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Scoring system to predict the success rate of external cephalic versions and determine the timing of the procedure

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Abstract. – OBJECTIVE: We aimed to examine the prenatal clinical characteristics of women with single pregnancies undergoing external cephalic version (ECV) without anesthesia, develop a novel scoring system for predicting the ECV success rate, and demonstrate that this scoring system can be used to individualize the timing of ECV attempts.

PATIENTS AND METHODS: We enrolled 270 women who underwent ECV without anesthesia at 37-40 weeks of gestation in the Fujian Maternity and Child Health Hospital from 2016 to 2019 and divided them into two ECV outcome groups (success *vs.* failure). We identified five clinical features (the fetal buttocks' station, the sum of the fundal height and station, the fetal head location, and whether the fetal head or buttocks could be grasped) as independent factors affecting the ECV success rate, and we scored them using a regression coefficient.

RESULTS: Women with scores of 0-3 points had ECV success rates, vaginal delivery rates, and delivery gestational ages at 16.67%, 16.67%, and 38.88 weeks, respectively; those with scores of 4-6 points had ECV success rates, vaginal delivery rates, and delivery gestational ages at 65.75%, 58.90%, and 39.62 weeks, respectively; and those with scores of 7-9 points had ECV success rates, vaginal delivery rates, and delivery gestational ages at 93.71%,74.83%, and 40.00 weeks, respectively.

CONCLUSIONS: The ECV success and vaginal delivery rates increased with the score, and the delivery gestational age showed an initial increase. To optimize the ECV procedure and reduce the hospital burden, this scoring system should be used routinely to predict the ECV success rate and determine the timing of ECV attempts.

Key Words:
External cephalic version (ECV), Success rate, Scoring system, Influencing factors, ECV procedure, Prediction model.

Introduction

A successful external cephalic version (ECV) reduces the caesarean section rate by lowering the incidence of breech presentations. Moreover, the risk of an adverse event occurring as a result of ECV is small[1-3]. Both the American College of Obstetricians and Gynecologists (ACOG) and the Royal College of Obstetricians and Gynecologists (RCOG) recommend that all women with singleton breech pregnancies who are near term should be offered an ECV from 36 weeks of gestation or later in the absence of contraindications, and that elective cesarean section may be suggested after a failed ECV attempt and in the absence of emergencies[3-5]. The Fujian Maternity and Child Health Hospital has been performing ECVs since January 2016. Many women with unsuccessful ECV attempts at 37-38 weeks of gestation are discharged and usually readmitted to the hospital for caesarean section at around 39-40 weeks of gestation, increasing the number of hospitalizations and the burden on the hospitals. ECV success can be predicted to some extent[5], but no individualized evaluation criteria exist for assessing the timing of the ECV attempt.

Subjects and Methods

Subjects

We collected clinical data from 270 singleton breech pregnancies who underwent ECV attempts between 37 and 40 weeks of gestation at the Fujian Maternity and Child Health Hospital from 2016 to 2019. We confirmed the fetal presentations of the women without cesarean section indications and willing to attempt vaginal delivery by ultrasound. The women and their family

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members provided a signed informed consent before having the ECV performed. We excluded cases of women with the following conditions: scarred uterus, multifetal gestation, premature rupture of membranes, prenatal hemorrhage, oligohydramnios, fetal distress, uterine malformation, placenta previa, preeclampsia, and recent uterine bleeding. We divided cases into success and failure groups according to whether the ECV procedure was successful or not.

Preparation for ECV

We used data from the comprehensive prenatal care and ultrasound examinations to determine the presentation at 37 weeks of gestation. A surgeon ruled out the contraindications for ECV and measured the following variables:

Fundal height: the distance from the midpoint of the maternal pubic symphysis to the uterine fundus as measured with a tension-free tape.

Station of the fetal buttocks: the lowermost portion of the fetal breech presentation that descended from the pelvic inlet toward the ischial spines as measured by vaginal examination using the designations of –5 cm, –4 cm, –3 cm, –2 cm, –1 cm, and 0 cm.

Sum of the fundal height and station: the measurements of each of these variables were added (e.g., if the fundal height was 33 cm and the station of the fetal buttocks -4 cm, the sum was 29 cm).

Fetal head location based on clock positions: fetal head under the maternal xiphoid process (1-11 o'clock), in upper left maternal abdomen (1-2 o'clock), in upper right maternal abdomen (10-11 o'clock), in left maternal abdomen (2-3 o'clock), and in right maternal abdomen (9-10 o'clock), respectively.

Whether the surgeon could grasp the fetal buttocks or head with a hand: graspable *vs.* ungraspable.

Fetal weight, amniotic fluid volume, placental position, the categories of the breech presentations, according to results of ultrasound examination.

Information on routine prenatal care collected through the electronic medical records, and the fetal presentation and number of times the fetus turned spontaneously in the third trimester.

