ORIGINAL ARTICLE

Predicting mode of delivery using mid-pregnancy ultrasonographic measurement of cervical length

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Abstract

Background: It has been recognized that preterm labor is related to short cervical length and that poor progress in labor is a major indication for cesarean section at term. We therefore hypothesize that long cervix is not associated with increased risk of cesarean delivery during labor at term.

Objectives: The objective is to determine the relationship between cervical length at mid-pregnancy and mode of delivery and preterm delivery.

Materials and Methods: Trans-vaginal ultrasonographic scan measurement of cervical length was done for 281 pregnant women at a mean gestational age of 22 weeks. These women were followed up till delivery and the mode of delivery and the cervical length were analyzed for associations.

Results: Cesarean section due to poor progress in labor at term constituted 11.7%. The cesarean section for the highest quartile cervical length (40–67 mm) was 50% (*P* value 0.0018 for trend). Of the 33 women whose mode of delivery was cesarean section due to poor pregress 18 (54.5%) had cervical length of more than 40 cm. The likelihood ratio of cesarean section due to poor progress of labor at term among women at the upper quartile cervical length is 10.28 (*P* value 0.0013)

Conclusion: Long cervical length at mid-pregnancy predicts the possibility of cesarean delivery early in pregnancy. Hence, cervical length in mid-pregnancy can be of value in predicting the mode of delivery in early pregnancy.

Key words: Cervix, labor, poor progress, ultrasound

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Introduction

Programmed development of the uterus in early pregnancy plays an important role in labor and delivery.[1] It has been noted that the chance of preterm delivery is inversely related to the length of the cervical canal[2] and short cervix has been associated with increased risk of spontaneous preterm birth.[3] Long cervix in mid-pregnancy may be associated with the risk of cesarean birth at term among primiparous women.[4]

Cesarean section rates have increased dramatically throughout the world in recent years.[5] In less developed countries such as Nigeria, the rate of Cesarean section has also been rising due the increase in the acceptability of the procedure.[6,7] The major cause of primary cesarean delivery is poor progress during labor [dystosia][8] though the true biologic cause of poor progress in labor has not been clearly understood.

Some studies in Nigeria have identified associations between short cervix by ultrasound evaluation and increased risk of cervical incompetence[9] and an association between an unfavorable Bishop score by digital clinical assessment and failed induction of labor[10] but no study has directly

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associated the mid-trimester ultrasonographic cervical length with Cesarean section.

The aim of this study is to determine the usefulness of mid-pregnancy ultrasonographic measurement of the cervix in predicting Cesarean section at term.

Materials and Methods

Background of the study

The study was undertaken in the Obstetrics and Gynecology department of Ebonyi State University Teaching Hospital, Abakaliki, the obstetrics unit of Mile Four Hospital, Abakaliki and the Ultrasonographic unit of the department of Radiology of Ebonyi State University Teaching Hospital, Abakaliki. Ebonyi State University Teaching Hospital is a tertiary health institution which serves as a major referral centre for the state and her neighbors.

The Department of Obstetrics and Gynecology of the Hospital runs daily antenatal clinics managed by Consultants and Resident doctors with trained nurses, except on Wednesdays. The antenatal clients who are booked on Wednesdays are distributed to the four teams in the department with nine consultants. The Obstetrics Unit of the Mile Four Hospital also conducts both secondary and tertiary obstetrics services for women in Abakaliki, the capital city of Ebonyi State and the neighboring cities and villages. The Mile Four Obstetrics unit is supervised by three Consultant Obstetrician and Gynaecologists, three Senior Registrars, Senior Medical Officers and trained Nurses and Midwives. This Obstetric Unit conducts her booking clinic on Mondays and runs regular antenatal clinics on Tuesdays and Fridays. The obstetrics units in these hospitals encourage their antenatal clients to undergo at least one ultrasound scan; subsequent scans are usually for specific indications.

The Ultrasonographic unit which is part of the Radiology Department of the Ebonyi State University Teaching Hospital is located in the antenatal ward and is easily accessible to the obstetricians and the antenatal clients. The unit has three Consultant Radiologists and five trained Ultrasonologists. Staff of this unit also visit the Mile Four Hospital, Abakaliki to conduct and supervise obstetric scanning. A significant number of the regular obstetric scanning is done by the Obstetricians in these hospitals.

