Original Article

FETAL FIBRONECTIN AS A PARAMETER FOR PREDICTION OF SUCCESSFUL INDUCTION OF LABOUR

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ABSTRACT

Background: Induction of labor is a method of artificially stimulating labor before spontaneous labor, with Fetal Fibronectin fFN being identified as a signal for term labor and delivery. **Aim:** To identify a parameter for predicting successful labor induction, reduce maternal and neonatal morbidity in patients undergoing labor trials, and assist medical staff in predicting vaginal delivery. **Patients and Methods:** A prospective case-series study involved 100 pregnant women who visited the Obstetrics and Gynecology department at Al-khansaa teaching hospital during labor. Data collection was conducted using a questionnaire form, followed by abdominal and pelvic examination. A 3-4 ml liquor sample was collected from the posterior fornix after rupture membrane rupture and sent for fFN detection. **Results:** The correlation between Bishop Score and fetal fibronectin showed a direct but weak correlation (r=0.217) with statistically significant association (p=0.034). The ROC test for the fetal fibronectin in relation to the Bishop score revealed that the area under the curve (AUC) was 0.668 with statistically significance (p=0.012). The statistical characteristics of fetal fibronectin showed that, at the cut-off point of (36.04); the sensitivity is 76.0%, while the specificity is 60.3%. Positive and negative predictive values are 65.6% and 71.5% respectively. **Conclusion:** The study found that detecting fetal fibronectin in cervicovaginal secretions can indicate disruption of the choriodecidual interface, potentially indicating a vaginal birth delivery route, with a statistically significant AUC of 0.668, unlike previous studies.

KEYWORDS: Fetal Fibronectin, Labour Induction, Predictive Parameter.

INTRODUCTION

Induction of labor (IOL) is a method of stimulating labor prematurely or artificially before spontaneous labor, with an increased incidence in recent decades due to increasing evidence of fetal risks from 41 weeks and beyond. IOL is typically done to reduce maternal and fetal morbidity or mortality, when the risks of continuing the pregnancy are greater than the risks of planned birth. For example, women are often induced for prolonged pregnancy to reduce stillbirth risk.[1,2]

Labor induction is a procedure where the risk of pregnancy continuation outweighs the risk of induced labor and delivery. Factors influencing success include Bishop score, parity, BMI, maternal age, estimated fetal weight, diabetes, and fetal fibronectin. Studies show a decreased rate of failed induction and cesarean section when women have an unfavorable cervix or obesity.[3]

Pharmacological techniques for inducing labor include oxytocin and oral and vaginal prostaglandins. If there are no restrictions, vaginal prostaglandin E2 (PGE2) is the suggested technique. Despite having comparable effectiveness, oral misoprostol seems to be safer than vaginal misoprostol. Depending on the mother's health, cervical examination, parity, prior delivery method, and fetal characteristics, labor induction may be carried out for either maternal or fetal causes. Labor induction is currently advised by the Royal College of Obstetricians and Gynecologists at 41 full weeks of pregnancy.[4-6]

Fibronectin is a high-molecular weight (250 kDa subunit) component of the extracellular matrix in deciduous basalis that through binding integrities receptor of the cell surface act as a key player of communication between intra and extra cellular environment thus controlling cell behavior as one of its

function.[7,8] Fibronectin also binds to other extracellular matrix proteins such as collagen, fibrin, and heparan sulfate proteoglycans. FN divided in two types plasma Fn and cellular FN, and exists as a protein dimer, consisting of two nearly identical monomers linked by a pair of disulfide bonds.[9,10] Fibronectin is a crucial protein involved in coagulation, wound healing, cell adhesion, growth, migration, differentiation, and embryonic development. Its onco-fetal domain contains alpha-N-acetylegalactosamine. Plasma fibronectin forms blood clots at injury sites, protecting the underlying tissue. Fibroblasts and macrophages repair the area, degrading the provisional blood clot matrix. Fibroblasts secrete proteases to digest plasma fibronectin, assembling it into an insoluble matrix. Fragmentation of fibronectin promotes wound contraction and is a significant serum biomarker in patients with pulmonary hypertension.[11]

Numerous studies have recently identified fetal fibronectin (fFN) as a signal for the start of term labor and delivery. The amnion and the region between the decidua parietalis and the chorion contain fFN, which is found in high concentration in the amniotic fluid.[3] fFN leaks in large amounts from the choriodecidual interface via the cervix and into the vagina prior to the start of labor. Fast-reacting fFN detection assays, both quantitative and qualitative, have been the focus of extensive research in recent years.[12]

