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Ultrasound examination at 37 weeks' gestation in the prediction of pregnancy outcome: the value of cervical assessment

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KEYWORDS: 37-week scan; cervical length; induction of labor; post-term; ultrasound screening

ABSTRACT

Objective *To examine the potential value of routine measurement of cervical length in singleton low-risk pregnancies at 37 weeks of gestation in the prediction of onset and outcome of labor.*

Methods *Cervical length was measured by transvaginal sonography at 37 weeks in 1571 singleton low-risk pregnancies. Outcome measures were gestation at spontaneous onset of labor, post-term delivery, duration of labor and mode of delivery.*

Results *The median cervical length at 37 weeks was 30 mm and there was a significant association between cervical length and gestation at delivery, which increased from a mean of 38 weeks for cervical length of 10 mm to 41 weeks for cervical length of 35 mm. The incidence of delivery after 40 weeks and 10 days was 296 (18.8%) and the incidence increased with cervical length at 37 weeks from 0% to 6%, 35% and 68% for respective cervical lengths of < 20, 21–30, 31–40 and 41–50 mm. In the pregnancies with spontaneous onset of labor the incidence of Cesarean section for failure to progress increased from 3.6% to 6.0%, 6.4% and 11.8% for cervical lengths of < 20, 21–30, 31–40 and 41–50 mm, respectively. In the pregnancies requiring induction for post-term the incidence of Cesarean section for failed induction or failure to progress increased from 7.5% to 20.1% to 25.0% for cervical lengths of 21–30, 31–40 and 41–50 mm, respectively.*

Conclusion *Measurement of cervical length at 37 weeks can define the likelihood of spontaneous delivery before 40 weeks and 10 days and the risk of Cesarean section in those requiring induction for prolonged pregnancy.*
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INTRODUCTION

Traditionally, antenatal assessment is based on clinical examination, which is carried out at 4-weekly intervals to 28 weeks, at 2-weekly intervals to 36 weeks and every week thereafter to delivery. The main objectives of such care is to diagnose and manage appropriately maternal and fetal complications and in the last few weeks to determine potential problems that may arise in labor and delivery.

In the last few years ultrasonography has become an integral part of antenatal care, playing a central role in accurate pregnancy dating and screening for fetal abnormalities, placenta previa and multiple pregnancy. Furthermore, several screening studies at mid-gestation suggest that Doppler ultrasound may be a useful predictor of pregnancies at high risk for pre-eclampsia and fetal growth restriction[1], and sonographic measurement of cervical length identifies pregnancies at high-risk of spontaneous preterm delivery[2,3]. In the third trimester, ultrasound is used selectively in the diagnosis and management of problems suspected from clinical examination, such as fetal growth restriction, macrosomia, malpresentation and antepartum hemorrhage. Recent studies have reported that sonographic measurement of cervical length is a useful predictor of the likelihood of successful induction of labor[4,5].

Our aim was to determine the potential value of a routine ultrasound examination in low-risk pregnancies at 37 weeks for the diagnosis of unsuspected fetal growth restriction, macrosomia and malpresentation, and in the prediction of the onset and likely outcome of labor, including the risk of prolonged pregnancy and the need for Cesarean section for failed induction or lack of progress in labor. In the present study we report the findings of cervical length at 37 weeks and the relationship to the onset and outcome of labor.

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METHODS

This was a prospective screening study of ultrasound examination at 37 weeks of gestation in singleton, low-risk pregnancies attending for antenatal care at King George and Harold Wood Hospitals, Essex, UK. In these hospitals ultrasound examination is carried out routinely at 11–14 weeks and at 23 weeks of gestation. Women were recruited from the antenatal clinics and offered the 37-week scan and those attending for this study, which was approved by the ethics committees of the hospitals, gave written informed consent.

The entry criteria were singleton pregnancies at 37 weeks of gestation, live fetus with vertex presentation clinically, no placenta previa or major fetal abnormalities (confirmed from the early scans) and no pregnancy complications, such as pre-eclampsia, malpresentation or fetal growth restriction (diagnosed at routine antenatal visits).

At the 37-week clinic the maternal blood pressure and weight were measured, abdominal palpation was carried out for determination of presentation and measurement of symphysis–fundal height, transabdominal ultrasound examination was performed for the determination of fetal presentation and placental site and measurement of fetal head and abdominal circumference, fetal femur length and amniotic fluid index and Doppler studies for measurement of pulsatility index in the umbilical artery and fetal middle cerebral artery.

