British Journal of Obstetrics and Gynaecology
June 1999, Vol 106, pp. 589–593

Newborn shoulder width: a prospective study of 2222 consecutive measurements

*Eric Verspyck *Consultant*, †François Goffinet *Consultant*, **Marie F. Hellot *Statistician*, ‡Jacques Milliez *Professor*, *Loïc Marpeau *Professor*

*Departments of *Obstetrics and Gynaecology and **Biostatistics, Rouen University Hospital; †Department of Obstetrics and Gynaecology, Cochin University Hospital, Paris; ‡Department of Obstetrics and Gynaecology, Saint-Antoine University Hospital, Paris, France*

Objectives To relate maternal and infant characteristics to newborn shoulder width and to evaluate the predictive value of newborn shoulder width measurement in cases of shoulder dystocia.

Design Newborn shoulder width was systematically measured at birth during a period of 18 months.

Setting Department of Obstetrics and Gynaecology of Saint-Antoine University Hospital, Paris, France.

Population A total of 2222 newborn shoulder width measurements were performed and 22 cases of true shoulder dystocia occurred during the study period.

Methods Newborn shoulder width measurements were reviewed and correlated with maternal age, parity, nonpregnant weight, weight gain during pregnancy, height, race, fasting glucose and one hour glucose levels, gestational age, birthweight and sex of the neonate. A receiver–operating characteristics curve was constructed to evaluate newborn shoulder width as a test for predicting shoulder dystocia.

Results The mean newborn shoulder width was 122·06 mm (10·50 SD). Stepwise multiple regression showed that newborn shoulder width was significantly associated with birthweight ($P < 0·001$), parity ($P = 0·04$), and nonpregnant weight ($P = 0·04$). We estimated that the best cut off for shoulder dystocia prediction was a newborn shoulder width measurement with a low false positive rate (< 10%) in association with a high sensitivity rate. Therefore, newborn shoulder width measurement ≥ 140 mm was selected. This measurement should have a low sensitivity of 27·27%, a specificity of 91·82%, a positive predictive value of 4·02%, and a negative predictive value of 99·01% for shoulder dystocia prediction. Nevertheless, birthweight ≥ 4000 g should have a better predictive value retrospectively for shoulder dystocia.

Conclusions Newborn shoulder width measurement, which is strongly correlated with birthweight, still remains a poor predictor for shoulder dystocia, even when this evaluation is correct antenatally.

INTRODUCTION

The reported incidences of shoulder dystocia range from 0·15% to 1·17% of all vaginal deliveries and appear to be increasing[1–4]. This infrequent event may be responsible for substantial trauma to the neonate (i.e. asphyxia, brachial palsy, fractured clavicle, and hypoxic encephalopathy)[3]. Few studies[4,5] have attempted to identify a number of risks factors in order to prevent this complication, but others[3] have concluded that shoulder dystocia was actually impossible to predict by studying these traditional risks factors.

Studies on newborn babies have demonstrated that there are significant differences in anthropometric measurements between newborn infants with and without shoulder dystocia[2]. Bahar[6] recently reported that the mean bisacromial diameter of the neonates is larger than controls in cases of true shoulder dystocia. The purpose of our prospective study was to relate maternal and infant characteristics to bisacromial diameter or newborn shoulder width, and to study its predictive value for shoulder dystocia.

METHODS

The study was carried out in the Department of Obstetrics and Gynaecology of Saint-Antoine University Hospital, Paris, France. From March 1995 to September 1996, newborn shoulder width was measured systematically at birth by midwives, using a craniometer in the delivery rooms. The newborn was placed in a recumbant position with the arms lying at the sides of the trunk and

Correspondence: Professor L. Marpeau, Clinique Gynécologique et Obstétricale. CHU, Charles Nicolle. 1, rue de Germont, Rouen, France.

the outer margin of acromion was localised. The inside edges of the craniometer's arms were placed under the outside edges of the acromial process, and the counter was read to the nearest millimetre. The average of three measurements was recorded.

