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Assessment of factors individually and as a scoring system in predictive screening for VBAC in patients undergoing trial of labor after single previous cesarean section.

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I. Introduction

While there is increased maternal and perinatal morbidity associated with the failure of trial of vaginal birth after cesarean section (VBAC), a successful trial of VBAC reduces the risk of complications in future pregnancies, associated with a repeat cesarean section. Studies in patients attempting VBAC have shown that the highest rate of maternal complications occur in patients who have a failed attempt at VBAC, intermediate in those who have an elective repeat cesarean section and lowest in those who have a successful VBAC[1]. There is evidence to suggest that overall success of a VBAC ranges from 72-76 % [2], with factors that can increase or decrease the chances of success. Assessment of individual risks and the likelihood of VBAC can help determine appropriate candidates for trial of labor. Screening tools consider the relative effect of multiple factors to predict an individual's likelihood of vaginal delivery [3]. Majority of the scoring systems have used indication of previous cesarean, Bishops score and history of VBAC in their screening tools. Some have used other factors like maternal age, weight, inter-delivery period, estimated fetal weight and history of term/preterm cesarean section [4]. Although all these factors have been shown to influence VBAC trail outcome in some studies , they have not achieved statistical significance in other studies. All these factors have thus not been collectively included in various screening tools. Among all demographic factors analyzed ethnicity has shown to have a significant impact on the outcome of trail. Ethnicity has been shown to influence not only trial of labor (TOL) rates but also rates of VBAC. Indian patients have not had a large representation in former studies.

We aim to assess the influence of known antenatal and intrapartum factors on the likelihood of vaginal birth in Indian patients attempting trial of vaginal birth after one previous cesarean section. Many patients in developing countries present for the first time in their pregnancy when in labor. Some of the patients do not have access to optimum antenatal care and they do not have the chance to be timely assessed by a qualified clinician. The parameters influencing TOL available on admission from history and examination can collectively be evaluated to help guide the clinician and estimate the probability of success of TOL after previous one cesarean section. This can result in timely referral of patients unlikely to have a successful VBAC.

II. Materials and Methods

A prospective observational study was done in patients with previous one cesarean section delivering at our institute over a period of six months. We studied the factors influencing outcome of TOL. All patients with a singleton fetus in cephalic presentation having previously had one lower segment cesarean section, and had given an informed consent for a trial of labor were included. The exclusion criterion was multiple pregnancies, non-cephalic presentations, patients not willing for vaginal trial of labor and patients in which there was history of previous rupture uterus.

A detailed history was taken from all the participants. History of the previous cesarean section was taken. Factors that were noted for assessment were the indication for which the cesarean was performed, whether it was at term or pre-term, time interval between cesarean and the present labor, and whether there was any history of fever in the post-operative period. Operative records of previous cesarean were not available in majority of the cases, thus the technique of uterine closure and its influence on the success of trial of labor could not be assessed.

Note was made of antenatal parameters in the present pregnancy such as, maternal age, maternal weight gestational age at the time of labor and estimated fetal weight. The maternal weight on admission was taken as many patients presented late in pregnancy or in labor and there was no estimation of their pre-pregnancy weight. A clinical estimation of fetal weight was done on admission. Intra-partum parameters like type of labor (spontaneous/augmented/induced) and Bishop's score were also noted for scoring and assessment. The association of the sex of child, duration of labor and duration of augmentation was retrospectively assessed for the influence on outcome of TOL.

Each patient was scored on admission, using a set of markers for predicting vaginal delivery as given in table 1

Table 1: Proposed scoring system used for prospective assessment:

Parameter	Score 0	Score 1	Score2
Inter-delivery interval	≤1yr	1-2yrs	>2yrs
Indication of previous cesarean*	CPD	NPOL	Not dystocia
History of post-operative fever		Yes	No
Gestation at time of previous cesarean	Pre-term		Term
History of VBAC*	No		Yes
Present labor*	Induced	Augmented	Spontaneous
Maternal weight	<50kg	50-65kg	>65kg
Present gestational age		≤37wks	37-42wks
Estimated fetal weight	≤2.8kg	2.8-3.5kg	>3.5kg
Bishops on admission*	< 7		≥ 7
*statistically significant parameters Found On analysis.			

