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Antenatal and intrapartum prediction of shoulder dystocia

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ABSTRACT

Objectives: To (1) develop algorithms to calculate the risk of shoulder dystocia at individual deliveries; (2) evaluate screening for shoulder dystocia.
Study design: Retrospective analysis of 40284 consecutive term cephalic singleton pregnancies using a 'train and test' method. Four models were derived using logistic regression and tested (birthweight alone; birthweight and other independent antenatal variables; birthweight and all independent antenatal and intrapartum variables; and all independent variables excluding birthweight).
Results: Shoulder dystocia occurred in 240 deliveries (0.6%). Birthweight was the most important risk factor although 98 cases (41%) occurred in babies weighing <4.0 kg. Birthweight and maternal height were the only independent antenatal variables; for intrapartum use, only these and instrumental delivery were independent. The antenatal model could calculate an individual's risk; the intrapartum model could also calculate the risk if an instrumental delivery were undertaken. Both showed 0.7% women to have a risk of shoulder dystocia of >10%. Although the antenatal model had high predictability (area under curve 0.89), it was no better than birthweight alone and had a sensitivity of 52.4%. Where birthweight was excluded, prediction of shoulder dystocia was poor.
Conclusion: Antepartum and labour calculation of the risk of shoulder dystocia is possible. Whilst greatly hindered by the inaccuracy of estimating weight, it allows due weight to be given to factors which may already be influencing clinical practice. However, shoulder dystocia cannot be predicted with sufficient accuracy to allow universal screening.

1. Condensation

Independent antenatal and intrapartum risk factors for shoulder dystocia can be used to calculate an individual's risk but effective screening is not possible.

2. Introduction

Shoulder dystocia at delivery is defined as occurring when additional obstetric manoeuvres to release the shoulders are required. Though rare, with an incidence of 0.2–2.0%, it is an obstetric emergency with the potential for severe morbidity and even mortality. Management relies on treatment rather than prevention [1,2]. This is difficult: in a review of 56 fatal cases of shoulder dystocia referred to in the Confidential Enquiry into Stillbirths and Deaths in Infancy in 1994–1995 the mean time between delivery of the head and body of the fetus was 5 min [3].

The ideal would be prevention, rather than emergency management of shoulder dystocia. The best-known risk factor is fetal macrosomia [4] but this is difficult to predict even with ultrasound [5]. ACOG guidelines recommend that babies estimated to weigh >5000 g should be delivered by caesarean section and in diabetics the weight limit should be 4500 g [6]. UK guidelines do not recommend caesarean section in non-diabetics whatever the estimated fetal weight [1]. Therefore whilst compliance with ACOG Guidelines will prevent very few cases, the UK guidelines attempt virtually no antenatal prevention at all and consider that 'shoulder dystocia is. . .a largely unpredictable and unpreventable event.' In spite of this, the current situation is that obstetric and maternal concern about fetal size is contributing to an increasing induction and caesarean section rate [7]. Further, successful medicolegal defence of a case of shoulder dystocia is difficult [8].

If reliable risk factors other than birthweight were considered, it might be that shoulder dystocia is more accurately predicted, whilst preventing the virtual reliance on estimation of birthweight. The aims of this paper are to (1) identify independent antenatal and intrapartum risk factors for shoulder dystocia, (2) re-evaluate the potential effectiveness of these in preventing shoulder

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dystocia, and (3) develop individualised risks for shoulder dystocia in a pregnancy both antepartum and during labour.

3. Materials and methods

This is a retrospective cohort study of all live deliveries in the Oxford area between 01/04/1995 and 31/12/2002; after this the database was unfortunately changed. Only singleton vaginal cephalic deliveries at 36 or more completed weeks were included. Mothers with pre-existing or gestational diabetes and those with previous shoulder dystocia were further excluded from the study because of their very high elective caesarean section rate. Pregnancy data are entered into a database (OXMAT) by the midwife, and after discharge by coding personnel. Shoulder dystocia is coded according to the International Classification of Diseases (ICD-10). This dataset has been extensively validated and used: only where fields relied on data prior to the index pregnancy (such as previous shoulder dystocia) was accuracy not high.

The following maternal characteristics were noted: ethnic group, age, parity, gestation at delivery, height, weight and body mass index (BMI), use of oxytocin, labour induction, epidural analgesia, electronic fetal monitoring (EFM), length of first stage of labour, length of second stage of labour and instrumental delivery. The following neonatal characteristics were included: shoulder dystocia, gender, birthweight, Apgar score <5 at 1 min, admission to the neonatal unit, neurological sequelae and neonatal mortality. Data were not available for neonatal brachial plexus injuries.