A total of 2222 in-depth measurements were assessed during this period for maternal and neonatal parameters. Maternal characteristics assessed included maternal age, parity, nonpregnancy weight, weight gain during pregnancy, height and race. Additional characteristics were levels of fasting glucose and one-hour glucose, gestational age, birthweight and gender of the infant.

All pregnant women were screened for carbohydrate intolerence with a one-hour glucose (50 g) challenge between week 24 and 28 of gestation. Gestational age at delivery was calculated from the last menstruation period and confirmed by ultrasonographic examination performed before a gestational age of 15 weeks. Ethnic variations were studied after comparaisons between caucasians, North African, black and Asian groups. Shoulder dystocia was defined as manoeuvers that were required to deliver the shoulders in addition to downward traction of the fetal head and episiotomy.

Simple and stepwise multiple regression were used to test the relationships between newborn shoulder width value and the maternal and neonatal characteristics. Differences in the mean between the shoulder dystocia group and the control group were calculated by a Mann-Whitney *U* test. Differences in the mean between ethnic groups were calculated by an Anova test. Newborn shoulder width was evaluated as diagnostic test for shoulder dystocia. Sensitivity and specificity were calculated for each test value and a receiver–operating characteristics curve was constructed. Maternal and neonatal characteristics are presented as mean, standard deviation (SD).

RESULTS

The mean (SD) value of newborn shoulder width was 122·1 mm (10·5) and a measurement ≥ 140 mm represented the 90th centile value of the total population. Table 1 shows the correlations between newborn shoulder width and maternal or neonatal characteristics. Parity, nonpregnant weight, weight gain during pregnancy, maternal height, fasting glucose and one hour glucose values, gestational age and birthweight were significantly correlated with newborn shoulder width. Birthweight had the strongest correlation ($n = 2222$, $r = 0{\cdot}59$, $P < 0{\cdot}001$). Male infant newborn shoulder width mean was 126·6 mm (9·7) compared with 123·9 mm (9·9) for newborn shoulder width female infants ($P = 0{\cdot}01$). The mean newborn shoulder width was not different between white infants [121 mm (10·1), 52·08%], North African infants [122·2 mm (10·8), 14·84%], black infants [120·9 mm (10·6), 14·25%] and Asian infants [121·2 mm (11·9), 8·9%].

Stepwise multiple regression showed in the first step that the weight of the infant was strongly correlated with newborn shoulder width ($P < 0{\cdot}001$), followed by parity ($P = 0{\cdot}04$) and nonpregnant weight ($P = 0{\cdot}04$) (Table 2).

1772 singleton vertex deliveries (79·75%) and 22 cases of shoulder dystocia were diagnosed (1·24%) during the study period. Newborn shoulder width was increased significantly in case of shoulder dystocia (mean = 130·05 (9·6), $P < 0{\cdot}001$).

A receiver–operating characteristics curve for newborn shoulder width as a test for predicting shoulder dystocia is presented in Fig. 1. Predisposing factors for shoulder dystocia were maternal weight gain ($P < 0{\cdot}001$), gestational age ($P = 0{\cdot}004$), birthweight ($P < 0{\cdot}001$), and newborn shoulder width values ($P < 0{\cdot}001$) in our study. On the other hand, no significant association was found between maternal age, parity, nonpregnant weight, height, sex of the neonate and shoulder dystocia. Table 3 shows predictive values of maternal and neonatal variables which are significantly associated with shoulder dystocia. Birthweight ≥ 4000 g should provide the highest sensitivity rate (36·3%)

Table 1. Maternal and neonatal characteristics and relation to newborn shoulder width.