Higher score for these markers favored vaginal delivery while lower score favored LSCS. Middle score indicated unpredictability of outcome. The decision for augmentation with oxytocin was as for patients with unscarred uterus. However titration of dose of oxytocin was to a maximum of 32mU/min. Informed consent was taken prior to induction, cesarean section or assisted vaginal delivery in relevant cases. Induction was done by a single intra-cervical instillation of 0.5mg prostaglandin E2 gel with a post-induction reassessment after six hours. In case of any emergency cesarean section for failed TOL, intra operative findings were noted. Scar dehiscence was defined as when the scar had given way with a overlying intact visceral peritonem. Uterine rupture was defined as full thickness disruption of the uterine wall inclusive of the peritoneum. Finally, note was made of the outcome of TOL and associated significant maternal and fetal outcomes (rupture uterus, scar dehiscence, post partum hemorrhage, low apgar score, meconium stained liquor) were also noted.

We studied the influence of individual markers used in our scoring system on TOL outcome and analyzed the scoring system as a whole for its sensitivity, specificity and predictive value. We made a modified scoring system using only the factors reaching statistical significance individually, in our study. The performance of this scoring system (using only significant parameters) was retrospectively applied to the same cases and its performance assessed and compared.

III. Results

A total of 132 patients were included in the study. Of these 61 (46.2%) had a successful VBAC and 71 (53.8%) underwent a repeat emergency cesarean. Each patient was scored on admission based on a scoring system (Table 1.) and the results are shown in Table 2.

Table 2: Results of scoring system using all factors

Total Score	LSCS (%)	Vaginal delivery (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)	Odds Ratio	p-value
9	3	0	4.23	100	100	47.29	48.48	-	0.104
10	7	1	14.08	98.36	90.91	49.59	53.03	9.836	0.010
11	9	3	26.76	93.44	82.61	52.29	57.58	5.207	0.002
12	14	5	46.48	85.25	78.57	57.78	64.39	5.018	< 0.001
13	13	10	64.79	68.85	70.77	62.69	66.67	4.067	< 0.001
14	11	11	80.28	50.82	65.52	68.89	66.67	4.207	< 0.001
15	7	8	90.14	37.70	62.75	76.67	65.91	5.534	< 0.001
16	3	5	94.37	29.51	60.91	81.82	64.39	7.012	< 0.001
17	2	8	97.18	16.39	57.5	83.33	59.85	6.765	0.007
18	2	6	100	6.56	55.47	100	56.82	-	-
19	0	3	100	1.64	54.20	100	54.55	-	-
20	0	1	100	0	53.79	-	53.79	-	-

On analysis of score we observed that the mean total score for patients who delivered vaginally was 14.89 ± 2.35 which is significantly higher than that of patients requiring LSCS (12.82 ± 2.09). This total score calculated on the basis of scoring system in Table 1, was found to be significantly correlated with the outcome ($p<0.001$).

We analyzed the significance of individual parameters used in the scoring system in influencing outcome and found that spontaneous onset of labor, history of previous VBAC, favorable bishops on admission and previous cesarean performed for indications other than dystocia or CPD were significantly associated with a successful VBAC. (Table 3)

Table 3: Analysis of factors used in the scoring system

Para meter		NVD	LSCS	Chi square p-value	Odds Ratio in favor of LSCS (95% Confidence interval)
Weight (kg)	>65	6 (9.8%)	13(18.3%	0.321	2.053 (0.74, 5.714)
	50-65	41(67.2%)	46 (64.8%)		0.898 (0.435, 1.848)
	<50	14(23.0%)	12 (16.9%)		0.682 (0.289, 1.61)
Previous CS	Term	2 (3.3%)	6 (8.5%)	0.214	2.725 (0.56, 13.158) (in favor of Term)
	Pre-term	59 (96.7%)	65 (91.5%)		
Expected BW	2.8-3.5kg	31 (50.8%)	39 (54.9%)	0.637	1.179 (0.594, 2.342) (in favor of 2.8-3.5kg)
	<2.8kg	30 (49.2%)	32 (45.1%)		
Labor	Induced	9 (14.8%)	25 (35.2%)	0.024	3.145 (1.359, 7.246)
	Augmented	10 (16.4%)	11 (15.5%)		0.935 (0.364, 2.381)
	Spontaneous	42 (68.9%)	35 (49.3%)		0.44 (0.217, 0.893)
Prev.VBAC	No	49(80.3%)	67(94.4%)	0.017	4.102 (1.335, 12.658) (in favor of NO)
	Yes	12(19.7%)	4 (5.6%)		
Prev cs indication	CPD	2 (3.3%)	7 (9.9%)	0.048	3.226 (0.695, 14.925)
	Dystocia	6 (9.8%)	15 (21.1%)		2.457 (0.907, 6.667)
	Other	53 (86.9%)	49 (69%)		0.336 (0.806, 0.14)
Interdelivery interv.	≤1yr	7(11.5%)	12(16.9%)	0.521	1.57 (0.579, 4.255)
`	1-2yr	9 (14.8%)	13 (18.3%)		1.295 (0.512, 3.268)
	>2yr	45 (73.8%)	46(64.8%)		0.654 (0.31, 1.381)
Gestational age	<37wks	9(14.8%	8(11.3%)	0.551	0.733 (0.265, 2.033) (in favor of < 37wks)
	37-41wks	52(85.2%)	63(88.7%)		
Bishops score	< 7	27 (46.6%)	55 (82.1%)	< 0.001	5.262 (2.412, 11.483) (in favor of < 7)
	7≥	31 (53.4%)	12(17.9%)		
	Mean ±SD	6.41 ± 1.97	4.33 ± 2.34	< 0.001*	-
Maternal age	Mean ±SD	26.28 ± 3.77	26.6 ± 3.81	0.630*	-
History of post-op fever		2 (3.3%)	2 (2.8%)	0.877	0.855 (0.117, 6.247)

