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Macrosomia is the only reliable predictor of shoulder dystocia in babies weighing 3.5 kg or more

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1. Introduction

Shoulder dystocia is an obstetric emergency that has been dubbed an ‘obstetrician’s nightmare’ because of the dilemma that is faced when the obstetrician encounters the problem [1,2]. In most instances it is unexpected, unanticipated and unpredictable. Part of the reason for its unpredictability lies in its low prevalence [3–5].

Notwithstanding, there are some factors commonly associated with its occurrence. These include macrosomia, diabetes in the mother, assisted deliveries, high parity, prolonged labor and prolonged second stage. But again, these are common obstetric problems seen in daily practice and, in the majority of these, shoulder dystocia does not occur. Furthermore, even though the recurrence rate of shoulder dystocia is ten times higher than the rate for the general population, the prediction rate in those cases is still low [6].

Because there have been numerous reported studies on the prediction of shoulder dystocia in a general obstetric population and since macrosomia appears to be a consistent factor [7–9] we decided to take a different approach. The purpose of this study was to examine whether these traditional variables were good discriminators in a population at greater risk of developing shoulder dystocia, that is, of term babies weighing 3.5 kg or more.

2. Materials and methods

A case–control study nested within a perinatal database was conducted at the University Malaya Medical Centre (UMMC) Kuala Lumpur, Malaysia on mothers and their babies who fulfilled the study criteria. Cases included pregnancies that encountered shoulder dystocia at delivery. Controls were deliveries over the same period that were not complicated by shoulder dystocia. A logistic regression model was created with macrosomia, parity, previous delivery of more than 3.5 kg, diabetes in pregnancy, prolonged labor, prolonged second stage and instrumental delivery as the independent variables. The adjusted odds ratio and the receiver operator characteristics (ROC) curves were used to see if these variables, both individually and as a model, were associated with or were discriminative enough to predict shoulder dystocia; an ROC curve of more than 0.7 showing good prediction.

Results: There were 36 cases of shoulder dystocia during the study period, an incidence of 4%. Previous delivery of more than 3.5 kg, prolonged labor and prolonged second stage were not associated with shoulder dystocia. Although diabetes and instrumental delivery were independently and significantly associated with shoulder dystocia their importance as a predictor became relevant only in the presence of macrosomia.

Conclusion: Macrosomia is the only reliable predictor of shoulder dystocia.

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downward traction had failed, irrespective of whether or not the mother was already in the lithotomy position.

Macrosomia was defined as any baby weighing 4 kg or more [2,10].

Prolonged labor was defined as established labor being more than 12 h in a multipara and more than 18 h in a primigravida.

Diabetes in pregnancy included women who were confirmed diabetics or those proven to have the disease in the present pregnancy by a positive oral glucose tolerance test.

Prolonged second stage labor was defined as more than 2 h in nulliparous and more than 1 h in multiparous women.

Instrumental delivery was one where the baby was delivered by either forceps or the ventouse.

2.1. Statistical analysis

A logistic regression model was created with shoulder dystocia as the outcome variable. The independent or exposure variables included macrosomia (macrosomic and non-macrosomic) treated as a dichotomous variable, the presence or absence of diabetes in pregnancy as a dichotomous variable, the presence of prolonged second stage as a dichotomous variable; the presence of an instrumental delivery as a dichotomous variable and the history of a baby weighing more than 3.5 kg in her previous pregnancy as a dichotomous variable.

The model estimates the odds of having a shoulder dystocia compared to the odds of not having one in the presence of the selected independent variables after controlling for each other. The degree of significance was assessed using the Wald statistic. An alpha level of 0.05 was taken as being significant.

To assess the global performance of the model to predict those who did or did not have shoulder dystocia, the receiver operator characteristics (ROC) curve was used. It was based on the estimated probabilities or odds of having shoulder dystocia. This was done following the creation of a logistic regression model for those individual variables [11]. The test is summarized by the area under the curve (ROC curve); the greater the area under the curve the better the global performance of the prediction, i.e. the higher the true-positive rate is relative to the false positive rate, the greater the area under the curve. If the area is around 0.5, the model is performing no better than a ‘toss of coin’. A satisfactory area should exceed 0.70 [12].