The release of fibronectin from the junction between the chorion and the decidua is employed in tests to predict preterm labor. Fibronectin and elastin are also seen among the collagen fibers. In order to promote the commencement of labor and permit dilatation, the cervix must undergo a number of modifications. This process, called cervical ripening, causes the cervix to become malleable and soft as a result of a number of intricate biochemical interactions. Cervical collagenase, elastase, and hyaluronic acid levels rise in the latter stages of pregnancy. This results in an increase of water molecules which intercalate among the collagen fibers.[13] The current study aimed to assess another biomarker for prediction of successful induction of labour.

PATIENTS AND METHODS
Study design, setting, and data collection time
A prospective case-series study recruited 100 pregnant women who attended at time of labor to the Obstetrics and Gynecology department at Alkhansaa teaching hospital which contains 100 beds specialized for obstetrics/gynecology /medical and surgical pediatric specialty at Nineveh Health Directorate, Mosul, Iraq. The data collection period extends from 20th of December 2021 to the 1st of June 2022. A sample of 100 pregnant women of reproductive age group (15-49 years old according to WHO) were included in the study after meeting the inclusion criteria. The verbal and written consent was taken from every pregnant woman before taking liquor sample and includes: 100 pregnant women

with intact membrane carrying these following criteria indicated for induction of labour.

The study included primigravida and multiparous women, pregnant singleton women with gestational age over 37 weeks, with oligohydramnia and decreased fetal movement. Exclusion criteria included chronic hypertension, diabetes mellitus type 1 and 2, cardiovascular disease, multiple gestations, previous uterine scars, and contrainduction for labor.

Gestational age was determined by last menstrual cycle if it was regular in some women, while the first trimester ultrasonography was used in others alternatively when the cycle irregular. A questionnaire form was used to facilitate data collection followed by general; abdominal and pelvic examination to assess bishop score with regard of unfavorable cervix suitable for induction of labour to compare with fetal fibronectin. Blood sample was taken from all participants for blood group. After performing general abdominal and pelvic examination to determine that the patient was admitted due to decreased fetal movement or prolonged pregnancy and that she met the criteria for pharmacological labour induction with unfavorable cervix, Obstetrician started to give her vagiprost 25 mcg when uterine contractions started or cervical dilation reached the situation allowing obstetrician for doing ARM so the patient transferred to the labour ward where she underwent Artificial Rupture of Membranes in the lithiotomy position under sterile technique Sample of liquor collected by sterile syringe put it in plain tube after hygiene situation made to patient at time of artificial rupture of membrane from post fornix about 3-4 ml then the sample transported to lab in which centrifuge done for twenty minutes.

The filtrate part of the sample was taken in to new tube for assessment and then the filtrate part freeze at temperature ≤23degree centigrade until to be sent later for laboratory testing. At the end result some of the patients delivered by vaginal delivery and other by caesarean section follow up was done for all and for the new borne baby by Apgar score. The method of fibronectin estimation was done by the use of Enzyme-Linked Immunosorbent Assay (ELISA) method using (Rayto device).

Statistical analysis
The data collected during the study were summarized in sheets of Microsoft Excel 2010. The statistical analysis performed by using Statistical Package for Social Science (IBM-SPSS 20). The normality of these data tested by Shapiro-Wilk test, and the Chi square test, t-test for one sample mean, and one way ANOVA tests were used. The Pearson's correlation coefficient was used to investigate the relationship between fetal fibronectin levels with Bishop Score. The "r" is correlation coefficient, values close to 1 indicate strong correlation between two variables and those close to zero indicate poor correlation. Receiving operating curve (ROC) test

was performed to find the area under curve (AUC) with cut-off point, sensitivity, specificity, positive, and negative predictive values. The AUC indicators were; 1.000-0.900 excellent, 0.900-0.800 good, 0.800-0.700 fair, 0.700- 0.600 poor. The p-value ≤ 0.05 considered as significant.

RESULTS

The distribution of age groups among the study sample showed that the mean age was 24.89±5.11 years; the age group (20-25 years) was the most frequent group representing 39.0% of the study sample while the age group (≥35 years) is the least frequent group. Concerning the occupations, the 97.0% of the sample are housewives and the remaining 3.1% are students as showed in table (1).

Table 1: Demographic characteristics of study sample.