The overall success of trial of labor had no significant correlation with maternal or fetal weight, period of gestation at the time of labor, duration of labor, or the inter-delivery period There was no correlation of successful VBAC with maternal age (p=0.630). Average age of the patients undergoing VBAC was 26.28 ± 3.77 yrs and of those undergoing repeat cesarean section was 26.6 ± 3.81yrs. The average birth weight for VBAC was 2.69 ± 0.41 kg as against 2.72 ± 0.52 kg for repeated CS and had no significant effect (p-value = 0.365) on labor outcome. Of the 19 mothers weighing more than 65kg thirteen (68.4%) had repeat LSCS but the effect of maternal weight on outcome of labor was not found to be statistically significant.

The odds ratio of having a vaginal delivery after spontaneous onset of labor was 2.27 as compared to 0.32 for induced labor and 1.07 for labor requiring augmentation with oxytocin. The number of patients who had induction of labor was 34 (25.7%) of which 73.5% underwent a repeat cesarean section. Twenty five of the 34 (73.5%) patients in whom induction of labor was done had a repeat cesarean section whereas 54.5% of the patients in spontaneous labor had a successful VBAC. This was found to be statistically significant (p=0.024)

In our study, there was a significant association between history of previous vaginal birth after cesarean and successful outcome. Patients with no history of previous vaginal delivery after cesarean section were 4.102 times (p-value = 0.015) more likely to have an unsuccessful trial of labor compared to women who had history of VBAC.

The influence of indication of previous cesarean section on outcome of trail of labor was found to be statistically significant (p= 0.048). The odds ratio for a LSCS in patients who underwent previous cesarean for indications other than CPD or dystocia was 0.336 compared to 3.226 for those patients who were operated for CPD and 2.456 for those who were operated for dystocia. There were nine patients in whom the previous cesarean was done for CPD .Of these 7 (77.8%) had a repeat cesarean section. Of the 21 patients who had had a previous cesarean for cervical dystocia 15 (71.4%) had a repeat cesarean section. Further, the bishops score on admission was found to be significantly correlated with the outcome of the TOL (p<0.001).The bishops score for patients who had a successful trail of labor was 6.41 ± 1.97 which was significantly higher than that of the patients who had repeat LSCS, where the score was 4.33 ± 2.34. A bishops score of greater than 7 was associated with an 17.9% increased likelihood of VBAC.

The mean duration of active labor in the patients having successful VBAC was 10.5 ± 5.7 hrs and in those having a repeat cesarean section was 8.6 ± 3.6 hrs. This difference was not found to be statistically significant .The mean duration of augmentation with oxytocin was 10 ± 5.1 hrs in VBAC group and 6.3±3 hrs in the repeat LSCS group. This difference was also not found to be statistically significant. Majority (30.9%) of the repeat cesarean sections were done for non progress of labor, 25.4% were done for fetal distress (non reassuring CTG), 14% for thick meconium stained liquor. Eight repeat cesareans were for failed induction, four for maternal tachycardia and scar tenderness, three were done for suspected scar dehiscence or rupture uterus, two for cephalo-pelvic disproportion and one each for second stage arrest, compound presentation and cord prolapse. Intra-operatively eight (6%) patients had scar dehiscence and six (4.5%) had rupture uterus. The details of these cases are shown in Table 4.