The average annual booking rates in the Ebonyi State University Teaching Hospital is 3300, the annual average delivery rate is one thousand five hundred and the cesarean section rate is 19.7%.[6] Emergency cesarean sections constitutes about 80% of all the cesarean section in most hospitals in this area.[11] The average maternal mortality ratio in the hospital was quoted as 1884/100 000 and cesarean section contributes significantly to this mortality.[12,13] The average annual antenatal booking rate in Mile Four Hospital is 4000, annual average delivery rate of 2500 and cesarean section of 10.2%.

Also poor progress of labor contributes substantially to the rising cesarean section rates in these hospitals, especially emergency cases with its attendant increase in the maternal and perinatal morbidity and mortality.[6,11]

Study participants

The recruitment for the study was done from 1st of April, 2008 through 31st of March, 2009 in Ebonyi State University Teaching Hospital, Abakaliki and from the 1st of May, 2008 to 30th April, 2009 in Mile Four Hospital, Abakaliki. Recruitment was done among women attending antenatal clinic. The women were mostly civil servants, farmers, traders, and students. All women with singleton pregnancy, who made commitment to deliver in the facility and who will be undergoing ultrasonography at 20–24 weeks of gestation were recruited consecutively. They signed the consent forms before recruitment.

The exclusion criteria were; suspected fetal abnormalities, women with previous history of Cesarean section and extremely short-statured women or a previous history of a preterm birth, due to cervical incompetence who were counseled for cervical cerclage. Also pregnant women who were not sure that they will deliver in the study facilities were excluded. Gestational age was determined from the menstrual history and/or by early ultrasound studies. The ethics Committee of the Hospitals granted approval for the study. The days of the week when the recruitment were done were selected by random sampling and Mondays, Tuesdays and Fridays were selected.

The Medical history was obtained from the mothers using an interviewer administered structured questionnaire. Thereafter, they underwent vaginal ultrasonography for cervical length assessment using the Siemens Ultrasound Machine at a frequency of 7.5 MHz. The cervical length was taken from the point of internal Os to the external Os. Cervical lengths were determined by ultrasonograophers trained in these methods and the Investigators and quality control was performed on a regular basis by the Consultant Ultrasonologists. The report as regards the cervical length was recorded in the coded structured questionnaire, while the rest of the other ultrasonographic findings were recorded in the patients' normal antenatal records. The women were subsequently managed according to the departmental protocol.

The outcome of each pregnancy was obtained from the delivery records and included gestational age at delivery, mode of delivery, whether the patient was in spontaneous labor or if labor was induced, and indications for Cesarean section if abdominal delivery was done. The primary outcome measures were Cesarean delivery performed during labor at term for poor progress in labor, preterm delivery

and term vaginal delivery. The pregnancy outcome was compared with the mid- pregnancy cervical length and same analyzed for association. The cervical length was graded as follows; less than 20 mm, 20 mm–30 mm, 31 mm–40 mm, and more than 40 mm.[4,9,14,15]

Preterm labor is defined as the onset of labor before 37 completed weeks, while term is defined as gestational age between 37 completed weeks and 42 weeks. Poor progress in labor is defined in this study as failure of cervical dilatation to progress at 1 cm per hour during active phase labor in the presence of adequate uterine contractions, (even after augmentation with oxytocin) in the absence of feto-pelvic disproportion. Cesarean sections resulting from other indications were not included in this study as main outcome measure.

Sample size

The sample-size calculation was based on the maximum Cesarean section rate of one of the study centers which was 19.7%. To detect this difference at a significance level of 5%, 300 Patients were recruited for the study, using the formula by Taylor.[16]

Data analysis

The data were collected in a spread sheet in a personal computer and subsequently analyzed using the Epi info statistical software package version 3.3.2 (2005). Using the Kruskal–Willis test, the continuous variables were summarized and the various sub groups' calculated means and median of the clients were compared. Subgroup analysis were performed on the basis of various mode of delivery recorded in the delivery records, including cesarean section for failure to progress in labor, other indications for cesarean section, spontaneous preterm labor and term vaginal delivery. The independent variable is the cervical length which was categorized in interquartiles groups as above and the dependent variable analyzed were the various mode of delivery. Comparison of categorical data was performed with Chi-square test for trend and a *P* value of less than 0.05 was considered to indicate statistical significance.