ECV Procedure

All the women provided informed consents, they accepted terbutaline and lubrication, and did not receive anesthesia. The same obstetrician performed all the procedures in an operating room. The procedure was deemed successful if the fetus was turned to achieve a persistent vertex presentation, and the procedures failed if the fetus was not turned from a breech to a cephalic presentation.

Management after ECV

A nonstress test was performed immediately after the ECV attempt, and the patients were monitored for at least 30 minutes.

On the first day after the procedure, the fetal presentation was confirmed by ultrasound and the fetal evaluation was repeated.

Emergency cesarean section was performed in cases with persistent fetal bradycardia, placental abruption, or premature rupture of membranes during the version.

All the women accepted routine prenatal care after discharge; patients who underwent successful procedures were admitted at the onset of labor, while those whose procedures failed underwent a selective cesarean section at 39-40 weeks of gestation.

Statistical Analysis

We tested quantitative data for normality. We expressed normally distributed data as means ± standard deviations (SD) and used independent sample *t*-tests to compare variables between groups. We expressed non-normally distributed data as medians (P_{50}; 25th percentile, P_{25}; and 75th percentile, P_{75}), and we compared variables between the two groups using the Mann-Whitney U test. In addition, we expressed qualitative data as frequencies and percentages (%) and used the χ^2-test for comparisons between the groups. We calculated the weighting of factors using the XGBoost algorithm of sklearn 0.22. Among the indices with a $p<0.05$ in the univariate analysis, we included 14 factors in the multivariate logistic regression analysis due to their higher weightings. We selected five independent variables with $p \leq 0.05$ in the multivariate analysis to establish the scoring system for the success rate, and we used the area under the curve (AUC) of the regression model to evaluate its accuracy; we also used the receiver operating characteristic (ROC) curve analysis to determine the optimal boundary point and established a prediction score sheet for the ECV success rate according to the regression coefficients of the logistic regression analysis. Finally, we divided data from the participants into three groups according to whether they had

high, medium, or low scores, and compared the ECV success rates, gestational ages at delivery, and vaginal birth rates among the three groups. Moreover, we used the ROC curve to evaluate the accuracy of the prediction score sheet. We performed all statistical analyses using the IBM SPSS Statistics version 26.0 (IBM, Armonk, NY, USA).

Results

In total, 270 women underwent ECVs; of them, 191 (70.74%) underwent successful procedures at 37.71 weeks of gestation (37 to 39.14 weeks) and gave birth at 40 weeks of gestation (39.29 to 40.86 weeks). Among the 191 women who successfully underwent ECV, 2 (0.7%) and 4 cases (2.09%) required a category I caesarean sections after the successful ECV due to persistent fetal bradycardia ≥ 5 minutes and abruptio placentae, and they underwent selective cesarean section for the indications of macrosomia and oligohydramnios, respectively. Of the remaining 185 cases that accepted a trial of labor, 147 had vaginal deliveries, but 38 underwent cesarean section during labor for indications such as fetal distress (96.86%), persistent posterior occiput (79.46%), or transverse position (25.85%). Of the 79 women (29.26%) whose ECV failed at 37.86 weeks (37 to 39 weeks) and who gave birth at 39 weeks (38.43 and 39.49 weeks), 68 (86.08%) underwent cesarean sections and 11 cases (13.92%) had a vaginal delivery of a breech fetus. We found similar gestational ages between the two groups at the time of the ECV; however, we found statistically significant differences in the gestational ages at delivery and according to delivery modes (Table I).

The univariate analysis found that the women in the success group were older, shorter in length, and weighed less. Moreover, the univariate analysis showed that compared to the women in the ECV failure group, the women in the success group were more often multiparous; had gained less weight during pregnancy; had more amniotic fluid; had fetuses with shorter legs; had smaller stations of the fetal buttocks and sum of the fundal heights and stations; had the fetal head and buttocks (in the breach position) grasped easily by one hand of the surgeon; had fetal head locations other than at 11-1 o'clock; had more spontaneous versions during pregnancy; had fewer uterine contractions during late pregnancy; had clear uterine contours; and had more relaxed uteruses. However, the gestational age at which the patient underwent ECV, the placental position, the category of the breech presentation, the presence of the umbilical cord around the neck, and the fetal spine direction were not influencing factors (Table II).

We used the XGBoost algorithm to perform machine learning on all 270 patient samples using 37 prenatal features; for the output, each feature was assigned a weighting to obtain a list based on the feature importance (Figure 1 and Table III). We selected 14 features that had both a $p < 0.05$ in the single factor analysis and a high weighting in the XGBoost algorithm. The multivariate logistic regression analysis found that the station of the fetal buttocks, the sum of the fundal height and station, the fetal head location, and whether it was easy to grasp the fetal head or buttocks were independent factors for the success rate of the procedure. These five features predicted the ECV success rate with high accuracy; AUC, 0.907 (95% confidence interval [CI], 0.863 to 0.951; Figure 2).