Age parameter		Mean ± SD
Age (Mean ± SD)/ years		24.89±5.11
Age groups		**No. (%)**
<20 years		14(14.0)
20-<25 years		39(39.0)
25-<30 years		25(25.0)
30-<35 years		18(18.0)
≥35 years		4(4.0)
Occupations	Housewives	97(97)
	Students	3(3.0)

The anthropometric characteristics of the study sample demonstrated that the mean of maternal body weight was 24.19 with a range of 18.0-36.0. The normal BMI was found in 58.0% of the sample, overweight in 33.0% while obese was only in 9.0% as showed in table (2).

Table 2: Anthropometric characteristics of the study sample.

BMI	Mean	Range
	24.19	18.0-36.0
Classification of BMI	**No.**	**%**
Normal (20-24.9)	58	58.0
Over weight (25-29.9)	33	33.0
Obese (≥30)	9	9.0

The obstetric variables of the study sample showed that 83.0% have gravidity <5 and 17.0% have gravidity ≥5. Women with parity <5 are 93.0% while those with parity ≥5 are 7.0%. The abortion presents in only 6.0% of the study sample as shown in table (3).

Table 3: Obstetric variables of the study sample.

Obstetric variables		No. (%)
Gravidity	1-4	83 (83.0)
	≥5	17 (17.0)
Parity	0-4	93(93.0)
	≥5	7(7.0)
Abortion	No	94(94.0)
	Yes	6(6.0)

The menstrual variables among the study sample demonstrated that the interval between cycles ≤ 24 days was 6.1%, 25-30 days interval was 64.0%, 30-35 days interval was 13.0%, and ≥ 35 days intervals was 17.0%. The duration of menstrual phase <5 was 42.0% and ≥5 was 58.0%. Concerning the regularity, 74.0% of the sample has regularity while 26.0% irregular. Normal menstrual cycle was found in 92.0% of the study sample and severe bleeding in only 8.0% as showed in table 4.

Table 4: Menstrual variables.

Menstrual variables		No. (%)
Interval	≤ 24	6(6.0)
	25-29	64(64.0)
	30-34	13(13.0)
	≥ 35	17(17.0)
Duration	<5	42(42.)
	≥5	58(58.0)
Regularity	Regular	74(74.0)
	Irregular	26(26.0)
Severity of bleeding	Normal	92(92.0)
	Severe	8(8.0)

The Bishop score among the study sample showed that the position of cervix distributed as 13.0% anterior, 40.0% medium, and 47.0% posterior. The dilatation of cervix <1cm was found in 12.0%, 1-2cm in 73.0%, 2-4 cm in 2.0%, and >4 cm in 13.0% of the study sample. Firm consistency of cervix found in 35.0%, medium found in 57.0%, and the soft cervix found in only 8.0%. Regarding the effacement of cervix, 25.0% of the study sample had 0-30%, 68.0% had 40%-50%, and 7.0% had 60-70%. Concerning the station of cervix, 32.0% of the study sample were -2, while 68.0% were -3 as showed in table (5).

Table 5: Bishop score distribution among the study sample.

Bishop score distribution		No. (%)
Cervical Position	Anterior	13(13.0)
	Medium	40(40.0)
	Posterior	47(47.0)
Cervical Dilatation	Closed	12(12.0)
	1-2cm	73(73.0)
	3-4 cm	2(2.0)
	5-6	13(13.0)
Cervical Consistency	Firm	35(35.0)
	Medium	57(57.0)
	Soft	8(8.0)
Cervical Effacement	0-30%	25(25.0)
	40%-50%	68(68.0)
	60-70%	7(7.0)
	80.0%	------
Station of the presenting part	-3	68(68.0)
	-2	32(32.0)
	-1, 0	------
	+1,+2	------

Decreased fetal movement found in 78.0% of the study

sample, Oligohydramnios in 9.0%, and Post date in 13.0% with statistically significant difference (p=0.000). The episiotomy was done in 46.0% of the study sample but with no significant difference. Vaginal

delivery was found in 87.0% of the study sample while CS was found in 13.0% with statistically significant difference (p=0.000) as showed in table (6).

Table 6: Indications of labor and mode of deliveries among study sample.