The association between the categorized cervical length and some of the major categorical outcome variables such as cesarean section for poor progress in labor at term, preterm labor, and term vaginal delivery were assessed. The relationship between the cervical length and poor progress in labor as a major outcome effect was further tested for significance using the attributable risk from the odds ratio calculated from the logistic regression.

Results

Three hundred (300) pregnant women attending antenatal clinic in these hospitals who met the criteria for recruitment were enrolled into the study within a year. The mean gestational age at the time of ultrasound scan was 22 weeks and 3 days and the median gestational age at scan was at 23 weeks. (Variance was 2.27 and standard deviation was 1.51.)

Nineteen (19) women dropped out of the study, four (4) had abortion and fifteen (15) did not deliver in these facilities. Two hundred and eighty one (281) subjects were used for this analysis; this represents 93.6% of all the recruited patients. Thirty three (11.7%) women had preterm vaginal delivery, one hundred and ninety seven women (70.1%) had term vaginal delivery, and 51 women had cesarean section (18.2%). Of all the women recruited 33(11.7%) had cesarean section due to poor progress in labor at term, while 17(6.5%) had cesarean section due to other indications. Poor progress in labor constituted 66% percent of all the cesarean section performed in this study.

The maternal characteristics of the participants in relation to the quartile of cervical length are summarized in Table 1. This study shows that the cervical length at a mean gestational age of 22 weeks is positively associated with increasing gestational age at delivery (*P* value <0.001), maternal weight (*P* value 0.046), fetal weight at birth (*P* value 0.0167), all cesarean sections (*P* value 0.0018), cesarean section for poor progress in labor (*P* value 0.0103) and negatively associated with preterm labor (*P* value <0.001). The association between mid-pregnancy cervical length and maternal age was not significant (*P* value 0.335).

The cesarean section rate in these women progressively increased with the cervical length measured at 22 weeks of gestation. The cesarean section for all indications was 6% for the first quartile, 16% for the second quartile, 28% for the third quartile and 50% for the fourth quartile. (*P* value 0.0018 for trend). The cesarean section rate for poor progress of labor was lowest for the first quartile (3%), second quartile (18.2%), third quartile (24. 3%), fourth quartile (54.5%), *P* value 0.0103 for trends. The risk for cesarean section increased progressively with the cervical length at mid-pregnancy. The rate of cesarean section seems to increase significantly at the cervical length of above 40 mm and indeed doubled the rate of cesarean section below 40 mm. [Table 1]. The association between the quartiles of cervical length and the cesarean section for other indications was not significant (*P* value 0.073) Table 2 showed simple frequency table of the various delivery modes according to the cervical quartiles.

Table 3 showed that the odds for cesarean section due to poor progress in labor at term had negative correlation with cervical length quartiles of 40 mm and below (*P* value >0.05), while the odds ratio for cesarean section due to poor progress in labor was positively related (OR=3.37, RR=3.40, 95% confidence interval 1.60–7.00, *P* value=0.0008.) for cervical

Table 1: Maternal characteristics of the cohort according to the quartile of cervical length at a mean gestational age of 22 weeks

Maternal characteristics or outcome	Quartiles of cervical length (mm) N = 281				$\chi 2$	*P* value
	a (15–19) *N*=10 (%)	b (20–30) *N*=86 (%)	c (31–40) *N*=102 (%)	d (41–67) *N*=83 (%)		
Cervical length (mm)						
Mean	18.20	26.45	36.50	50.54		
Median	18.50	28.00	36.00	50.00	245.83	<0.001
Age (years)						
Mean	26.00	26.00	27.00	27.00		
Median	29.10	26.26	27.25	27.60	3.39	0.335
Gest. age at delivery						
Mean	36.10	37.98	39.25	39.24		
Median	36.00	38.00	39.00	40.00	29.75	<0.001
Maternal weight						
Mean	64.60	65.03	66.26	68.43		
Median	60.50	62.00	62.00	68.00	8.05	0.046
Fetal weight						
Mean	2.59	3.00	3.17	3.20		
Median	2.33	3.00	3.22	3.25	10.23	0.017
Caesarean delivery						
All C/S	3 (6)	8 (16)	14 (28)	25 (50)	14.98	0.0018
C/S (poor progress)	1 (3)	6 (18.2)	8 (24.26)	18 (54.5)	11.28	0.0103
C/S (other indications)	2 (11.1)	2 (11.1)	6 (33.3)	8 (44.4)	6.93	0.073
All preterm delivery	6 (18.2)	19 (57.6)	3 (9.1)	5 (15.2)	41.45	<0.001
Term vaginal delivery	7 (3.0)	78 (33.8)	88 (38.1)	58 (25.1)	14.98	0.0018