Table 4: Rupture uterus cases

	Indication of previous LSCS	Present labor	H/O VBAC	Inter delivery interval	Duration of labor	Indication of Em. LSCS
Case-1	Cervical dystocia	Induced followed by 6 hrs augmentation	no	>2yrs	6 hrs	Meconium stained liquor with fetal distress
Case -2	Other than dystocia or CPD	spontaneous	yes	>2yrs	4hrs active phase	Suspected rupture uterus in active phase.
Case-3	Other than dystocia or CPD	spontaneous	no	<1yr	Latent labor for >24hrs	Bleeding PV with fetal distress, poor bishops and precious pregnancy.
Case -4	Other than CPD or dystocia	spontaneous	no	<1yr	5hrs active phase	Suspected rupture in active phase.
Case -5	Cervical dystocia	spontaneous	no	>1yr	12hrs active phase	Fetal distress in second stage.
Case -6	Other than CPD or dystocia	spontaneous	no	<1yr	10hrs active phase	Suspected rupture in second stage

Five of the six patients with uterine rupture were admitted in spontaneous labor. There was no history of VBAC in all but one patient .Two of these six patients (case 3 and 4, Table 4) had pre term labor pains (<37 wks) with an inter-delivery interval of less than a year and no history of previous VBAC. First had a previous elective cesarean for nuchal cord and had presented in the latent phase of labor. The second patient had a rupture uterus in active phase of labor. Her previous cesarean was done for ante-partum hemorrhage.

Of the eight patients who had scar dehiscence, it was observed that 4 (50%) were having augmentation of labor with oxytocin. Seven of them had had a previous pre term cesarean section .Five of the patients had a repeat cesarean for non progress of labor, one for scar tenderness ,one for fetal distress and one for thick MSL.. Apgar score less than 7 at one minute of birth was seen in 8 cases, of which one was an intrauterine death due to rupture uterus. All eight patients had a cesarean section. There was one early neonatal death due to meconium aspiration syndrome. Postpartum hemorrhage occurred in 8 patients (all in the repeat LSCS group). There was no maternal death.

With the aim of increasing the sensitivity of our scoring system and applying the results of our analysis, we retrospectively evaluated the same group of patients using a modified screening tool. This scoring system was the same as our original proposed tool but incorporating only the significant parameters (Bishops, history of VBAC, type of labor, indication of previous cesarean section) from our analysis. With a total score calculated using only significant parameters, a correlation with outcome was again established (p-value < 0.001).Table 5.

Table 5: Results of scoring system using only significant factors

Total Score (significant parameters)	LSCS (%)	Vaginal delivery (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)	Odds Ratio	p-value
0	1	0	1.41	100	100	46.56	46.97	-	0.704
1	7	1	11.27	98.36	88.89	48.78	51.52	7.619	0.057
2	22	7	42.25	86.89	78.95	56.38	62.88	4.848	<0.001
3	11	4	57.75	80.33	77.36	62.03	68.18	5.581	<0.001
4	16	15	80.28	55.74	67.86	70.83	68.94	5.127	<0.001
5	6	6	88.73	45.90	65.63	77.78	68.94	6.682	<0.001
6	7	19	98.59	14.75	57.38	90	59.85	12.115	0.008
7	0	5	98.59	6.56	55.12	80	56.06	4.912	0.245
8	1	4	100	0	53.79	-	53.79	-	-

The mean total score (significant parameters only) for vaginal delivery was 4.89 ± 1.75 which was significantly higher than that of LSCS (3.29 ± 1.62) as shown in Table 6.