The cut-off values for the sum of the fundal height and station (30.75 cm) and for the station of the fetal buttocks (-3.5 cm) were calculated using the ROC curve (Figure 2). In our multiple regression analysis, the odds ratio for the stations of the fetal buttocks (divided into ≥3.5 cm and ≤3.5 cm) was 4.06, that for the sums of the fundal height

Table I. Outcomes of two groups.

Outcomes	Failure group (N = 79)	Success group (N = 191)	$t/Z/\chi^2$	p
Underwent ECV (weeks of gestation)	37.86 (37, 39)	37.71 (37, 39.14)	-0.060	0.952
Delivery gestation (weeks of gestation)	39 (38.43, 39.49)	40 (39.29, 40.86)	-13.52	< 0.001
Delivery mode			91.49	< 0.000
Vaginal delivery11 (13.9)	147 (77.0)			
Cesarean section68 (86.1)	44 (23.0)			

ECV, external cephalic version.

Table II. Comparison of prenatal factors between the two groups.

Prenatal factors	Failure group (N = 79)	Success group (N = 191)	$t/Z/\chi^2$	*p*
Age (years)	27.29 ± 3.78	29.70 ± 3.82	-4.728	< 0.001
Maternal height (m)	1.62 (1.56, 1.70)	1.60 (1.53, 1.67)	-2.649	0.008
Gravidity	1.00 (1.00, 3.00)	2.0 (1.00, 4.00)	-3.639	0.000
Parity	0.00 (0.00, 1.00)	1.00 (0.00, 1.00)	-4.252	0.000
Miscarriage	0.00 (0.00, 1.00)	0.00 (0.00, 2.00)	-1.179	0.239
Duration since the last delivery (years)	0.00 (0.00, 4.00)	0.00 (0.00, 6.00)	-3.386	0.001
Newborn weight in the last delivery (g)	3100 (0.60, 3560)	3300 (942.13, 3600)	-1.64	0.102
Weight before pregnancy (kg)	53.87 ± 7.66	52.74 ± 8.04	1.061	0.290
Weight in ECV (kg)	67.85 ± 7.82	65.39 ± 8.63	2.195	0.029
Weight increase during Pregnancy (kg)	13.98 ± 4.28	12.64 ± 4.22	2.365	0.019
BMI before pregnancy (kg/m2)	20.51 ± 2.66	20.47 ± 3.17	0.100	0.921
BMI in ECV (kg/m2)	25.84 ± 2.58	25.41 ± 3.48	1.003	0.317
BMI increase (kg/m2)	5.33 ± 1.60	4.93 ± 1.67	1.788	0.075
Abdomen circumference (cm)	97.13 ± 6.47	97.01 ± 5.91	0.159	0.874
Fundal height (cm)	33.81 ± 1.63	33.55 ± 1.35	1.365	0.173
The sum of the fundal height and the station (cm)	31.27 ± 1.72	29.65 ± 1.48	7.801	< 0.001
Gestation of the breech presentation occurred	31.88 ± 3.27	32.62 ± 3.59	1.565	0.119
Gestation of the ECV was underwent	37.86 (37, 39)	37.71 (37, 39.14)	-0.06	0.952
BPD (cm)	9.15 ± 0.40	9.20 ± 0.34	1.078	0.282
HC (cm)	33.27 ± 0.93	33.26 ± 0.98	0.228	0.820
AC (cm)	32.99 ± 1.54	32.98 ± 1.65	-0.044	0.965
FL (cm)	7.05 ± 0.38	6.93 ± 0.22	-3.303	0.001
Amniotic fluid volume (cm)	12 (8.9, 16, 24)	14 (10, 19.7)	-4.46	< 0.001
Fetal weight (g)	3038.70 ± 315.95	3006.73 ± 290.49	-0.798	0.426
The station of the fetal buttocks (cm)	-3 (-4, -1)	-4 (-5, -3)	-8.916	0.000
Spontaneous version times during third trimester			12.733	0.005
0	47 (59.5)	77 (40.3)		
1	31 (39.2)	91 (47.6)		
2	1 (1.3)	16 (8.4)		
3	0 (0.0)	7 (3.7)		
Spontaneous contractions during third trimester			14.274	0.001
Frequent	14 (17.7)	10 (5.2)		
Occasional	65 (82.3)	171 (89.5)		
Never	0 (0.0)	10 (5.2)		
Contractions before ECV?			6.493	0.011
No	65 (82.3)	177 (92.7)		
Yes	14 (17.7)	14 (7.3)		
Is the outline of the uterus clear?			4.008	0.045
No	9 (11.4)	9 (4.7)		
Yes	70 (88.6)	182 (95.3)		
Fetal head location			29.893	< 0.001
11-1 o'clock	38 (48.1)	32 (16.8)		
1-2 and 10-11 o'clock	40 (50.6)	146 (76.4)		
9-10 and 3-2 o'clock	1 (1.3)	13 (6.8)		
Could the fetal head be grasped easily			36.915	< 0.001
Non- graspable	40 (50.6)	29 (15.2)		
Graspable	39 (49.4)	162 (84.8)		
Could the fetal breech be grasped easily?			93.263	< 0.001
Non- graspable	58 (73.4)	26 (13.6)		
Graspable	21 (26.6)	165 (86.4)		
Umbilical cord Around Neck			2.934	0.231
No	37 (46.8)	111 (58.1)		
1 circle	35 (44.3)	68 (35.6)		
2 circles	7 (8.9)	12 (6.3)		