		No. (%)	p-value*
Indications of labour induction for IOL	Decreased F.M.	78(78.0)	**0.000**
	Oligohydramnios	9(9.0)	
	Prolonged pregnancy	13(13.0)	
Episiotomy	Yes	46(46.0)	0.592
	No	41(41.0)	
Mode of delivery	Vaginal delivery	87(87.0)	**0.000**
	CS	13(13.0)	

*Chi square test has been used

Among the 13 women who delivered by CS, the causes distributed as 7, 3, 2, and 1 were due to NPOL in 1st stage (active phase), 2nd stage- NPOL, FOI in 1st stage

(latent phase), and fetal distress respectively as shown in figure (1).
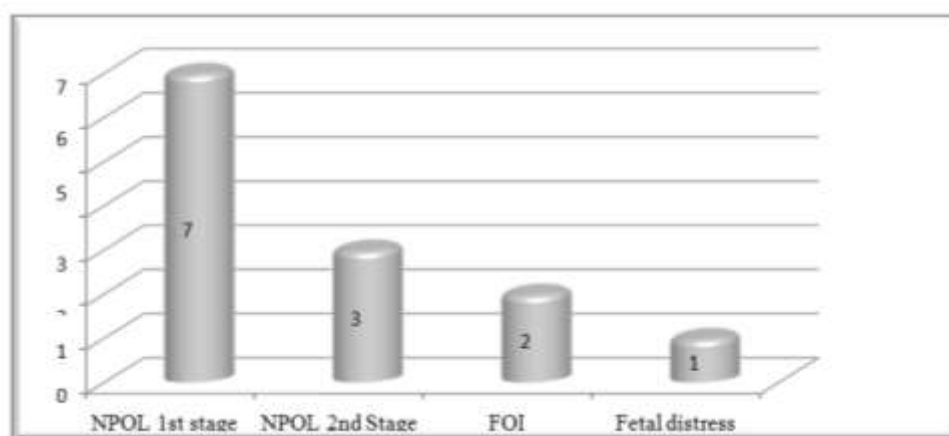
Figure 1: Causes of CS among study sample.

The fetal outcomes among the study sample were shown in table (7); the neonatal weight <2500 g found in 4.0%, weight between 2500-3999 g found in 91.0%, and above

4000 g in 5.0%. Moreover, the Apgar score of the study sample at 1 min was 5.92±0.820 and at 5 min was 7.95±0.751.

Table (7): Neonatal outcomes among the study sample.

Neonatal weight	No.	(%)
<2500	4	4.0
2500-3999	91	91.0
>4000	5	5.0
APGAR score	Mean	SD
At 1 min	5.92	0.820
At 5 min	7.95	0.751

The distribution of study sample according to Bishop score was demonstrated in figure (2) where 42.0% of the study sample had Bishop score 4 and 19.0% had Bishop

score 5. Only 2.0% of the study sample had Bishop score 0.
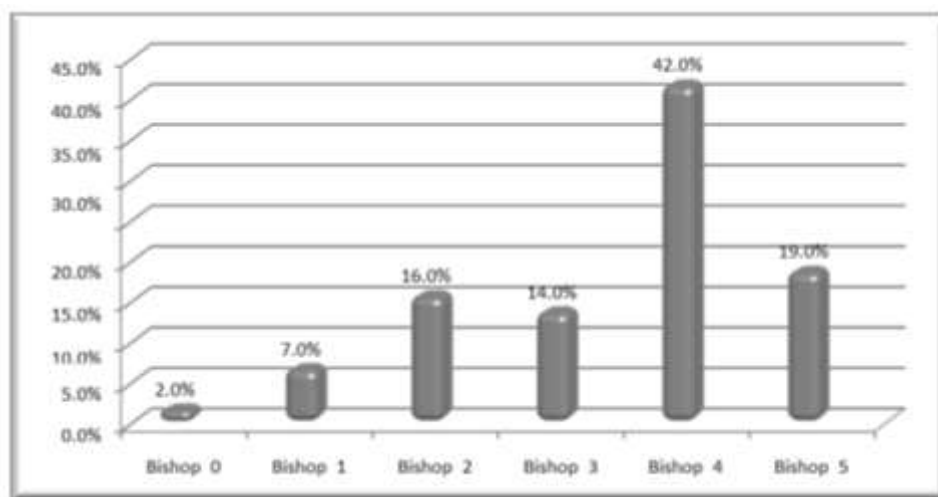
Figure (2): Distribution of the study sample according to the Bishop score.

The comparison of fetal fibronectin level according to the Bishop Score of the study sample was demonstrated in table (8) and revealed an insignificant statistical difference.

Table 8: Comparison of fetal p level according to the Bishop Score.