The Stata Version 9 Statistical Software (StataCorp LP) was used for the analysis.

### Table 1
Simple logistic regression of the unadjusted odds ratio for shoulder dystocia against the independent variables.

| Independent variables | Shoulder dystocia | Odds ratio | Std. error | z | P>|z| | 95% Conf. interval |
|-----------------------|-------------------|------------|------------|---|------|------------------|
| Macrosomia            | 9.71              | 3.42       | 6.46       | <0.001 | 4.87–19.38 |
| Parity                | 0.99              | 0.33       | 0.02       | 0.981  | 0.51–1.93 |
| Previous baby >3.5 kg | 1.13              | 0.39       | 0.34       | 0.733  | 0.56–2.26 |
| Diabetes in pregnancy | 2.52              | 0.94       | 2.48       | 0.013  | 1.21–5.26 |
| Prolonged labor       | 4.85              | 3.14       | 2.40       | 0.016  | 1.33–17.33 |
| Prolonged second stage| 1.88              | 0.86       | 1.37       | 0.172  | 0.76–4.64 |
| Instrumental delivery | 3.83              | 1.38       | 3.71       | <0.001 | 1.88–7.77 |

### Table 2
Multiple logistic regression model of the odds ratio for shoulder dystocia against the independent variables adjusting for each other.

| Independent variables | Adj. odds ratio | Std. Err. | z | P>|z| | 95% Conf. interval |
|-----------------------|-----------------|-----------|---|------|------------------|
| Macrosomia            | 11.41           | 4.49      | 6.15  | <0.001 | 5.2–24.7 |
| Parity                | 1.62            | 0.72      | 1.09  | 0.277  | 0.67–3.87 |
| Previous baby >3.5 kg | 0.59            | 0.27      | -1.13 | 0.259  | 0.24–1.47 |
| Diabetes in pregnancy | 2.74            | 1.137     | 2.43  | 0.015  | 1.21–6.18 |
| Prolonged labor       | 2.58            | 2.01      | 1.21  | 0.225  | 0.58–12.01 |
| Prolonged second stage| 0.774           | 0.427     | -0.46 | 0.644  | 0.26–2.28 |
| Instrumental delivery | 5.25            | 2.60      | 3.37  | 0.001  | 2.00–13.81 |

### Table 3
Receiver operator characteristics (ROC) for the full model and the full model without macrosomia, instrumental delivery and diabetes in pregnancy respectively.

<table>
<thead>
<tr>
<th>Observations</th>
<th>ROC area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full model</td>
<td>0.790</td>
</tr>
<tr>
<td>Full model without macrosomia</td>
<td>0.655</td>
</tr>
<tr>
<td>Full model without instrumental delivery</td>
<td>0.754</td>
</tr>
<tr>
<td>Full model without diabetes in pregnancy</td>
<td>0.769</td>
</tr>
</tbody>
</table>

3. Results

During the study period, 8764 patients had singleton term vaginal deliveries at the UMMC and 899 (10.3%) newborns weighed 3.5 kg or more. Of these 899 deliveries, there were 36 cases of shoulder dystocia, giving an incidence of 4%.

The crude or unadjusted odds ratios for shoulder dystocia are shown in Table 1. Of these, only macrosomia, diabetes in pregnancy, prolonged labor and instrumental delivery proved to be significant at the 5% level. However, after adjusting for the independent variables, only macrosomia, diabetes in pregnancy and instrumental delivery were significant factors (Table 2).

Table 3 summarizes the area under the ROC curves for the full model and the model without the three significant independent variables individually, i.e. macrosomia, diabetes in pregnancy and instrumental delivery. Overall, the model had a good prediction of 0.790. But this good prediction appeared to be dependent only on macrosomia; removing it made the model a poor predictor (0.655) despite the presence of the others, i.e. instrumental delivery and diabetes. On the other hand, removal of instrumental delivery or diabetes in pregnancy did not affect the prediction of the model; the areas under the curve remaining 0.754 and 0.769 respectively.

