Original Article

Clinical Predictive Score for Shoulder Dystocia

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Objective: To develop a new risk score as a predictive tool from clinical risk factors for determining high-risk pregnancy with shoulder dystocia.

Materials and Methods: A retrospective study was performed. The demographic data, prenatal care history, and the risk factors, such as total weight gain, estimated fetal weight, and the instrumental assisted vaginal delivery (InVD), were recorded and compared between the shoulder dystocia (SD) and non-shoulder dystocia (non-SD) groups. The risk score for prediction was developed by multivariate logistic regression analysis.

Results: Of 872 vaginal deliveries, 42 SD cases were collected and 830 non-SD cases were included. In a multivariate analysis, there were three clinical risk factors, statistically significant; total weight gain ≥16 kg (TWG16), Estimated fetal weight ≥3,200 grams (EFW3200) and the InVD. The odd ratios of these risk factors were calculated and converted to the risk score. The final score model to predict shoulder dystocia had receiver operating characteristic curve of 79.73%. Each patient was given a score as the presented risks; TWG16 = 2, EFW3200 = 3, and InVD = 5. Then, the summation of the score was divided into low-, intermediate-, and high-risk groups at cut off value scores of 0 to 4, 5 to 6, and ≥7, respectively. Positive likelihood ratio in those groups were 0.12, 5.94 and 10.97, in orderly, with statistically significance (p-value <0.001).

Conclusion: The study has developed an easy and practical new risk score for predicting pregnant women who at risk of shoulder dystocia.

Keywords: Predictive score, Shoulder dystocia

J Med Assoc Thai 2020;103(Suppl.3): 32-6
Website: http://www.jmatonline.com

Shoulder dystocia is a complication that can occur during delivery when a baby's shoulders become lodged or when the fetal head is delivered, and the shoulders have not been delivered within 60 seconds, or if the baby needs an obstetrics' maneuver to help deliver the shoulders[1-3]. Because of its varying incidence, which averages around 0.1 to 3 percent, its variability might be affected by the difference in criteria diagnosis, data analysis, data collection, and statistical analysis[4].

A complicated vaginal delivery from shoulder dystocia is an emergency condition and a nightmare in obstetrics. This complication is an important cause of maternal and fetal morbidity which might lead to long-term consequences and create an impact on family and social scales. Many of the adverse effects happen to both the mother and the newborn baby, such as postpartum hemorrhage, perineal lacerations, obstetric anal sphincter injuries (OASIS), uterine rupture, brachial plexus injury, Erb or Klumpke palsy, and hypoxic ischemic encephalopathy, etc. However, the prediction of shoulder dystocia is difficult because of poor positive predictive value of risk factors[4,5].

The commonly known risk factors of shoulder dystocia are fetal macrosomia, maternal diabetes, maternal obesity, post-term pregnancy, prolong duration of labor, and a history of shoulder dystocia[5]. Furthermore, shoulder dystocia is an unpredictable and unpreventable situation and, therefore, the obstetrician needs to be prepared for the possible occurrence. If shoulder dystocia is diagnosed, obstetrics' maneuvers such as McRoberts maneuver, suprapubic pressure, deliver of posterior arm, Rubin maneuver, Woods Screw maneuver, posterior axilla sling traction, the Gaskin all fours maneuver, Zavanelli maneuver, and symphysiotomy may be applied promptly[1]. Although these maneuvers assist the baby's shoulder delivery, the morbidity is still high. For that reason, it is important to have a highly accurate tool in the prediction of shoulder dystocia. Therefore, the prediction of shoulder dystocia could ultimately play a crucial role in the reduction of peripartum and perinatal morbidity and mortality. The purpose of this study is to develop a risk factor to the scoring system for the prediction of shoulder dystocia.

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How to cite this article: Vorathiankul N, Tanprasertkul C, Ruengorn C, Nanthakomon T, Vinayanuvattikhun N, Somprasit C. Clinical Predictive Score for Shoulder Dystocia. J Med Assoc Thai 2020;103(Suppl.3): 32-6.

Materials and Methods

This case-control study was conducted in Thammasat University Hospital, Thailand. The approval from the Ethics Committee of Faculty of Medicine, Thammasat University was obtained prior to the study (MTU-EC-OB-6-201/60). The data were extracted from medical records of term pregnant women who had vaginal deliveries during January 2015 to December 2018.

The cases were women who had delivered babies with the complication of shoulder dystocia (SD), which was defined as the difficulty to deliver the baby's shoulders or when the fetal head was delivered but needed the use of an obstetrics' maneuver to assist the delivery of the shoulders [1]. The control group was women who had an uncomplicated vaginal delivery and were randomly selected on the same day of the cases. A ratio of 1 case per 20 controls were pre-specified.