Table 2: Simple frequency table for mode of delivery according to the cervical length

Mode of delivery	Cervical length (mm)			
	<20 *n* (%)	20–30 *n* (%)	31–40 *n* (%)	>40 *n* (%)
Preterm	6 (66.7)	19 (20.5)	3 (2.9)	5 (6.0)
Term Vag. delivery	1 (8.3)	59 (69.9)	85 (83.5)	54 (65.1)
All C/S	3 (25.0)	8 (9.6)	14 (13.6)	24 (30.1)
Total	10 (100.0)	86 (100.0)	102 (100.0)	83 (100.0)
C/S for poor progress	1 (8.5)	6 (7.2) (21.7)	8 (7.8)	18
C/S for other indications	2 (16.5)	2 (2.4)	6 (5.8)	8 (8.4)

Vag = Vagina, C/S = Cesarean section

Table 3: Odds ratio for cesarean section due to poor progress in labor at term according cervical length quartiles

Variables	Odds ratio	Relative risk		95% CI		*P* value
Quartile cervical length (mm)						
a (15-19)	0.67	0.70	0.08	-	5.39	0.707
b (20-30)	0.49	0.53	0.19	-	1.24	0.127
c (31-40)	0.51	0.55	0.22	-	1.18	0.115
d (41-67)	3.37	3.40	1.60	-	7.00	0.0008

CI = Confidence interval

Table 4: Odds ratio for preterm labor according to the cervical length quartiles

Variables	Odds ratio	Relative risk		95% CI		*P* value
Quartile cervical length (mm)						
a (15-19)	19.52	7.17	5.48	-	69.42	<0.0001
b (20-30)	2.92	2.53	1.40	-	6.13	0.003
c (31-40)	0.14	0.17	0.04	-	0.49	0.0004
d (41-67)	0.38	0.43	0.14	-	1.046	0.053

CI = Confidence interval

length of 40 mm and above. The risk of cesarean section for poor progress is significantly associated with an increasing cervical length of more than 40 mm.

In Table 4, the odds for preterm labor was highest at a cervical length quartile of 15–19 mm (OR=19.52, RR=7.17, 95% confidence interval: 5.48–69.42, *P* value <0.0001) from the cervical length of length of 31 mm and above, the cervical length was not associated with preterm labor. Cervical length of <20 mm was significantly associated with preterm labor. Table 5 shows the odds ratio for term vaginal delivery according to cervical quartiles

Since the cesarean section due to poor progress was the major outcome variable considered, multivariate logistic regression tested for this major outcome showed that the attributable

risk for cesarean section for poor progress in labor at term was associated with the upper quartile cervical length and this was expressed as a attributable risk of 10.28 (OR=3.38. 95% confidence interval 1.61–7.06, *P* value 0.0013) [Table 6].

Discussion

The Cesarean section rate in this study is 18.2%, which compares with the Cesarean section rate of 19.7% earlier recorded in Ebonyi State University Teaching Hospital, Nigeria.[6] Poor progress in labor constituted a significant percentage of all cesarean sections carried out in this study (66%); this agreed with the study by Ibekwe, *et al*. and Ekanem, *et al*. in Abakaliki and Calabar, Nigeria respectively, which concluded that poor progress in labor contributes substantially to the rising cesarean section rates.[6,11] But this is slightly lower than the findings of Gordon and co- workers, where poor progress in labor contributed 80%.[4]

This study shows a significant association between the cervical length during the mid- pregnancy period and cesarean section due to poor progress in labor at term. This association gradually becomes stronger as the cervical length increased, peaking at the critical cervical length of more than 40 mm when the rate of cesarean section more than doubled. The rate of cesarean section reaches the average cesarean section rate at cervical length of between 20 mm and 30 mm, but beyond cervical length of 30 mm, the cesarean section rate goes beyond the average for the centers and significantly increased beyond that cervical length. These findings suggest a strong association between the mid-pregnancy cervical length and poor progress of labor at term. This finding is consistent with the findings by Gordon *et al*. in United Kingdom whose studies suggested the cervical length at mid pregnancy as an important indicator of the risk of cesarean section at term.[4]