4. Comment

The results of our study show firstly, that when we confine our study population to babies weighing 3.5 kg or more, the incidence (4%) of shoulder dystocia is higher than the incidence of 0.2–3% in a general study population [2]. Secondly, although diabetes mellitus and instrumental delivery were strongly associated with shoulder dystocia they became relevant only in the presence of macrosomia. All other traditional factors such as parity, previous baby with a birthweight of more than 3.5 kg, prolonged labor and prolonged second stage were poor indicators.
The limitations of the study are recognized. It was a case–control study nested in a database of all deliveries in a busy obstetric unit and information was derived from the case records. Firstly the required information may not have been documented accurately. Secondly, detection bias may have crept in while collecting the data. Attempts were made to reduce this to a minimum by exercising objectivity.

Most other studies which did not confine their study population to those weighing 3.5 kg or more suggest that shoulder dystocia is difficult to predict [2,13–15]. Geary [8] found that the predictive value of antepartum factors was less than 2% individually and only 3% when combined. In another study only 25% of their shoulder dystocia cases had at least one significant risk factor [16]. What is consistent however is that macrosomia appears to be an essential factor [2,17]. Nocon et al. [15] reviewed a large series of close to 13,500 vaginal deliveries and found that shoulder dystocia was close to impossible to predict. Furthermore, all the traditional factors became relevant only in the presence of macrosomia.

There are exceptions. A study reviewed 498 cases of shoulder dystocia and 622 controls and, using a logistic regression model, found that maternal height, maternal weight, gestational age and parity were most predictive of shoulder dystocia [18]. They concluded that their model was a good predictor.

Notwithstanding, it must be appreciated that these factors are non-specific and are not the traditional factors that concern most obstetricians. Belfort et al. [7] used a multivariate model and ROC curve and found that the covariates birthweight, a 1-h blood glucose level and operative vaginal delivery reached a sensitivity and specificity of more than 80%. They felt that their model provided for ‘a clinically acceptable accuracy’ in predicting shoulder dystocia. Nevertheless they did not report a prospective analysis for their model.

We took a different approach from other studies when we considered the effect of the independent variables in a model as a discriminator by using the area under the ROC curve. In the context of the ROC curve, the only discriminator in our study was macrosomia. Only when it was included in the model did the area under the curve exceed 7. Its removal from the model in the presence of all the other parameters reduced it below 7. Said in another way, although diabetes and instrumental delivery were significantly associated with shoulder dystocia their importance as a predictor became relevant only in the presence of macrosomia.

In can be argued therefore, that if shoulder dystocia is to be predicted, our estimation of fetal weights must be accurate. However, in our experience in the unit, clinical estimation of fetal weight has been disappointing. Of concern was that we tended to underestimate the large ones and overestimate the small ones [19]. Even ultrasound examination, at least in our experience, offered no great advantage over clinical estimation [20]. Furthermore, obesity in the mother would make the estimation even more difficult.

The experience of others is not different. Deter and Hadlock found that the use of the usual ultrasound parameters used in estimating fetal weight was only ‘marginal effective’ [21]. In a review of studies that involved prediction of macrosomia, Sacks and Chen found that the correct prediction rate among the studies ranged from as low as 15% to high as 81% [10].

Because shoulder dystocia is difficult to predict, should we then do caesarean sections for all suspected macrosomic fetuses? In a cost effective analysis for formulating policies of delivery for diabetic mothers, it was found that with prophylactic caesarean section for a baby weighing 4000–4500 g, it would require 1000 caesarean deliveries and millions of dollars to avert a single permanent brachial plexus injury [22].

In conclusion, the results of our study show that shoulder dystocia is difficult to predict even in a population at high risk of developing it. Furthermore, all other traditional factors became relevant only in the presence of macrosomia. The clue to prevent therefore is to improve our estimations of fetal weight but even with sophisticated ultrasound machines there are difficulties. These findings have important legal implications to our experts who give evidence in court on whether shoulder dystocia can or cannot be predicted.

References