased the risk for shoulder dystocia 5.1 times in diabetic and 8.5 times in non-diabetic women, and birth weight over 4,000 grams and operative delivery increased the risk 12.3 and 13.7 times, respectively.

Levy *et al.* (Levy *et al.* 2006) compared pregnancies complicated with shoulder dystocia of patients with and without diabetes mellitus. Neonates of diabetic patients weighed significantly more (mean birth weight 4,244 g vs. 4,051 g) and had higher rates of Apgar scores lower than 7 at the 1st min (50.0% vs. 25.9%), but not at the 5th min (2.6% vs. 2.0%) when compared to the non-diabetic group. In our observations, children of diabetic moth-

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ers born in deliveries complicated by shoulder dystocia had significantly higher birth weights (4,425 g vs. 4,006 g; p=0.03) despite the fact that the deliveries occurred in earlier weeks of pregnancy; the frequency of deliveries before the completion of the 38th week of gestation was 30.8% in diabetic patients vs. 5.7% in non-diabetic patients.

Similarly, in our study, neonates of diabetic patients with shoulder dystocia compared to the non-diabetic group had significantly higher rates of Apgar scores lower than 7 at the 1st min (61.6% vs. 28.6%), but not at the 5th min (15.4% vs. 5.7%). Furthermore, neonates of diabetic mothers with shoulder dystocia had significantly higher shoulder widths and abdominal circumferences. Unfortunately, ultrasound scan-estimated body weight (approximately 3,700 g) did not correlate with mean birth weight either in children of diabetic mothers (4,425.4 g) or in children of non-diabetic mothers (4,006.9 g).

In a study by Jazayeri *et al.* (Jazayeri *et al.* 1999), abdominal circumference measurement of 35 cm or more identified more than 90% of macrosomic infants who were at risk for shoulder dystocia. The authors suggested that induction of labor in macrosomic patients increased the risk of shoulder dystocia. Here, we found that abdominal circumference of 35 cm or more was observed in prepartum ultrasound scans in 53% of babies to be born from diabetic mothers with shoulder dystocia compared to only 17% babies to be born from non-diabetic mothers with this complication. Therefore, caution should be exercised when qualifying diabetic women for spontaneous deliveries. In our study, shoulder dystocia was more common in pre-term deliveries and when ultrasound-estimated fetal weights were significantly less than 4,200 g.

A population-based study by Tsur *et al.* (Tsur *et al.* 2012) showed that shoulder dystocia, associated with macrosomia, labor dystocia, diabetes mellitus and advanced maternal age, was an independent risk factor for perinatal mortality. The authors suggested that shoulder dystocia was additionally associated with significant neonatal morbidity, including non-reassuring FHR patterns and Apgar scores lower than 7. The neonatal mortality rate at our site was 0%. No differences were observed in 5-minute Apgar scores or umbilical blood parameters between neonates born of diabetic and non-diabetic mothers with shoulder dystocia.

A population-based case-control study by Moore *et al.* (Moore *et al.* 2008) analyzed risk factors for recurrent shoulder dystocia. Gestational diabetes in index pregnancy and subsequent delivery were not risk factors for recurrent shoulder dystocia. BMI, gestational weight gain, and gestational age in index and subsequent pregnancies were also not predictive factors. Birth weight greater than or equal to 3500 g, vaginal operative delivery, and severe shoulder dystocia in index pregnancies significantly increased the risk for recurrent shoulder dystocia. In turn, a significantly increased risk of shoulder dystocia recurrence was associated with gestational diabetes and induction of labor. In our department, all women after shoulder dystocia are qualified for elective cesarean section.

The results of the study of Poggi *et al.* (Poggi *et al.* 2003) suggested that even after birth weight, diabetes mellitus and parity are controlled for, permanent plexus injury remained unpredictable in deliveries complicated by shoulder dystocia. We found that newborns injured after shoulder dystocia were more likely to be born to diabetic than non-diabetic mothers (61.5% versus 17.1%, p=0.002).

In a risk factor analysis for shoulder dystocia by Ouzounian and Gherman (Ouzounian and Gherman 2005), the trial of labor induction, oxytocin use and birth weight greater than 4,500 grams created a cumulative odds ratio of 23.2 for shoulder dystocia; however, the sensitivity and positive predictive value were only 12.4% and 3.4%, respectively.

Neumann *et al.* (Neumann *et al.* 2001) investigated pre-pregnancy BMI in non-diabetic women who experienced shoulder dystocia. Non-diabetic women experiencing shoulder dystocia did not have a higher BMI than non-diabetic women delivering without this experience, given a fixed fetal weight. In another study (Robinson *et al.* 2003), maternal obesity was not significant as an independent risk factor for shoulder dystocia. For obese non-diabetic women carrying fetuses whose weights were estimated to be within normal limits, there was no increased risk of shoulder dystocia. In our study, 70% of women with gestational diabetes who experienced shoulder dystocia had BMI of >25 kg/m^2.

To summarize, shoulder dystocia in women with diabetes mellitus during pregnancy was associated with earlier gestational age during labor. Those women were more frequently overweight. The newborns of the diabetic mothers after shoulder dystocia appeared to have increased risk for perinatal morbidity in comparison to the newborns of the non-diabetic mothers experiencing this complication, with the children more frequently affected by Erb's brachial plexus palsy and presenting with respiratory disturbances. Furthermore, these children had a greater incidence of birth weights above the 90th percentile (not necessarily reaching 4,000 g) compared to children born to non-diabetic mothers.

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