Our finding in this study leads to the rejection of our hypothesis that mid-pregnancy cervical length is not associated with the risk of cesarean section during labor at term. The attributable risk for cesarean section for poor progress in labor was associated with the upper quartile cervical length and was expressed as a likelihood ratio of over 10. The association was significant with a *P* value of 0.0013. These findings agree with a previous study which suggested that the events during normal parturition at term are influenced by a programmed development of the uterus in early pregnancy.[1]

Previous studies had recorded the association between an unfavorable Bishop score by digital clinical assessment at term and failed induction of labor at term,[10] but this study did not follow up the changes in the cervical length of the study group till term in order to relate consistency of the cervical findings in earlier pregnancy with the eventual mode of delivery and the reason for such mode of delivery.

In this study, preterm labor among women whose cervical length are in the lower quartile (<20 mm) constituted 66.7% of all women in the study population who had preterm delivery. Conversely, the preterm labor among women with cervical length in the upper quartile cervical length is only 6%. This finding agrees with the findings of Bergherlla, *et al*. who concluded that the risk of spontaneous preterm birth increases as the cervical length of the cervix decreases and that the gestational age at which the spontaneous labor occur also decreases.[12,17] Further test for association between the various interquartiles cervical lengths and preterm labor showed a strong positive association at the cervical length of less than 20 mm (OR 19.52 (5. 48-69.42), which is the highest among all interquartiles lengths. This association was statistically significant. At a cervical length of above 30 mm, there were no associations between the cervical length and spontaneous preterm delivery (*P* value 0.0004). These findings agree with the study by Ejikeme and Umeora in a rural mission hospital in Nigeria which concluded that the rate of mid-trimester loses and preterm births increased with decreasing cervical lengths.[9] But the study differs from this one in that trans-abdominal ultrasonographic scan was done before the 18th week of gestation as against trans vaginal scan done at an average GA of 22 weeks. Also the

Table 5: Odds ratio for term vaginal delivery according to cervical quartiles

Variables	Odds ratio	Relative risk		95%	CI	*P* value
Quartile cervical length (mm)						
a (15-19)	0.032	0.113	0.004	-	0.257	0.000002
b (20-30)	0.930	0.981	0.53	-	1.640	0.822
c (31-40)	2.900	1.315	1.59	-	5.31	0.00037
d (41-67)	0.680	0.680	0.39	-	1.17	0.1692

Table 6: Unconditional logistic regression of cervical quartiles for cesarean section due to poor progress in laborat term

Cervical quartiles (mm)	*N* (%)	*n* (%)	OR	95%	CI	L. ratio	*P* value
a (15-19)	10 (3.6)	1 (3.1)	0.67	0.08	5.39	0.15	0.71
b (20-30)	86 (30.6)	6 (18.2)	0.49	0.20	1.20	2.52	0.13
c (31-40)	102 (36.3)	8 (24.2)	0.51	0.22	1.19	2.62	0.12
d (41-67)	83 (29.5)	18 (54.5)	3.38	1.61	7.09	10.28	0.0013
Total	281 (100)	33 (100)					

OR = Odds ratio, CI = Confidence interval, L. ratio = Likelihood ratio

definition of short cervix was cervical length of less than 25 mm, where as this study defined short cervical length as those less than 20 mm.

Another study which agreed with the findings in this study is that of to and colleagues who demonstrated that asymptomatic women who had a cervical length of 15 mm and less had a greatly increased risk for spontaneous early preterm delivery.[18] These findings suggest a significant relationship between short cervix and preterm birth and that long cervices more than 30 mm protects against spontaneous preterm birth.

One limitation of this study is the composite analysis of both primigravidae and multigravidae as the dynamics of labor in these two groups differ to some extent. Categorizations of these groups are subjects of further investigations in the future.

Conclusion

In this study, the mode of delivery is associated with the ultrasonographic cervical measurement at mid- pregnancy and can be used as a predictive tool to determine the possible outcome of labor and route of delivery. Poor progress in labor at term is a major indication for Cesarean section at term and contributes significantly to cesarean section rate. Long cervical length at mid- pregnancy can predict the possibility of cesarean delivery early in pregnancy. Hence, cervical length in mid pregnancy can be of value in predicting the mode of delivery in early pregnancy.

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