Continued

and stations (divided into >30.75 cm and ≤ 30.75 cm) was 2.48, that for the fetal head locations (divided into 11-1 o'clock and 1-2 or 10-11 o'clock) was 17.82, that for the graspable fetal buttocks

Table II *(Contiued)*. Comparison of prenatal factors between the two groups.

Prenatal factors	Failure group (N = 79)	Success group (N = 191)	$t/Z/\chi^2$	*p*
Placental position (of uterus)			13.053	0.221
Anterior wall	30 (38.0)	66 (34.6)		
Flank wall	3 (3.8)	7 (3.7)		
Posterior wall	13 (16.5)	47 (24.6)		
Fundus	0 (0.0)	4 (2.1)		
Fundus and flank wall	0 (0.0)	2 (1.0)		
Anterior and flank wall	11 (13.9)	15 (7.9)		
Fundus and Posterior wall	15 (19.0)	26 (13.6)		
Flank and Posterior wall	2 (2.5)	14 (7.3)		
Fundus and Anterior wall	2 (2.5)	1 (0.5)		
Anterior, flank and posterior wall	3 (3.8)	6 (3.1)		
Anterior and posterior wall	0 (0.0)	3 (1.6)		
Relationship between the fetal back and the maternal abdominal wall			9.688	0.207
Left anterior	30 (38.0)	57 (30.0)		
Right anterior	15 (19.0)	40 (21.1)		
Left transverse	11 (13.9)	32 (16.8)		
Right transverse	2 (2.5)	23 (12.1)		
Left Posterior	3 (3.8)	3 (1.6)		
Right Posterior	4 (5.1)	7 (3.7)		
Anterior	10 (12.7)	16 (8.4)		
Transverse	4 (5.1)	12 (6.3)		
Breech presentation categories			5.923	0.314
Frank	31 (39.2)	54 (28.3)		
Both feet lie below the breech	8 (10.1)	16 (8.4)		
Complete	28 (35.4)	69 (36.1)		
One foot lies below the breech	4 (5.1)	16 (8.4)		
Transverse	2 (2.5)	12 (6.3)		
Unknown	6 (7.6)	24 (12.6)		
Is the uterus relaxed			31.144	< 0.001
Yes	33 (41.8)	147 (77.0)		
No	46 (58.2)	44 (23.0)		

ECV, external cephalic version; BMI, body mass index; BPD, biparietal diameter; HC, head circumference; AC, abdominal circumference; FL, foot length.

(in the breech position) was 8.58, and that for the graspable heads (in the breech position) was 6.62 (Table IV).

We assigned scores to the above five indicators based on the regression coefficients (Tables IV and V). Table V shows the scoring of the samples. The ECV success rate increased with increasing scores. The success rates at scores 0-1 rose from 0% to 50%-94.4% at scores 5-9 (Table VI). We divided data from the participants into low- (0-3 points), medium- (4-6 points), and high-scoring groups (7-9 points). The higher the group scores, the higher the success rates, the gestational age at delivery, and the vaginal delivery rates (p <0.001, Table VII). The preoperative score sheet predicted the ECV success rates with high accuracy (AUC, 0.885; 95% CI, 0.837 to 0.933; Figure 3).

Discussion

The Effect of ECV on Delivery

A meta-analysis of the ECV-associated risks concluded that the success rate for ECV ranged from 16% to 100%, with pooled success and complication rates of 58% and 6.1%, respectively[2]. However, in a systematic review of three and eight cohort and case-control studies, respectively, de Hundt et al[6] concluded that even after successful ECV, women with breech presentations remained at an increased risk of caesarean delivery for both obstructed labor and fetal distress compared with fetuses with cephalic presentations (OR 2.2 for both; 95% CIs, 1.6 to 3.0 and 1.6 to 2.9, respectively). In this study, the ECV success rate was 70.74%, probably because all the procedures were performed by the same expert physician. Com-