The records demonstrated characteristics and risk factors for shoulder dystocia such as age, pre-pregnancy body weight, pre-pregnancy body mass index (BMI), parity, total weight gain (TWG) during pregnancy (baseline weight of pregnant women to weight at term), estimated fetal weight (EFW) from clinical examination with Leopold's maneuver, diabetes status such as overt diabetes and gestational diabetes (GDM), induction of labor, the instrumental assisted vaginal delivery (InVD) namely, forceps or vacuum extraction, duration of labor, and newborn weight. The retrieved data was analyzed in 2 individual groups: shoulder dystocia and non-shoulder dystocia or control group.

The sample size was calculated based on at least a total of 872 pregnant women (830 for controls and 42 cases of SD) to explore the presumed risk factors of a given power of 80 and 5% alpha error with a two-sided test. The incomplete or uncertain data that were not enough for analysis were excluded.

Statistical analysis

For data and statistical analysis, the baseline characteristics between the two groups were compared. The count number with percentages and mean with standard deviation were used for described for categorical and continuous data, respectively. The Fisher's exact test and independent t-test were used to compare categorical and continuous data, respectively. A two-stage analysis was performed. The first stage, univariate binary logistic regression was used to identify the risk factors, the results illustrated were crude odds ratio and 95% CI. At the second stage, clinical parameters with *p*-value less than 0.05, then selected to multivariate binary logistic regression model. The predictive score was developed from the coefficient of each selected factor from the final multivariate logistic regression. The model was selected and illustrated with an area under the curve of predicted receiver operating characteristic curve (ROC). The significant coefficients were transformed into each parameter score by diving the lowest coefficient and rounded up or down to the nearest complete number. Each patient was given a score as the presented risks; We proposed the name "SD score" for the predictive scoring system. Finally, the SD score was divided into low-, intermediate-, and high-risk groups at the appropriated cut-off value. The likelihood ratio of positive (LHR+) was used to evaluate the proper cut-off values.

Results

From a total of 886 recruited vaginal delivery women, 14 cases were excluded due to incomplete data. There were 872 cases that had the complete data for analysis of these 42 cases of shoulder dystocia were reported and classified as the case or SD group. The remaining patients were classified as the control or non-SD group as shown in the demographic data shown in (Table 1). There was no difference in the mean age ($p = 0.52$) and pre-pregnancy body weight ($p = 0.37$). The body weight at term and total weight gain during pregnancy in SD had a more significant difference than the non-SD group ($p<0.001$). Women who had total weight gain at least 16 kg in SD was 69% compared to 25.7% in non-SD. The parity was comparable in both groups. The mean of estimate fetal weight in SD was significantly higher than non-SD; 3,297 grams, and 3,031.8 grams, respectively ($p<0.001$). Only 35.1% in non-SD had an EFW ≥3,200 grams compared to 79.5% in the SD group. For diabetic status, there was no statistical difference in overt diabetes mellitus but the SD group had higher numbers of GDM 14.3% compared to 5.2% in non-SD. InVD in SD group was 7.1% while in non-SD was only 1.3% which was statistically significant difference ($p = 0.002$). In addition, the average time in the first stage and second stage of labor in SD group were significantly higher than non-SD; 559.0 versus 447.6 minutes with $p = 0.005$ and 23.3 versus 13.8 minutes with $p<0.001$, respectively.

The four risk factors that univariate was significantly had put into the multivariable model. Only 3 significant predictors were demonstrated, which comprised of the TWG16, EFW3200 and InVD had OR 3.74, 4.8. 8.2 respectively (Table 2). The predicted area under AUC of final model for these predictors were 0.7973. Then the coefficient and item assignment were calculated and converted to the risk score.

Each patient was given a score as the presented risk. The TWG16, EFW3200, and InVD had the scores 2, 3, and 5, respectively. To evaluate the discrimination of the developed score, the data was reanalyzed, which focused on the shoulder dystocia group whether it was standardized or not. The distributional plot was made and the score in both groups was compared using a t-test that turned out to be statistically significant ($p<0.001$). The last model also checked its calibration using an observation graph compared with a predictive risk and combined with the Hosmer-Lemeshow goodness-of-fit test. The model fits very well as shown in Figure 1.