		Fetal fibronectin ng/ml		*P*-value*
		Mean	Standard Deviation	
Bishop Score	0	28.65	10.68	0.193
	1	33.16	11.73	
	2	32.70	6.99	
	3	31.62	8.06	
	4	39.44	14.46	
	5	37.45	12.75	

*One way ANOVA

Pearson's R correlation between Bishop Score and fetal fibronectin ng/ml showed a direct but weak correlation (r=0.217) with statistically significant association (p=0.034) as figure (3).
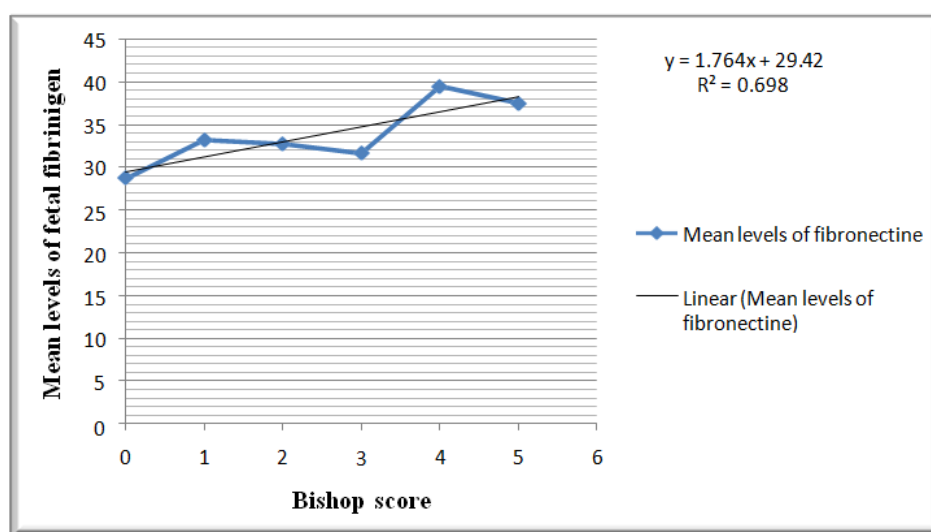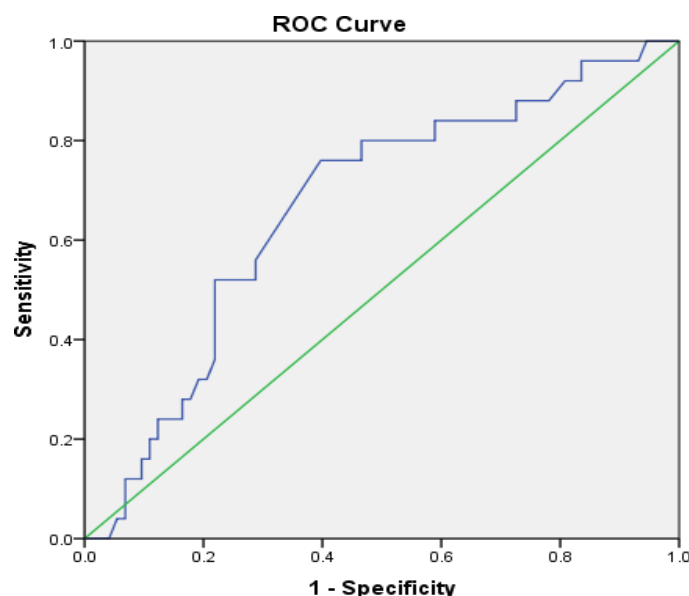

Figure 3: Scatter diagram of Bishop Score and fetal fibronectin.

The ROC test for the fetal fibronectin in relation to the Bishop score revealed that the area under the curve (AUC) was 0.668 with statistically significance (p=0.012) as showed in and figure 4.

Figure (4): ROC test and AUC of fetal fibronectin.

The statistical characteristics of fetal fibronectin showed that, at the cut-off point of (36.04); the sensitivity is 76.0%, while the specificity is 60.3%. Positive and negative predictive values are 65.6% and 71.5% respectively as demonstrated in Table 9.

Table 9: The statistical characteristics of fetal fibronectin.