Table 6: Correlation of outcome with both scoring systems:

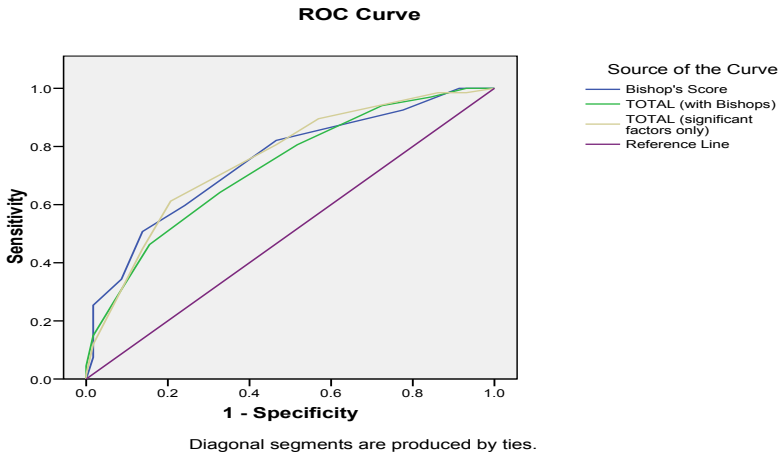
Outcome	N	Mean Score	Std. Deviation	p-value
Total score(all parameters) NVD				
LSCS	61	14.8852	2.35300	.000
Total	71	12.8169	2.09291	
	132	13.7727	2.43884	

Total score(sig parameters) NVD				
LSCS	61	4.8852	1.75213	.000
Total	71	3.2113	1.62054	
	132	3.9848	1.87382	

In order to find the critical value of the total score for predicting the outcome we note that a score in excess of 4 provides a sensitivity of 80.28% and specificity of 55.74% in favor of vaginal delivery. A score of 5 or higher yields greater sensitivity of 88.73% while decreasing the specificity to 45.9% .(table 5) For the total score using all parameters the critical value of ≥ 14 to predict vaginal delivery yields a sensitivity and specificity of 80.28% and 50.82% respectively. Extending this critical value to ≥15 increases the sensitivity to 90.14% while decreasing the specificity to 37.7 %.(Table 2)

In order to carry these correlations further and also to determine the critical values of these two calculated totals (all parameters and significant parameters) that will ensure greater sensitivity and specificity while predicting the outcome, ROC curves are made and given in figure 1 .

Figure 1:-



The areas under the ROC curve for total (all parameters) and total (significant parameters) is 72.6% and 75.5% respectively which is significantly greater than the line of equal distribution (p<0.001). Moreover we note that the total score with significant parameters has a higher area under the ROC curve as compared to total (all parameters) thus pointing towards a better balance between sensitivity and specificity (Table 7)

Table 7: Area under ROC curve

Test Result Variable(s)	Area	Std error[a]	Asymptotic Sig[b]	Asymptotic 95% Confidence Interval	
				Lower bound	Upper Bound
Bishop's score	0.749	0.043	.000	0.664	0.834
Total (all factors)	0.726	0.045	.000	0.639	0.814
Total (significant factors only)	0.755	0.043	.000	0.671	0.840

a. Under the non parametric assumption
b. Null hypothesis

IV. Discussion

There have been studies that have assessed individual parameters on outcome on trial of labor. Others have assessed scoring tools. No two scoring systems have been completely identical in terms of the parameters chosen to score. Since the VBAC report published in 2003 [(5)] new scored models have been created and evaluated to identify women for suitable for VBAC [(6, 7, 8, 9, 10)] none of the tools have the discriminating ability to consistency identify women who are risk for a repeat cesarean section.

Regarding the study of individual parameters various clinical and non clinical factors have been studied in the past. Maternal age has been examined by a number of studies as a factor influencing the success of VBAC with mixed evidence emerging from some studies. [(11, 12, 13, 15, 6)] The overall inference of maternal age on outcome of TOL appears to be that younger women are more likely to have a successful VBAC, particularly women under the age of 40years. [(13)] A prospective cohort study showed that increased BMI at delivery (greater

than 30) results in a decreased likelihood of VBAC [15,6] In our study there was no significant influence of maternal age, or weight on TOL outcome. This could be due to small sample size and younger maternal age in the study group.

A case control study has found that with gestational age greater than 36 weeks, the likelihood of VBAC significantly decreases with each week [16]. However, there was no influence of gestational age on outcome in our study. Similarly, some studies have shown that higher birth weights

(>4kg) were associated with reduced chances of successful VBAC [17, 18]. In the present study birth weight had no significant effect on the outcome of TOL.