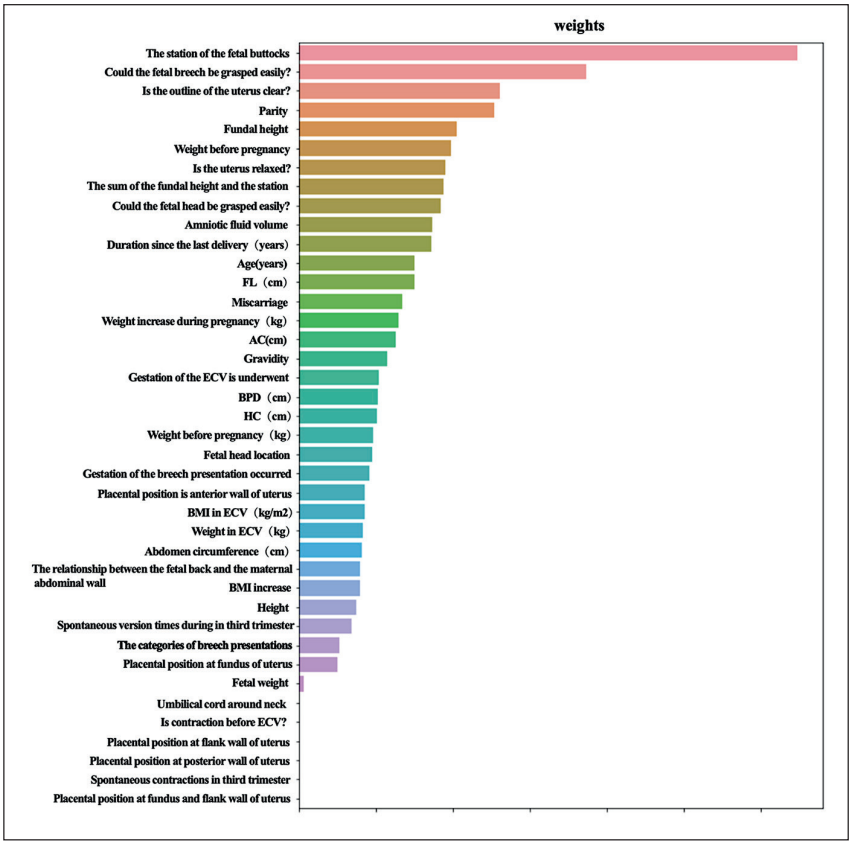

Figure 1. Weighting of prenatal factors.

pared with the failure group, the cesarean section rate of the success group was lower (23.0% *vs.* 86.1%, p=0.000); however, 25.85% of the women in the success group (38/185) still had cesarean sections during labor due to fetal distress and persistent posterior occiput or transverse posi-

Table III. Weights of prenatal factors.

Prenatal factors	Weights
The station of the fetal buttocks	0.129509
Could the fetal breech be grasped easily?	0.074759
Is the outline of the uterus clear?	0.052139
Parity	0.05076
Fundal height	0.040982
Weight before pregnancy	0.039683
Is the uterus relaxed	0.03815
Sum of the fundal height and the station	0.037614
Fetal head grasped	0.03689
Amniotic fluid volume	0.034654
Duration since the last delivery (years)	0.034545
Age (years)	0.030014
FL (cm)	0.029995
Miscarriage	0.026942
Weight increase during pregnancy (kg)	0.026036
AC (cm)	0.025236
Gravidity	0.02307
Gestation of the ECV is underwent	0.020728
BPD (cm)	0.020633

ECV, external cephalic version; BMI, body mass index; BPD, biparietal diameter; HC, head circumference; AC, abdominal circumference; FL, foot length.

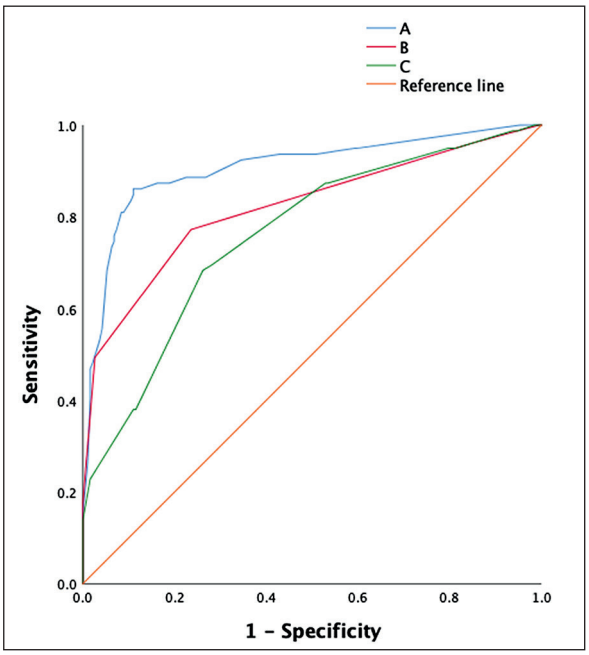

Figure 2. Receiver Operating Characteristic curve analysis. **A**, Results of multivariate logistic regression analysis for ECV outcome: sensitivity (%), 86.1; specificity (%), 89.0; AUC, 95% CI 0.907 [0.863 to 0.951]. **B**, Results with the station of the fetal buttocks for the ECV outcome: sensitivity (%), 76.40; specificity (%), 77.2; criterion, -3.5 cm; AUC, 95% CI 0.821 [0.759 to 0.883]. **C**, Results with the sum of the fundal height and the station for ECV outcome: sensitivity (%), 73.8; specificity (%), 68.4; criterion, 30.75 cm; AUC, 95% CI 0.761 [0.698 to 0.825].