Transvaginal sonography was then performed for measurement of cervical length (Toshiba Sonolayer SSH-140A with a 6-MHz transvaginal transducer, Toshiba Ltd, Tokyo, Japan). The women were asked to empty their bladder and were placed in the dorsal lithotomy position. The ultrasound probe was placed in the vagina approximately 3 cm proximal to the cervix to avoid any cervical distortion of its position or shape and a sagittal view of the cervix, with the echogenic endocervical mucosa along the length of the canal, was obtained. Calipers were used to measure the distance between the internal and external os, the furthest points at which the cervical walls were juxtaposed[6–8]. Three measurements were obtained and the shortest, technically best measurement in the absence of uterine contractions was recorded.

Patient characteristics, including demographic data and previous obstetric and medical history, were obtained from the patients at their first antenatal visit to the hospital by midwives and were entered into a computer database. Similarly, the clinical and ultrasound findings from the 37-week visit were recorded in the database at the time of the assessment.

Induction of labor was performed in all women that had not delivered by 40 weeks and 10 days, according to the guidelines of the Royal College of Obstetricians and Gynaecologists[9]. Nulliparous women with an unfavorable cervix (Bishop score less than 5) received 2 mg dinoprostone gel (Pharmacia & Upjohn, Milton Keynes, UK) vaginally. Those with a Bishop score of 5 or 6 and all parous women received 1 mg dinoprostone gel and those with a score of 7 or more had artificial rupture of the membranes. The women had further vaginal examinations at 6-hourly intervals and depending on the Bishop score further doses of dinoprostone gel were considered. The maximum dose over 24 h was 3 mg, or 4 mg in nulliparous women with an unfavorable cervix. The procedure was repeated the following day if labor did not ensue. Oxytocin augmentation was started in cases with unsatisfactory progress of labor or following amniotomy.

Data on pregnancy outcome were obtained from review of the medical notes.

Statistical analysis

Yates-corrected χ^2 test was used to analyze categoric variable and unpaired *t*-test, Mann–Whitney *U*-test and linear regression were used for continuous variables' analysis. Two-sided *P*-values are reported throughout. Univariate and multivariate Cox proportional hazards model were used to analyze sonographic cervical length at 37 weeks, parity and ethnicity in predicting the gestational age at delivery.

RESULTS

During the study period (September 2001–September 2002) 1743 singleton, low-risk pregnancies fulfilling the entry criteria attended the research clinic at $36 + 5$ to $37 + 6$ (median, $37 + 2$) weeks. At this clinic we diagnosed 27 cases of breech presentation and these pregnancies were excluded from further analysis. Also excluded were 145 pregnancies in which induction of labor or elective Cesarean section were carried out before 40 weeks and 10 days for a variety of indications, including antepartum hemorrhage, pregnancy-induced hypertension, fetal growth restriction, previous Cesarean section and maternal request (Figure 1). In the remaining 1571 pregnancies the median maternal age was 30 (range, 16–44) years, 1040 (66.2%) were Caucasian, 337 (21.5%) were Asian, 176 (11.2%) were Afro-Caribbean and 18 (1.1%) were Oriental, 810 (51.6%) were nulliparous and 761 (48.4%) were parous, 175 (11.1%) were cigarette smokers and none of the women admitted to taking recreational drugs.

Cervical length was successfully measured in all cases and the median value was 30 (range, 7–50) mm, with no significant difference between nulliparous and parous women ($P = 0.104$, 95% CI −1.0 to 1.0). There was a significant association between cervical length and gestation at delivery (gestation in days $= 255.806 + (0.89 \times$ cervical length in mm), $r = 0.734, n = 1571, P < 0.0001$; Figure 2); women with a cervical length of 10 mm at 37 weeks on average delivered at 38 weeks and those with a cervical length of 35 mm delivered at 41 weeks. Univariate analysis indicated that sonographic cervical length, parity and ethnicity were all significant predictors of gestational age at delivery. A Cox proportional hazards model