	No. of measurements	Mean (SD)	*P*	*r*
Maternal age (years)	2222	29·1 (5·13)	0·13	0·03
Parity	2222	1·9 (1·3)	< 0·001	0·08
Nonpregnant weight (kg)	2182	60·2 (11·4)	< 0·001	0·19
Weight gain (kg)	2176	12·9 (5·1)	< 0·001	0·08
Maternal height (cm)	2189	163 (6·4)	< 0·001	0·08
Fasting glucose (mmol/L)	2220	4·56 (0·54)	< 0·001	0·08
1 h glucose (mmol/L)	2215	5·86 (1·6)	< 0·001	0·01
Gestational age (weeks)	2222	39·34 (1·42)	< 0·001	0·24
Birthweight (g)	2222	3313·9 (462·7)	< 0·001	0·59

Table 2. Results of stepwise regression analysis of maternal and neonatal characteristics and relation to newborn shoulder width.

Variable	Coefficient	Standard error	Student's *t*-test	*P*
Constant	75·21	1·466	51·31	<0·001
Nonpregnant weight (kg)	0·03	0·017	2·03	0·04
Parity	0·29	0·142	2·05	0·04
Birthweight (g)	0·01	0·0004	33·24	<0·001

retrospectively in association with the lowest false positive rate (4·7%).

DISCUSSION

This prospective study reports for the first time determining factors of newborn shoulder width, which increases significantly with variables that affect birthweight including maternel height, parity, nonpregnant weight, weight gain during pregnancy, gender of newborn, and gestational age[7–9]. Furthemore, most of the variables had a very low correlation to newborn shoulder width value, except for birthweight, and therefore, have a limited clinical relevance. Maternal diabetes was not analysed because the number of diabetic patients was too small in our population ($n = 7$). Furthemore, the study demonstrates that fasting glucose and one hour glucose levels are correlated with newborn shoulder width. Finally, stepwise multiple regression demonstrated that newborn shoulder width is strongly correlated with the weight of the infant. This result is in agreement with previous reports which indicated that fetal macrosomia represents the principal risk factor for shoulder dystocia[3,6]. However, Gonen *et al.*[10] demonstrated that most cases of shoulder dystocia and birth trauma occur in non-macrosomic infants.

Because shoulder dystocia mechanism appears when the shoulders become stuck in the transverse diameter of the pelvic inlet, it is suggested that measurement of shoulder width could be a predictive indicator. Therefore, few authors attempted antenatally to evaluate the bisacromial diameter by magnetic resonance imaging or ultrasonography. Kastler *et al.*[11] reported a strong correlation between fetal shoulder width values performed by magnetic resonance imaging and newborn shoulder width measurements determined by an orthopoedic caliper ($r = 0{\cdot}955$, $P = 0{\cdot}0001$). Riska *et al.*[12] recently estimated the fetal shoulder width by ultrasonography. They measured the humerospinus value by calculating the distance between the lateral margin of the fetal cartilaginous caput humeri and the processus spinosus of the cervical vertebra. A significant linear correlation was found between these measurements and the shoulder width of the infant ($r=0{\cdot}612$, $P < 0{\cdot}001$).