Each woman was randomly assigned to one of two groups (the *train* and *test* datasets) such that the number of cases of shoulder dystocia was the same ($N = 120$) in each group. The women in the *train* dataset were used to derive the models and those in the *test* datasets were use to validate the models. In the *train* dataset, logistic regression was used to obtain four different models which could be used to predict a woman's risk of shoulder dystocia.

Model (A) included birthweight alone as risk factor. The subsequent three models included additional risk factors with a view to improving and comparing the resulting predictability. Model (B) included all significant ($p < 0.05$) independent antenatal risk factors (maternal height) with birthweight, to evaluate antenatal screening, and create individualized risks for women in the antenatal period.

Model (C) included all significant ($p < 0.05$) independent antenatal *and* intrapartum variables (maternal height and instrumental delivery) together with birthweight. This was to allow individualized risks to be calculated intrapartum when contemplating instrumental delivery.

Model (D) included all significant ($p < 0.05$) independent antenatal and intrapartum factors when birthweight was excluded (maternal height, BMI, parity, gestation, baby's sex, length of 2nd stage of labour, and instrumental delivery). This was created to inform intrapartum decision-making as above, but not relying on anticipated birthweight. We did this because of the unreliability of clinical or ultrasound estimation of fetal weight.

The predictive power of each model was assessed in the *train* dataset and a score was obtained for each woman by substituting the woman's data into the model equation. For each score value, we estimated the sensitivity and specificity that would occur if all women above a certain cut-off were classified as shoulder dystocia and the women below the score were classified as not shoulder dystocia. We then identified the score cut-offs which yielded low false positive rates (1%, 3% and 5%) as would be required in clinical practice. Receiver operator curves (ROC) of sensitivity plotted against (1 − specificity) were produced for the models shown and tables showing the groups at risk for particular cut-offs of model scores were created. There was not strong evidence of poor fit in any of the models presented, as assessed using the Hosmer–Lemeshow goodness of fit test. Statistical analyses were carried out using STATA software, version 10.0 (Stata Corporation, College Station, USA).

Ethics committee approval was granted (COREC) in September 2005.

4. Results

There were 52130 deliveries during the period. After exclusion of 544 vaginal breech births, 1769 babies from multiple pregnancies, 116 with diabetic mothers, 92 with prior shoulder dystocia, 2560 born before 36 weeks, and 9389 born by caesarean section (not mutually exclusive groups), there were 40284 births available for analysis. There were 240 occurrences of shoulder dystocia (risk 0.6%). In one there was a fatal outcome; in another there were neonatal seizures.

The data were randomly split into two halves: the *train* and *test* datasets. In the *train* dataset, the risk of shoulder dystocia increased markedly as birthweight increased, from 0.1% in babies with a birthweight of 3500 g or less to 10% in babies with a birthweight above 4500 g. Approximately 41% of babies delivered with shoulder dystocia weighed less than 4000 g. In univariate analysis, shoulder dystocia was significantly associated with all factors we examined except maternal ethnic group, maternal age, parity and use of an epidural (Table 1). No difference was observed between forceps or ventouse delivery.

A logistic regression model (Model A) using birthweight alone as a risk factor was fitted using the *train* data. When this model was

Table 1
Potential maternal and perinatal risk factors for shoulder dystocia using the train dataset.

Risk factor	Total $N = 20142$[a]	Shoulder dystocia $N = 120$[a]	p-Value
Birthweight (g)			<0.001
<3000	3259	2 (0.1%)	
3000–3500	7633	7 (0.1%)	
3501–3999	6700	40 (0.6%)	
4000–4500	2238	39 (1.7%)	
>4500	312	32 (10.3%)	
Gestation			0.023
36–38 weeks	3490	10 (0.3%)	
39–40 weeks	10744	67 (0.6%)	
>40 weeks	5908	43 (0.7%)	
Sex of baby			0.013
Male	10149	74 (0.7%)	
Female	9993	46 (0.5%)	
Risk factor	**Total $N = 20087$**	**Shoulder dystocia $N = 119$**	**p-Value**
Ethnic group			0.382
White	18558	108 (0.6%)	
Asian	647	5 (0.8%)	
Afro-Caribbean	241	3 (1.2%)	
Oriental	174	2 (1.2%)	
Other/mixed	467	1 (0.2%)	
Maternal age			0.157
<20	939	4 (0.4%)	
20–24	2618	11 (0.4%)	
25–30	7055	53 (0.8%)	
31–40	9236	52 (0.6%)	
>40	294	0 (0.0%)	
Risk factor	**Total $N = 15150$**	**Shoulder dystocia $N = 85$**	**p-Value**
BMI			0.004
<18.5	434	1 (0.2%)	
18.5–24.9	9192	37 (0.4%)	
25.0–29.9	3797	33 (0.9%)	
>=30.0	1727	14 (0.8%)	