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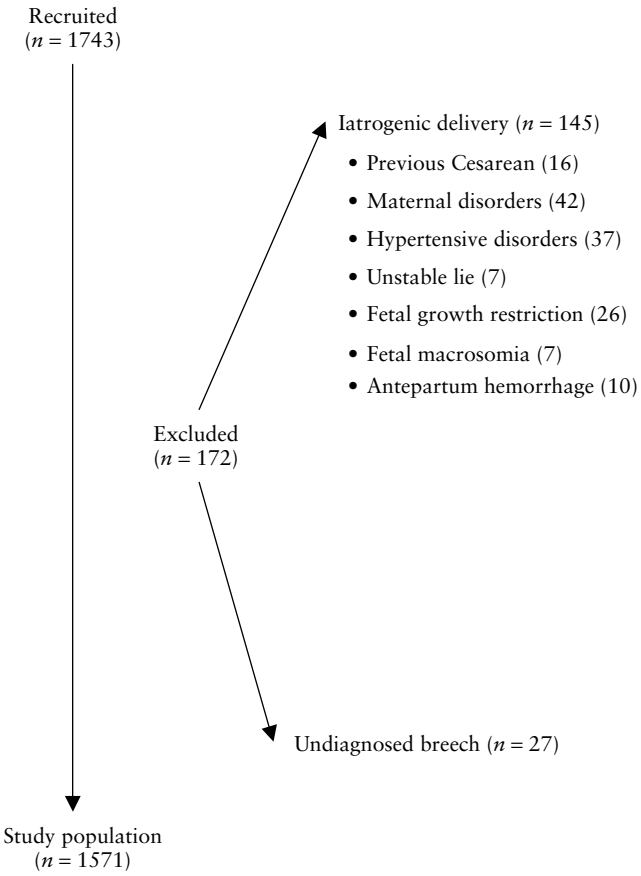

Figure 1 Population recruited ($n = 1743$) and breakdown of exclusions from the study population ($n = 172$).

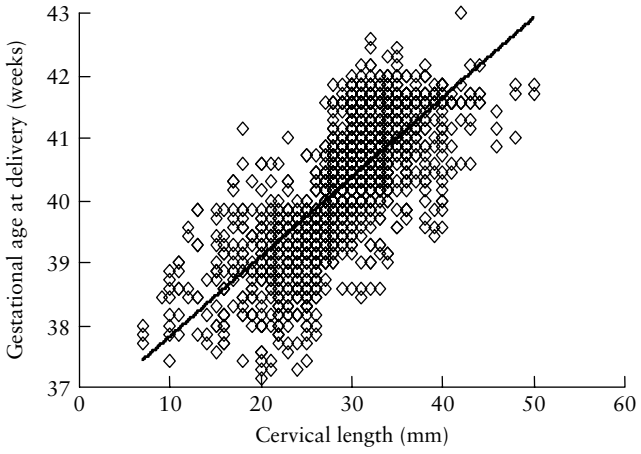

Figure 2 Association between gestational age at delivery and sonographically measured cervical length at 37 weeks.

was fitted using all the variables to assess their effect on gestational age at delivery. As shown in Table 1, there was a significant independent contribution of ethnicity. However, after adjusting for cervical length and parity, there was no significant difference between Afro-Caribbeans and Caucasians, or Orientals and Caucasians (probably due to the difference in number of cases in each group).

Spontaneous onset of labor and delivery before 40 weeks occurred in 100%, 94%, 61%, 10% and 0% for respective cervical lengths of < 10, 11–20, 21–30, 31–40 and 41–50 mm (Figure 3). Delivery at or before 40 weeks and 10 days occurred in 1275 (81.2%) cases. In the 296 (18.8%) cases that remained undelivered beyond 40 weeks and 10 days, 263 had induction of labor and 33 had spontaneous onset of labor. The incidence of those cases that had not delivered at or before 40 weeks and 10 days increased with cervical length at 37 weeks from 0% to 6%, 35% and 68% for respective cervical lengths of < 20, 21–30, 31–40 and 41–50 mm (Figures 3 and 4). The incidence was higher in nulliparous compared to parous women for cervical lengths of 31–40 mm (42% vs. 28%, $\chi^2 = 13.301$, $P = 0.0003$, 95% CI 1.343–2.602) and 41–50 mm (75% vs. 65%, $\chi^2 = 0.822$, $P = 0.822$, 95% CI 0.347–7.179).