Measures of the classification of prediction of SD showed the probability of categorized scores compared between shoulder dystocia and non-shoulder dystocia, together with the likelihood ratio of positive (LHR+), 95%

Table 1. Characteristics of pregnancy women, shoulder dystocia versus non-shoulder dystocia

Characteristics	Non-shoulder dystocia (n = 830)	Shoulder dystocia (n = 42)	*p*-value
Age (year)*	28.2 (5.9)	27.6 (4.5)	0.52
Pre-pregnancy body weight (kg)*	54.7 (10.0)	56.2 (11.4)	0.37
Body weight at term (kg)*	67.8 (11.8)	74.1 (11.4)	<0.001
Body mass index (kg/m^2)*	22.2 (7.4)	22.8 (4.4)	0.61
Total weight gain(kg)#			
<16	604 (74.3)	13 (31.0)	<0.001
≥16	209 (25.7)	29 (69.0)	<0.001
Parity#			0.24
Nulliparity	377 (45.6)	23 (54.8)	
Multiparity	450 (54.4)	19 (45.2)	
Estimated fetal weight (grams)#			
<2,799	48 (14)	1 (2.9)	<0.001
2,800 to 3,199	174 (50.9)	6 (17.6)	<0.001
≥3,200	20 (35.1)	27 (79.5)	<0.001
Overt diabetes mellitus#	4 (0.5)	0 (0.0)	0.65
Gestational diabetes mellitus (GDM)#	43 (5.2)	6 (14.3)	0.014
Route of delivery#			0.002
Spontaneous vertex delivery	819 (98.7)	39 (92.9)	
Instrumental vaginal delivery	11 (1.3)	3 (7.1)	
Induction of labor#	22 (2.7)	1 (2.4)	0.92
Duration of labor (min)*			
First stage	447.6 (254.2)	559.0 (203.3)	0.005
Second stage	13.8 (10.8)	23.3 (18.3)	<0.001
Third stage	6.7 (4.8)	6.8 (3.9)	0.90
Newborn birth weight (grams)*	3,083.0 (372.2)	3,683.5 (355.7)	<0.001

Data presented in mean (SD)* or number (%)#

Table 2. Risk factors of shoulder dystocia in a multivariate regression model reported in odd ratios with a 95% confidence interval and coefficient and item assignment

Risk factors for shoulder dystocia	Odds ratio	*p*-value	95% CI	Coefficient	Score
Total weight gain ≥16 kg	3.74	0.001	1.66 to 8.42	1.38	2
Estimate fetal weight ≥3,200 grams	4.80	0.000	2.10 to 10.94	1.57	3
Instrumental vaginal delivery	8.22	0.025	1.30 to 51.88	2.17	5
Gestational diabetes	1.67	0.441	0.45 to 6.15	0.51	-

confidence interval, and *p*-value. The summation score was classified into 3 groups, 0 to 4 defined as low risk, 5 to 6 defined as intermediate risk, and more than 7 defined as high risk. As in (Table 3), the LHR+ of 0.12 times in the low risk group and 10.97 times in the high-risk group are presumed that the cut-off scores are appropriate.

Discussion

The present study review and analysis of the retrospective data of a substantial amount found significant risk factors of shoulder dystocia, namely TWG16, EFW3200 and InVD.

The Institute of medicine (IOM) recommended weight gain should not exceed 16 kg (35 lb) in normal BMI (BMI 18.5 to 24.9 kg/m^2)[6]. In addition, the study of Fuchs et al demonstrated that pre-pregnancy women with normal BMI who weight gain within 16 kg could reduce risk of shoulder dystocia[7]. These findings are consistent with our data that showed a TWG16 significantly increased the risk of SD almost fourfold. While the study of Zhang et al found a significant relationship between maternal obesity and SD, their data concluded that the greater maternal obesity was the higher risk of shoulder dystocia[8]. However, our findings showed that a high pre-pregnancy BMI is not a risk for SD. This could be explained because most of the baseline BMI of both groups in our study were in the normal ranges and were not significantly statistically different. Therefore, the consequence of these effects was not clearly

shown in our data.

Our data showed clinical EFW3200 was the important risk factor of SD. At this cut off value, this risk factor itself had an estimated area under ROC curve at 0.7020 (data not shown) which means this factor could predict SD with high accuracy. Clinical examination with Leopold's maneuver for estimate fetal weight is usually considered to have some errors and inaccuracies, the study of Lanowski et al, showed that ultrasonography was more accurate than clinical estimate fetal weight[9]. Another research found that clinical estimate fetal weight could have an absolute error of more than 500 grams[10]. However, in limited resource settings, the clinical estimate fetal weight is still necessary. In select cases of suspected high fetal weight, ultrasonography then should be used for further investigation.