We saw that the likelihood of vaginal delivery increased by 2.97 times (p-value = 0.015) in women who had their previous cesarean done for indications other than dystocia or CPD. This finding is in line with the results of a meta-analysis of indicators for success of labor after previous cesarean section. In the meta-analysis it was seen that women with a previous caesarean done for CPD had the lowest success rates of trials of labor and those with history of previous vaginal birth had a higher likelihood of VBAC success[19]The same study also showed a decreased success of labor requiring augmentation with oxytocin. In our study, however the success of labor did not vary significantly in the augmentation group. Based on past studies, induction of labor with prostaglandins has been associated with an increased risk of uterine rupture and failure of TOL. However, there have been two studies which have found no association with uterine rupture and the use of prostaglandins for induction [20] [21] In our study though induction of labor was significantly associated with failure of trail of labor, it was not significantly associated with uterine rupture or scar dehiscence

Cervical factors, in terms of dilatation and effacement have been studied together and individually in studies and have been found to be useful in predicting vaginal birth [22] .It is seen that cervical effacement before induction of labor was associated with a successful vaginal delivery. Flamm [13] demonstrated that a cervical dilation of greater than 4 cm increases the chance of VBAC. Bishops score has already been identified by many researchers as a significant predictor of outcome and is used in scoring tools to predict outcome of pregnancies with previous LSCS [12, 7]. We used Bishops score at admission and found it to be a significant factor influencing VBAC .Weinstein et al [12] conducted a ten year retrospective cohort and concluded the bishops score >4 ,was the strongest and most significant predictor for a successful vaginal birth after cesarean section. A favorable cervix increased the chances of successful vaginal birth by a factor of 6 after adjusting for confounding variables.Bujold et al[7] found that a bishop score of more than 6 increased the likelihood of vaginal birth by 2 times. The likelihood of vaginal birth in patients with bishop score more than 7 on admission is 17.91% in our study.

In a large multicentre study by Flamm [13] a history of vaginal delivery after cesarean section increased the likelihood of VBAC by 7.7 times [3]. Studies have shown that the likelihood of successful trail of labor in women with zero, one, two, three, and four or more prior VBACs is 63.3, 87.6, 90.9, 90.6, and 91.6 percent ($p<0.001$), respectively [23] .

In a study addressing the effect of inter-delivery interval on the success of VBAC it was seen that a short inter delivery interval (<19 months), was associated with a decrease in the success rate of VBAC in patients whose labor was induced. A difference was not found in those who underwent spontaneous labor [24].In our study there was no significant correlation with inter-delivery interval and success of VBAC. In another study a short inter-delivery interval of less than 24 months was associated with a significantly higher risk of uterine rupture[25] [26] This correlation was also not observed in the six cases of uterine rupture and eight cases of scar dehiscence seen in our study. The limiting factor could be the number of cases studied and larger study group is required to derive conclusions.

Whether the previous cesarean was term or preterm and the inter-delivery period have not been included in the scoring systems in the past. In our study both these factors did not reach statistical significance, however a larger study is required to draw conclusions.

In evaluating the performance of screening tools, the studies report inconsistent accuracy for predicting overall delivery route (Gonen,2004: 84.3%[8]; Weinstein,1996: 80%;[22] Macones,2001 71.9%[27]).In a decision analysis [28] it was suggested that a scored model would be most useful clinically if it achieved a sensitivity and specificity of over 85%.Our study does not meet this cut off but a larger number of patients would be required to reassess.

Inclusion of all available patient parameters in the scoring system can fully individualize the risk estimation for each patient but cannot achieve the higher sensitivity as when using only statistically significant parameters .We found that the scoring system using significant parameters with critical cut off value at ≥ 5 was better than the scoring system using all parameters with critical cut off ≥ 15 in predicting vaginal delivery due to the following reasons:

1) Positive predictive value for scoring system based on significant parameters is 65.63% while that based on all parameters is 62.75%.

2) Negative predictive value for scoring system using significant parameters is 77.78% while that using all parameters is 76.67%
3) Diagnostic accuracy of scoring with significant parameters is 68.94% as compared to 65.91% for the scoring using all parameters.
4) If the total score (using significant parameters) is ≥5 the odds in favor of vaginal delivery increase by a significant 568.2% while for total (using all parameters) ≥15 it is 453.4%

V. Conclusion

Previous cesarean section remains one of the major indication of a repeat cesarean section and at the same time some failed trials of labor can end in disastrous consequences. There can be no consistent and accurate scoring system but an attempt to screen patients for their suitability for TOL is important. Scoring systems can help screen patients objectively. This study attempts to highlight this and also recognizes that more number of patients are required to draw definitive conclusions. However, VBAC remains a safe option provided patients are correctly selected and monitored.

Conflict of interest- There is no conflict of interest.

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