tions. At the same time, a total of 48 862 women with vertex presentations accepted a trial of labor, and 2463 of them (5.04%) had cesarean sections during labor. After comparing data in these two groups, we found a p=0.000; an OR of 4.870; and a 95% CI from 3.041 to 6.973. One of the reasons for these results is that in the breech position, the fetal weight is too great, or the head size is too large to be able to pass through the maternal pelvis. In such cases a trial of labor is likely to fail even after a successful ECV.

Factors Affecting the ECV Success Rate

We reviewed a number of randomized studies that suggested that the use of tocolysis can increase the ECV success rate and reduce the cesarean section rate[7-10] but found the evidence to be inconclusive to recommend favoring the use of spinal or epidural anesthesia during ECV attempts[3]. Routine use of regional analgesia or neuraxial blockade is not recommended[5]. The effects of other factors such as the amniotic fluid volume, placental position, maternal weight, category of the breech presentation, and fetal spine direction remain controversial[11-23]. In this study, we focused on all the participants who accepted terbutaline and lubrication and did not receive anesthesia to diminish biases, and we achieve similar conclusions as those in former studies: the amniotic fluid volume, placental position, maternal weight, category of the breech presentation, and fetal spine direction are not independent factors affecting the success rate of *ECV*. However, not all the failed attempts occurred with primiparous, young, or obese women or in those with excessive weight gain during pregnancy, a low amniotic index, a persistent breech position, or

Table IV. Multivariate logistic regression analysis for ECV success.

Prenatal factors	Regression coefficients	*p*	OR (95% CI)	Scoring
Station of the fetal buttocks	1.402	0.001	4.063 (1.834, 9.001)	
> 3.5 cm				0
≤ 3.5 cm				1
Sum of the fundal height and the station	0.909	0.021	2.482 (1.148, 5.366)	
> 30.75 cm				0
≤ 30.75 cm				1
Fetal head location (reference on 11-1)		0.010		0
1-2 or 10-11 o'clock	2.880	0.027	17.816 (1.387, 228.895)	3
9-10 or 3-2 o'clock	1.789	0.158	5.983 (0.499, 71.732)	2
Could the fetal breech be grasped easily? (Reference ungraspable)				0
Graspable	2.150	0.000	8.583 (3.796, 19.406)	2
Could the fetal head be grasped easily? (Reference ungraspable)				0
Graspable	1.890	0.000	6.618 (2.826, 15.499)	2

OR, odds ratio; CI, confidence interval; ECV, external cephalic version.

Table V. Preoperative ECV score sheet.

Index	Score			
	0	1	2	3
Sum of the fundal height and the station (cm)	> 30.75	≤ 30.75	/	/
Station of the fetal buttocks (cm)	> -3.5	≤ -3.5	/	/
Fetal head location (O'clock)	11-1	/	9-10 3-2	1-2 10-11
Could the fetal breech be grasped easily?	Ungraspable	/	Graspable	/
Could the fetal head be grasped easily?	Ungraspable	/	Graspable	/

ECV, external cephalic version.

Table VI. Descriptive statistical analysis of external cephalic version rate according to scores.

Score	Sample Size (n = 270)	Number of success (n = 191)	Number of fail (n = 79)	Success rate (%)
0	11	0	11	0
1	1	0	1	0
2	15	1	14	6.7
3	27	8	19	29.6
4	9	4	5	44.4
5	28	14	14	50.0
6	36	30	6	83.3
7	30	27	3	90.0
8	41	39	2	95.1
9	72	68	4	94.4
Total	270	191	79	70.74

ECV, external cephalic version.

a hard non-contracting uterus. ECV procedures are not easy to complete and more than four attempts[24] may be needed in some cases.

Influences of the Station of the Fetal Buttocks and the Sum of the Fundal Height and Station on the ECV Success Rate

In this study, we found that the higher the level of the fetal breech above the ischial spines, the higher the success rates. The success rates were higher when the breech was not engaged so that the fetal buttocks were easily elevated from the maternal pelvis and displaced laterally by one hand. In cases in which the fetal buttocks were close to the ischial spines, the fetus had usually entered the pelvic inlet and the surgeon could not grasp it with one hand or even touch the fetal spine or abdomen, making it hard to elevate the fetus. At the

Table VII. Comparison of success rate, delivery gestation, and delivery mode among 3 groups according to χ^2 test results.