The American College of Obstetrics and Gynecology (ACOG) advise a planned cesarean section if the estimate fetal weight is more than 4,500 grams in a diabetic mother, or prolonged second stage or arrest of descent in the second stage. The maternal and fetal morbidity and mortality, including shoulder dystocia, increase when estimate fetal weight is more than 4,000 grams and surprisingly increase when estimate fetal weight is more than 4,500 grams[11]. However, the fetal macrosomia is difficult and imprecise to diagnose. This advice may not apply to Asian pregnant women due to the difference in maternal race and ethnicity. There is no definite conclusive definition of macrosomia in Thai or South East Asian populations.

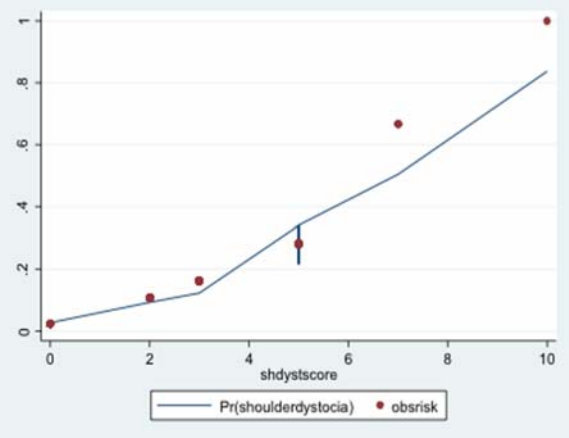

Figure 1. Probability of shoulder dystocia (SD) by SD score range 0 to 1; dotted by the real observe risk and the solid line by estimated by SD score.

The previous evidence showed that GDM is one of the risk factors for SD[1-4]. In the present study, univariate analysis found a high odd ratio of GDM but in a multivariate regression this effect did not show any significance. Therefore, GDM could be a confounder and may not be the real risk factor of SD. The diabetic status has an effect on SD though the pathway of increasing fetal weight, body or shape of the fetus.

In terms of InVD (forceps or vacuum extraction), these maneuvers are used to help the delivery of only the fetal head, hence the risk of shoulder dystocia is markedly increased if fetal truncal obesity and large abdominal circumference especially in high bodyweight newborns. The patients who range in the high risk group in our model, the obstetricians should be alert. The used of assisted instruments for vaginal delivery must be highly concerned.

The authors proposed that the risk score scheme for SD be categorized as low, intermediate, or high-risk groups as shown in (Table 3). The positive likelihood ratio of SD among pregnant women in the low risk group is only 0.12 compared to 10.97 in the high-risk group. These chance differences could be a very useful tool for medical personnel to differentiate and manage the patients in the most appropriate way.

To our knowledge, there were only a few studies that converted the risk factors into a risk score. The previous study claims that it was not useful in practical use[12]. From another point of view, the scoring system could help a general practitioner to divide patients into low-, intermediate-, and high-risk group. If a high- or intermediate risk patient is in a primary or secondary care hospital with no proper resource, referral might be considered.

The study had several limitations. It is a retrospective study which means that uncertainty of data is commonly found. The most common pitfalls are incomplete and loss of data. In addition, our limitation is due to the variety and difference of the diagnosis of SD. Also, the instrumental vaginal delivery (InVD), one of the calculated risk factors, is also unpredictable in the upcoming delivery. The prospective study on the predictive score especially on the instrumental vaginal delivery is needed. The study was conducted in our hospital which is tertiary medical care base and it is for this reason that the use of this score system still needs to be retested and validated

Table 3. Risk-scoring categorized by grouping as low, intermediate and high risk, respectively

Risk score	Non-shoulder dystocia	Shoulder dystocia	LHR+	95% CI	*p*-value
Low risk score = 0 to 4	301 (90.4%)	18 (52.9%)	0.12	0.05 to 0.28	<0.001
Intermediate risk score = 5 to 6	28 (8.4%)	12 (35.3%)	5.94	2.39 to 14.05	<0.001
High risk score ≥7	4 (1.2%)	4 (11.8%)	10.97	1.91 to 61.19	<0.001

in other settings.

Conclusion

The present study sought to prevent the occurrence of shoulder dystocia which could reduce the maternal and fetal morbidity and mortality. Our study discovered the significant risk factors for shoulder dystocia, then converted them into a predicting score. Each patient was given a score as their risks and were then grouped into low, intermediate and high-risk groups, respectively. The predicting score could be a simple tool that is easy to use, practical, and beneficial for health care providers in the management of patients, especially ones who have a high risk of shoulder dystocia.

What is already known on this topic?