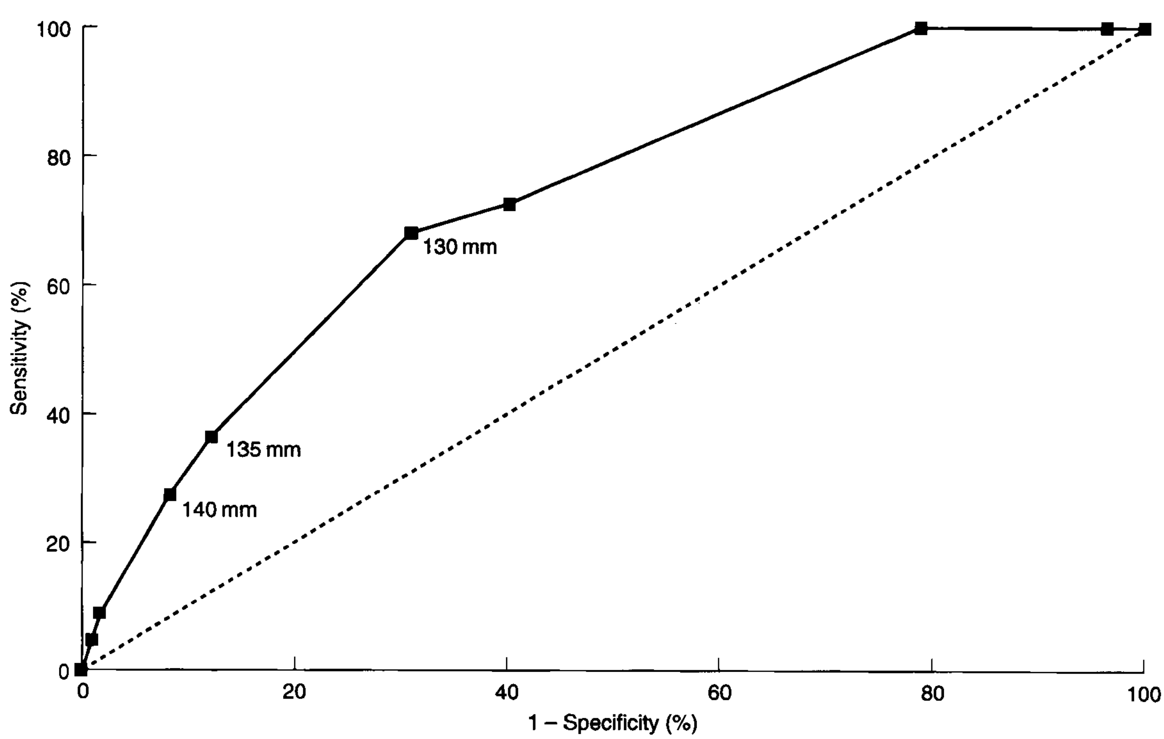

Fig. 1. Receiver–operating characteristics curve for newborn shoulder width as a test for predicting shoulder dystocia.

Table 3. Ability of maternal and neonatal characteristics to predict shoulder dystocia. PPV = positive predictive value; NPV = negative predictive value; NSW = newborn shoulder width.

Risks factors	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
NSW (mm)				
≥ 130	68·2	69·3	2·7	99·4
≥ 135	36·4	87·9	3·6	99·1
≥ 140	27·3	91·8	4·0	99·0
≥ 145	9·1	98·5	7·1	98·9
Maternal weight gain (kg)				
≥ 15	72·1	64·3	2·5	99·5
≥ 20	31·8	92·6	5·2	92·6
≥ 25	0	98·3	0	98·7
Birthweight (g)				
≥ 4000	36·3	95·3	8·7	99·2
≥ 4250	22·7	98·8	19·2	99·0
≥ 4500	13·6	99·5	25·0	99·5
≥ 5000	4·5	99·9	50·0	98·8
Gestational age (weeks)				
≥ 41	36·4	85·7	3·1	99·1
≥ 42	9·1	96·7	3·4	98·8

More recently, Winn *et al.*[13] determined by ultrasonography that the best predictor of the neonatal bisacromial diameter was the fetal chest circumference ($r = 0{\cdot}67$, $P = 0{\cdot}003$). As neonatal bisacromial diameter measurement prediction should be performed antenatally by magnetic resonance imaging[11], it is suggested that comparisons of fetal shoulder width and pelvic transverse diameter measurements by magnetic resonance imaging could be a possible indicator in predicting shoulder dystocia.