Cut-off point	Sensitivity	Specificity	PPV	NPV
36.04	76.0%	60.3%	65.6%	71.5%
PPV= Positive predictive value; NPV= Negative predictive value				

DISCUSSION
The presence of fFN in amniotic fluid samples offers a new indicator for labor prediction and successful labor induction. Compared to the Bishop score, fFN tests have higher sensitivity, specificity, and objectivity. This study aims to address the lack of reliable laboratory tests for labor onset, which leads to women being transferred to cities and inpatients, increasing healthcare costs and negatively impacting their health.[14]

The present study found that the mean of maternal age was 24.89±5.11. Which was parallel to that reported by Uygur *et al.,* study[15] in which, the maternal age was 23.3±4.5 ranging from (17–34) years. The normal BMI was found in 58.0% of women involved in the current study and the mean BMI was 24.0(18-36). Martos *et al.,* study[14] found that the mean BMI of women included in their study was 24.70 (18.05-47.40), moreover, the North *et al.,* study[16] found that the median BMI was 25(22–33). So, the current study had normal BMI more than the previous studies. Most of women included in the present study were multiparous (54.0%) while the nulliparous were (46.9%), history of abortion was only 6.0% among the study sample. While Grab *et al.,* study[17] found that 76(28.4%) of their study sample were nulliparous and 192(71.6%) were multiparous. Additionally, Moradi *et al.,* study[18] reported that (70.2%) had gravidity below 3 and the history of abortion reported in 19 (24.7%).

The study examines the Bishop Score, which measures cervical position, dilatation, and head station. It found that posterior cervical position was prominent in half of the patients, and cervical dilatation was 1-2 cm in three-quarters. The study also found a significant relationship between the unfavorable cervical degree for induction (<5) and fFN, similar to previous studies.[19,20]

Regarding the mode of delivery the current study found that vaginal delivery was the most frequent among the study sample (87.0%) which was occurred more than other studies as it was reported in Grab *et al.,* study[17] in 61.2% of the participants in Moradi *et al.,* study[18] in 57%. In the current study All women involved had unfavorable bishop score which goes with other observation, Dîră *et al.* study[21] revealed that most pregnant women gave birth vaginally with unfavorable Bishop score. Additionally, the Wood *et al.* study[14], had a Bishop Score of ≤6 in the week before delivery and also ended their pregnancy by normal vaginal delivery, so our findings are in agreement with those study that mentioned recently. Both studies found that fFN had its importance in predicting successful induction.

Weak but significant direct correlation between Bishop Score and fetal fibronectin ng/ml among women included in the present study who all had Bishop score ≤ 5 but had a success of induction depending on FFN. For many years, the Bishop score—which is directly related

to vaginal delivery—was used to analyze the response to induction.[22] However, the presence of FFN in cervicovaginal secretions is indicative of a breakdown in the choriodecidual interface, which may indicate a delivery pathway that favors vaginal birth.[23] There are publications comparing the predictive strength of qualitative and quantitative FFN measurements.[24, 25]

According to a recent research, the quantitative FFN test by itself is just as effective as the cervical length and qualitative FFN test combined.[26] The shorter cervical length was associated with a greater chance of vaginal delivery, albeit this relationship is not statistically significant. Mohammed *et al.,* study[19] found that the sensitivity, specificity, PPV, NPV, and Accuracy of Fibronectin test in induction of labour were (90.3%), (57.2%), (84.4%), (69.5%), and (81.0%) respectively while in our current study fFN sensitivity, specificity, PPV, NPV and accuracy was 76.0%, 60.3%, 65.6%, 71.5% respectively in that order and regarded that Fibronectin test shows had its accuracy and sensitivity in success of induction of labour. Moreover, Uygur *et al.,* study[15] reported by binary logistic regression analysis that only the fFN immunoassay to be an independent statistically significant predictor of vaginal delivery than bishop score within 24 hours of induction. The usefulness of fetal fibronectin testing in term pregnancies has been evaluated in a number of earlier research.[27,28]

The receiving operating curve test (ROC test)which was used in the analysis of the present study found that at the cut-off value of 36.04 for the fetal fibronectin in relation to the Bishop score revealed that the area under the curve (AUC) was 0.668 with statistically significance (*p*=0.012). According to Grab et al.'s study[17], the positive fFN assessment appears to play a significant role in determining whether labor began spontaneously within five days. It was obtained in 62.5% of these cases, compared to only 4.5% of those whose labor began spontaneously more than five days later, and it had a coefficient of 39.375. FFN in cervical secretions was linked to a higher chance of delivery within seven days, according to a different research by Rumbold et al.[29], which included 75 pregnant women with term pregnancies from rural parts of Australia.