Shoulder dystocia is an unpredictably and unprevented emergency obstetric condition which cause high maternal and fetal morbidity and mortality. As far as we concern, the risk factors for shoulder dystocia are fetal macrosomia, maternal diabetes, maternal obesity, post-term pregnancy, prolong duration of labor, and a history of shoulder dystocia. The incidence of shoulder dystocia is varies from 0.3 to 1 percents.

What this study adds?

This study was aim to identify risk factor and converted into risk score. Then the risk score could guide to prevent the occurrence of shoulder dystocia which could reduce the maternal and fetal morbidity and mortality. The predicting score could be a simple tool that is easy to use, practical, and beneficial for health care providers in the management of patients, especially ones who have a high risk of shoulder dystocia.

Acknowledgements

The present study was granted by the Research Fund of Thammasat University, Thailand, 2017.

Potential conflicts of interest

The authors declare no conflict of interest.

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เกณฑ์การทำนายทางคลินิกของภาวะการคลอดติดไหล่

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วัตถุประสงค์: เพื่อสร้างเกณฑ์การทำนายภาวะคลอดติดไหล่ในหญิงตั้งครรภ์เพื่อนำมาใช้จำแนกสตรีตั้งครรภ์ที่มีโอกาสเสี่ยงสูงต่อภาวะคลอดติดไหล่ได้

วัสดุและวิธีการ: การศึกษาแบบเก็บข้อมูลย้อนหลัง ทำการศึกษาที่โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ ทำการเก็บข้อมูลหญิงตั้งครรภ์ที่คลอดทางช่องคลอดในช่วงเดือนมกราคม พ.ศ. 2558 ถึง เดือนธันวาคม พ.ศ. 2561 ข้อมูลที่เก็บได้แก่ ข้อมูลทั่วไป ประวัติการฝากครรภ์ รวมทั้งความเสี่ยงต่างๆ อาทิ น้ำหนักที่ขึ้นระหว่างตั้งครรภ์ น้ำหนักทารกจากการคาดการณ์ รวมทั้งหัตถการช่วยคลอดต่างๆ โดยนำข้อมูลที่เก็บได้มาคำนวณแยกระหว่างกลุ่มควบคุมและกลุ่มที่มีภาวะคลอดติดไหล่ การคำนวณทางสถิติใช้วิธีถดถอยแบบพหุตัวแปรเพื่อทำเป็นคะแนนเสี่ยงและได้เป็นเกณฑ์การทำนายภาวะคลอดติดไหล่

ผลการศึกษา: จากการศึกษาจำนวนทั้งหมด 872 ราย พบการคลอดติดไหล่ 42 ราย โดยมีสามปัจจัยหลักที่มีผลต่อการคลอดติดไหล่อย่างมีนัยสำคัญทางสถิติ ได้แก่ น้ำหนักที่ขึ้นระหว่างตั้งครรภ์ตั้งแต่ 16 กิโลกรัม น้ำหนักทารกโดยการคาดการณ์ตั้งแต่ 3,200 กรัมและการคลอดที่อาศัยหัตถการช่วยคลอด เมื่อนำทั้งสามปัจจัยคำนวณเป็นสมการสุดท้ายพบว่าโอกาสการทำนายภาวะคลอดติดไหล่ได้คิดเป็นร้อยละ 79.73 หลังจากนั้นปรับค่าความเสี่ยงเป็นคะแนนโดยวิธีทางสถิติดังนี้ TWG16 = 2, EFW 3,200 = 3, InVD = 5 แล้วนำคะแนนดังกล่าวมารวมกันในผู้ป่วยแต่ละรายเพื่อจำแนกผู้ป่วยออกเป็นกลุ่มความเสี่ยงต่ำ ปานกลาง และสูงที่คะแนน 0 ถึง 4, 5 ถึง 6 และ ตั้งแต่ 7 ขึ้นไปตามลำดับ พบว่าโอกาสเกิดการคลอดติดไหล่เพิ่มเป็น 0.12, 5.94 และ 10.97 ในกลุ่มความเสี่ยงต่ำ กลุ่มความเสี่ยงปานกลางและความเสี่ยงสูงตามลำดับ

สรุป: การศึกษานี้เป็นการศึกษาเกณฑ์การทำนายภาวะคลอดติดไหล่ ซึ่งจะเป็นเครื่องมือที่ใช้ได้ง่ายและสามารถนำคะแนนที่ได้จากการประเมินความเสี่ยงเพื่อช่วยในการแนะนำและเฝ้าระวังภาวะคลอดติดไหล่ที่อาจเกิดได้ โดยเฉพาะกลุ่มความเสี่ยงสูง