However, no study has attempted to determine the ability of fetal bisacromial diameter measurement to predict shoulder dystocia. In our study we have constructed a receiver–operating characteristics curve in order to define the best cut off for shoulder dystocia prediction. If the cut off was represented by the lowest addition of false positive and negative rates, newborn shoulder width measurement ≥ 130 mm was selected. However, if this measure had a high sensitivity rate (68·2%), the specificity rate was also very low (69·3% with a false positive rate of 30·7%). This suggests that approximately one-third of the population should have a caesarean section ($n = 544$) to prevent two-thirds of shoulder dystocia. This strategy was not acceptable in a low risk population. Therefore, we deliberately chose a cut off with a false positive rate under 10% in association with the better sensitivity rate. In that way newborn shoulder width measurement ≥ 140 mm represents the best cut off for shoulder dystocia prediction in our study. Our investigation revealed that > two-thirds of shoulder dystocia occur when newborn shoulder width measurement is < 140 mm. Among shoulder dystocia with newborn shoulder width measurement < 140 or ≥ 140 mm, the false negative results were 72·72% and the false positive results were 8·18%. Macrosomia (birthweight ≥ 4000 g) retrospectively was the most obvious predisposing factor for shoulder dystocia in our study. Nevertheless, the ability to predict macrosomia by ultrasonography is limited antenatally[10].

In conclusion, even when shoulder width measurement could be correctly evaluated antenatally, our study shows a lower sensitivity rate to recommend this measurement in predicting shoulder dystocia. In fact, our results suggest that newborn shoulder width measurement which is strongly correlated with birthweight still remains a poor indicator of shoulder dystocia when studied independently.

Acknowledgements

The authors would like to thank Mr R. Medeiros for his valuable advice in editing the manuscript.

References

1 Gross SJ, Shime J, Farine D. Shoulder dystocia: predictors and outcome. *Am J Obstet Gynecol* 1987; **156**: 334–336.
2 Hopwood HG. Shoulder dystocia: fifteen year's experience in acommunity hospital. *Am J Obstet Gynecol* 1982; **144**: 162–166.
3 Nocon JJ, McKenzie DK, Thomas LJ, Hansell RS. Shoulder dystocia: an analysis of risks and obstetric maneuvers. *Am J Obstet Gynecol* 1993; **168**: 1732–1739.
4 Acker DB, Sachs BP, Friedman EA. Risks factors for shoulder dystocia in the average-weight infant. *Obstet Gynecol* 1986; **67**: 614–618.
5 O'Leary JA, Leonetti HB. Shoulder dystocia: prevention and treatment. *Am J Obstet Gynecol* 1990; **162**: 5–9.
6 Bahar AM. Risk factors and fetal outcome in cases of shoulder dystocia compared with normal deliveries of a similar birthweight. *Br J Obstet Gynaecol* 1996; **103**: 868–872.
7 Dougherty CRS, Jones AD. The determinants of birth weight. *Am J Obstet Gynecol* 1982; **144**: 190–200.
8 Godenberg RL et al. Maternal risk factors and their influence on fetal anthropometric measurements. *Am J Obstet Gynecol* 1993; **168**: 1197–1205.

9 Sciscione AC, Gorman R, Callan NA. Adjustment of birth weight standards for maternal and infant characteristics improves the prediction of outcome in the small-for-gestational-age infant. *Am J Obstet Gynecol* 1996; **175**: 544–547.
10 Gonen R, Spiegel D, Abend M. Is macrosomia predictable, and are shoulder dystocia and birth trauma preventable? *Obstet Gynecol* 1996; **88**: 526–529.
11 Kastler B et al. Fetal shoulder measurement with MRI. *J Comput Assist Tomogr* 1993; **17**: 777–780.
12 Riska A, Laine H, Voutilainen P, Kariniemi V. Estimation of fetal shoulder width by measurement of the humerospinous distance by ultrasound. *Ultrasound Obstet Gynecol* 1996; **7**: 272–274.
13 Winn HN, Holcomb W, Shumway JB, AL-Malt A, Amon E, Hobbins JC. The neonatal bisacromial diameter: a prenatal sonographic evaluation. *J Perinat Med* 1997; **25**: 484–487.

Received 15 May 1998
Returned for revision 3 November 1998
Accepted 20 January 1999