However, this group found that absence of fFN did not reliably exclude the onset of birth. In according to their observations, we also found sometimes, despite a negative FFN test, some women might have spontaneous onset of labor within the next days. Furthermore, Uygur *et al.,* study[15] positive cutoff value for fFN is 50 ng/mL or greater was found in 84.8% of the patients among the positive fibronectin assay, sensitivity, specificity of 84.9% and 50%, respectively were reported. In isolated northern communities, a negative fetal fibronectin test result which is <50-ng/mL cutoff was not predictive of a delay in labour at term in the same way but it predicts the absence of preterm delivery as the Healey *et al.,* study[30] reported. The findings that the test does not have

adequate specificity or sensitivity to be useful in predicting a delay in the onset of labour. The ROC analyses indicated an AUC of 0.67 (95% CI 0.50–0.83) for fFN. Using an fFN threshold of <20.5 ng/mL, we could predict that labour would not occur within seven days of testing with a sensitivity of 67% and a specificity of 66%.[26]

CONCLUSION
Finding fFN in amniotic fluid discharges as a sign of choriodecidual interface disruption, which gives a hint about the delivery method that favors vaginal birth. The fFN test predicts a successful induction of labor more accurately than the Bishop score. The sensitivity and specificity of a positive fibronectin test are 76% and 60.3%, respectively.

REFERENCES
1. Cunningham F, Leveno KJ, Bloom SL, etal. Physiology Nof Labor. In: Williams Obstetrics, 25th ed. McGraw Hill, 2018. January 01, 2023.
2. Rydahl E, Juhl M, Declercq E, et al. Disruption of physiological labour; - A population register-based study among nulliparous women at term. Sex Reprod Healthc, 2021; 27: 100571. doi:10.1016/j.srhc.2020.100571
3. Ryan RM and McCarthy FP. Induction of labour. Obstetrics, Gynaecology & Reproductive Medicine, Dec. 1, 2019; 29(12): 351-358.
4. Abdullah ZHA, Chew KT, Velayudham VRV, et al. Pre-induction cervical assessment using transvaginal ultrasound versus Bishops cervical scoring as predictors of successful induction of labour in term pregnancies: A hospital- based comparative clinical trial. PloS one., 2022; 17(1): e0262387. https://doi.org/10.1371/journal.pone.0262387
5. Kawakita T, Huang CC, Landy HJ. Risk Factors for Umbilical Cord Prolapse at the Time of Artificial Rupture of Membranes. AJP Rep., 2018; 8(2): e89-e94. doi:10.1055/s-0038-1649486
6. West HM, Jozwiak M, Dodd JM. Methods of term labour induction for women with a previous caesarean section. Cochrane Database Syst Rev., 2017; 6(6): CD009792. Published 2017 Jun 9. doi:10.1002/14651858.CD009792.pub3
7. Parisi L, Toffoli A, Ghezzi B, et al. A glance on the role of fibronectin in controlling cell response at biomaterial interface. The Japanese Dental Science Review, 2020; 56(1): 50-55. https://doi.org/10.1016/j.jdsr.2019.11.002
8. Cho J and Mosher DF. Role of fibronectin assembly in platelet thrombus formation. J Thromb Haemost, 2006; 4(7): 1461-1469. doi:10.1111/j.1538-7836.2006.01943.x
9. Ruggeri ZM and Mendolicchio GL. Adhesion Mechanisms in Platelet Function. Circulation Research, 2007; 100: 1673–1685. https://doi.org/10.1161/01.RES.0000267878.97021.ab
10. Dalton CJ and Lemmon CA. Fibronectin: Molecular Structure, Fibrillar Structure and Mechanochemical

Signaling. Cells, 2021; 10: 2443. https://doi.org /10.3390/cells10092443

11. Grab D, Doroftei B, Grigore M, et al. Fetal Fibronectin and Cervical Length as Predictors of Spontaneous Onset of Labour and Delivery in Term Pregnancies. Healthcare (Basel), 2022; 10(7): 1349. Published 2022 Jul 20. doi:10.3390/healthcare10071349

12. Bäz L, Roßberg M, Grün K, et al. Serum Liberation of Fetal Fibronectin Variants in Patients with Pulmonary Hypertension: ED-A+ Fn as Promising Novel Biomarker of Pulmonary Vascular and Right Ventricular Myocardial Remodeling. Journal of Clinical Medicine, 2021; 10(12). https://doi.org/10.3390/jcm10122559

13. Meier K, Parrish J, D'Souza R. Prediction models for determining the success of labor induction: A systematic review. Acta Obstetricia et Gynecologica Scandinavica, 2019; 98(9): 1100-1112. https://doi.org/10. 1111/aogs.13589

14. Martos MA, Engels V, Bueno B, et al. Development of Nomogram for Predicting the Success of Labor Induction in Full-Term Singleton Pregnancies. ReprodMed Int, 2018; 1: 005.