	Low-scoring group (0-3) (n = 54)	Middle-scoring group (4-6) (n = 73)	High-scoring group (7-9) (n = 143)	χ^2 (P)* χ^2 (P)#
Success rate (%)	16.67 (9/54)	65.75 (48/73)	93.71 (134/143)	113.60 (0.000)* 110.50 (0.000)#
Delivery gestation	38.88 (38.65, 39.11)	39.62 (39.37, 39.88)	40.00 (39.83, 40.16)	26.51 (0.000)
Delivery mode				54.76 (0.000)* 51.01 (0.000)#
Vaginal delivery (%)	16.67 (9/54)	58.90 (43/73)	74.83 (107/143)	
Cesarean section (%)	83.33 (45/54)	41.10 (30/73)	25.17 (36/143)	

*Difference analysis result; #trend χ^2-test results.

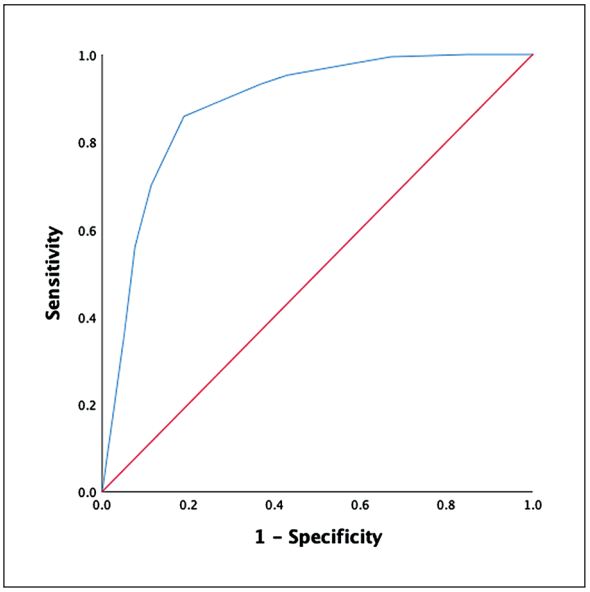

Figure 3. Receiver operating characteristic curve analysis. Results with preoperative score for ECV outcome: sensitivity (%), 85.9; specificity (%), 81.0; AUC, 95% CI 0.885 [0.837 to 0.933].

same time, under normal amniotic fluid volume conditions, the fundal height was related to the fetal weight and level of the fetal breech. The smaller the sum of the fundal height and station, the farther away the fetal buttocks were from the spine; and the lighter the fetal weight, the easier it was for the fetus to be rolled.

Does the Fetal Head Location and Ability to Grasp the Fetus Influence the ECV Success Rate?

Imagine a woman in which a presenting right sacral anterior part has the fetal head location closer to 12 o'clock on the maternal xiphoid process than to 2 o'clock, in a situation like this, the fetal body is extended and straight and is, therefore, difficult to roll the fetus forward. The inability to grasp the fetal head decreases the success rate of an ECV because in a woman with a fetal head tilted toward the maternal spine or with obesity, the surgeon cannot control the position and posture of the fetal head on the maternal abdominal wall.

Benefits of Using the Scoring Sheet

In this study, ECVs were attempted in the operating room according to the recommendations of the ACOG and RCOG. In Fuzhou (China), some women whose ECVs failed at 38 weeks of gestation chose an immediate cesarean section to save costs instead of waiting until 39-40 weeks of gestation. For pregnant women without complications, the closer the gestational age at delivery to the expected delivery date, the better the outcome for the newborn. According to our research, we designed a preoperative scoring table for ECVs aimed to improve the ECV procedure (Table V and Figure 4). Higher scores increased both the ECV success rate and the gestational age at delivery. We recommend that, in developing countries, each patient is scored before an ECV; if the score is 0-6 (the low- and medium-scoring groups), then the estimated ECV success rate is less than 70% and ECV should be offered at 39-40 weeks of gestation with the use of tocolysis and anesthesia. The cesarean section can be performed immediately if an ECV attempt is unsuccessful. If the score is 7-9 (high-scoring group), the estimated ECV success rate is more than 90% and ECV should be offered at 37-38 weeks of gestation with the use of tocolysis. The first ECV attempt should be performed without anesthesia, and if it fails, a second attempt under anesthesia should be performed. A cesarean section can be delayed until 39-40 weeks of gestation if the ECV attempts are unsuccessful.

Conclusions

ECV reduces the caesarean section rate by lowering the incidence of breech presentations at term. We created a novel scoring system to predict ECV success rates in which higher scores lead to higher ECV success and vaginal delivery rates (with higher gestational age at delivery). The scoring sheet should be used routinely to predict the ECV success rate and determine when it can be attempted to optimize the ECV procedure and reduce the number of hospitalizations and the burden on hospitals.