15. Uygur D, Ozgu-Erdinc AS, Deveer R, et al. Fetal fibronectin is more valuable than ultrasonographic examination of the cervix or Bishop score in predicting successful induction of labor. Taiwanese Journal of Obstetrics and Gynecology, 2016; 55(1): 94-97.

16. North R, Geraghty A, Luscombe G, et al. Using quantitative fetal fibronectin to predict term labour onset in Australian rural women: A pilot study. Australian and New Zealand Journal of Obstetrics and Gynecology, 2021; 1-5. doi:10.1111/ajo.1340110.1111/ajo.13401

17. Grab D, Doroftei B, Grigore M, et al. Fetal Fibronectin and Cervical Length as Predictors of Spontaneous Onset of Labour and Delivery in Term Pregnancies. Healthcare, 2022; 10(7). https://doi.org/10.3390/healthcare10071349

18. Moradi Z, Moradi P, Meshkibaf MH, et al. The comparison of plasma fibronectin in term and preterm delivery: A cross-sectional, descriptive-analytical study. International Journal of Reproductive Biomedicine, 2020; 18(1): 11-20. https://doi.org/10.18502/ijrm.v18i1.6191

19. Mohammed HI, Mohammed MA, Souidan II, et al. Fetal Fibronectin; A New Tool for the Prediction of Successful Induction of Labor. Benha Journal of Applied Sciences (BJAS), 2021; 6(2): 101-105.

20. Alpaslan A, Özcan K, Ali GH, et al. The Role of the Bishop Score For Successful Labor Induction. Perinatal Journal, April 2007; 15(1): 26-34.

21. Dîrǎ L, Drǎguşin RC, Şorop-Florea M, et al. Can We Use the Bishop Score as a Prediction Tool for the Mode of Delivery in Primiparous Women at Term Before the Onset of Labor? Current Health Sciences Journal, 2021; 47(1): 68-74. https://doi.org/10.12865/CHSJ.47.01.11

22. Bahadori F, Ayatollahi H, Naghavi-Behzad M, et al. Predicting factors on cervical ripening and response to induction in women pregnant over 37 weeks. Med Ultrason, 2013; 15(3): 191–198.

23. Tripathi R, Tyagi S, Mala YM, et al. Comparison of rapid bedside tests for phosphorylated insulin-like growth factor-binding protein 1 and fetal fibronectin to predict preterm birth. Int J Gynaecol Obstet, 2016; 135(1): 47- 50.

24. Hezelgrave NL, Abbott DS, Radford SK, et al. Quantitative fetal Fibronectin at 18 weeks of gestation to predict preterm birth in asymptomatic high-risk women. Obstet Gynecol, 2016; 127(2): 255-263.

25. Centra M, Coata G, Picchiassi E, et al. Evaluation of quantitative FFN test in predicting the risk of preterm birth. J Perinat Med., 2017; 45(1): 91-98.

26. Bruijn MM, Kamphuis EI, Hoesli IM, et al. The predictive value of quantitative fibronectin testing in combination with cervical length measurement in symptomatic women. Am J Obstet Gynecol, 2016; 215(6): 793.e1-793.e8.

27. Blackwell SC, Sullivan EM, Petrilla AA, et al. Utilization of fetal fibronectin testing and pregnancy outcomes among women with symptoms of preterm labor. Clinicoecon Outcomes Res., 2017; 9: 585-594.

28. Jun SY, Lee JY, Kim HM, et al. Evaluation of the effectiveness of foetal fibronectin as a predictor of preterm birth in symptomatic preterm labour women. BMC Pregnancy Childbirth, 2019; 19: 241. https://doi.org/10.1186/s12884-019-2403-7

29. Rumbold A, Kruske S, Boyle J, et al. Can the fetal fibronectin test be used by remote dwelling pregnant women to predict the onset of labour at term and delay transfer for birth in regional settings? Rural Remote Health, 2013; 13: 2126.

30. Healey GK, Macdonald WA, Grzybowski S, et al. Exploring fetal fibronectin testing as a predictor of labour onset in parturient women from isolated communities. Canadian Family Physician, March, 2018; 64(3): e108-e114.