Conflict of Interest
The Authors declare that they have no conflict of interests.

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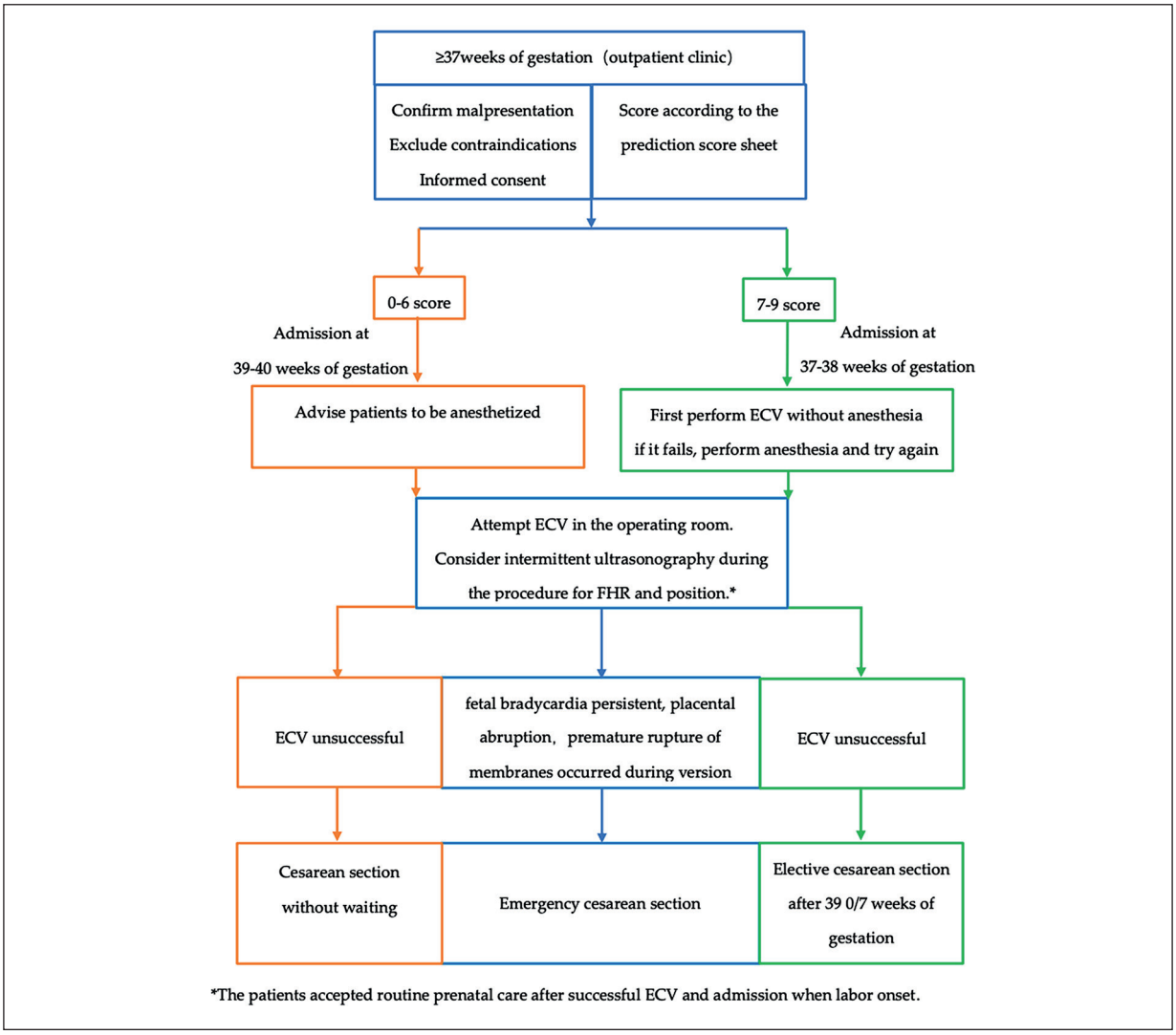

Figure 4. Algorithm for the patient management of external cephalic version.

Authors' Contribution

Conceptualization, Jianying Yan and Lianghui Zheng; methodology, Lianghui Zheng and Huale Zhang; software, Zhaodong Liu; formal analysis, Huale Zhang and Yunying Ma; investigation, Rongxin Chen; resources, Qiuping Liao; data curation, Lianghui Zheng, Huale Zhang, Yunying Ma; writing—original draft preparation, Jianying Yan and Lianghui Zheng; writing—review and editing, Lianghui Zheng and Jianying Yan; visualization, Zhaodong Liu; supervision, Rongxin Chen; project administration, Lianghui Zheng; funding acquisition, Lianghui Zheng and Jianying Yan.

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