In the pregnancies with spontaneous onset of labor the incidence of Cesarean section for failure to progress increased from 3.6% to 6.0%, to 6.4% and 11.8% for respective cervical lengths of < 20, 21–30, 31–40 and 41–50 mm (Figure 5). Nulliparous women were

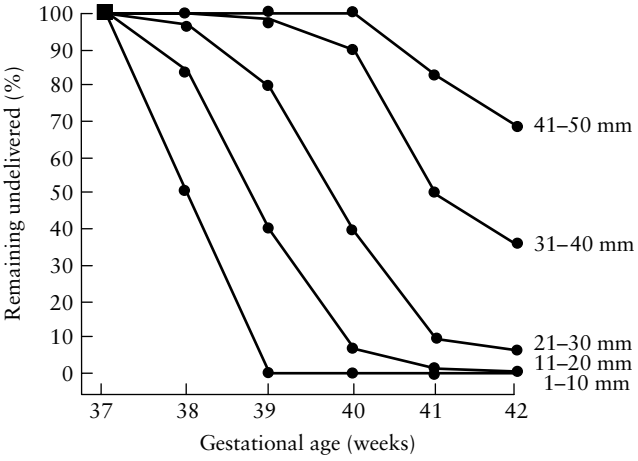

Figure 3 Survival curve estimates of percentages of women not delivered at different gestational ages, according to sonographically measured cervical length at 37 weeks.

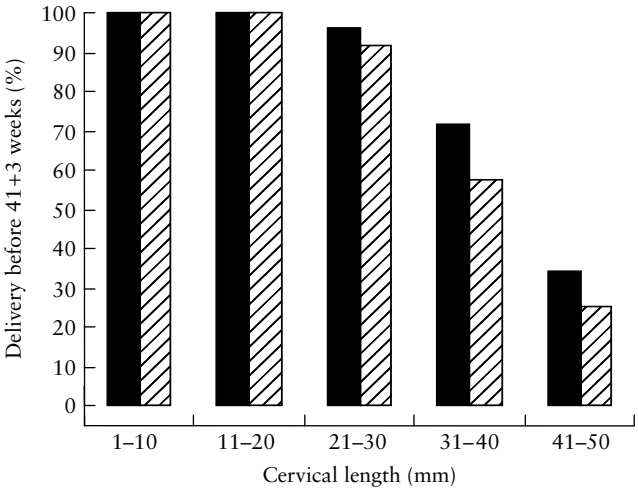

Figure 4 Percentages of nulliparous (▨) and parous (■) women delivering spontaneously before 40 weeks and 10 days according to sonographically measured cervical length at 37 weeks.

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Table 1 Univariate and multivariate Cox proportional hazards model of gestational age at delivery, looking at sonographic cervical length at 37 weeks, parity and ethnicity

	Univariate			*Multivariate*		
Variable	*Hazard ratio*	*95% CI*	P	*Hazard ratio*	*95% CI*	P
Cervical length	0.85	0.84–0.86	< 0.0001	0.85	0.84–0.86	< 0.0001
Parity			< 0.0001			< 0.0001
Nulliparae	1			1		
Parae	1.19	1.08–1.31		1.36	1.23–1.50	
Ethnic group			< 0.0001			0.001
Caucasian	1			1		
Afro-Caribbean	1.26	1.07–1.48	0.005	1.11	0.94–1.3	0.226
Asian	1.42	1.26–1.61	< 0.0001	1.28	1.14–1.45	< 0.0001
Oriental	2.03	1.27–3.23	0.003	1.28	0.80–2.05	0.299

more likely to have Cesarean delivery for failure to progress than parous women (8.1% vs. 3.7%, $\chi^2 = 10.728$, $P = 0.0011$, 95% CI 1.407–3.785) (Figure 6). In the pregnancies requiring induction for post-term the incidence of Cesarean section for failed induction or failure to progress increased from 7.5% to 20.1% and 25.0% for respective cervical lengths of 21–30, 31–40 and 41–50 mm (Figure 5). In this group, nulliparous women were more likely to have Cesarean delivery for failure to progress than parous women (24% vs. 11%, $\chi^2 = 6.020$, $P = 0.014$, 95% CI 1.239–5.075) (Figure 6). There was no significant association between cervical length at 37 weeks and the duration of either the first stage of labor ($r = 0.0003$, $n = 1412$, $P = 0.992$) or the second stage of labor ($r = 0.0276$, $n = 1412$, $P = 0.4637$). There was, however, a statistically significant difference in duration of labor between nulliparous and parous women, both for the first stage of labor (7.5 h for nulliparous women and 4.2 h for parous women, $P < 0.0001$) and the total duration of labor (9.2 h for nulliparous women and 4.7 h for parous women, $P < 0.0001$).

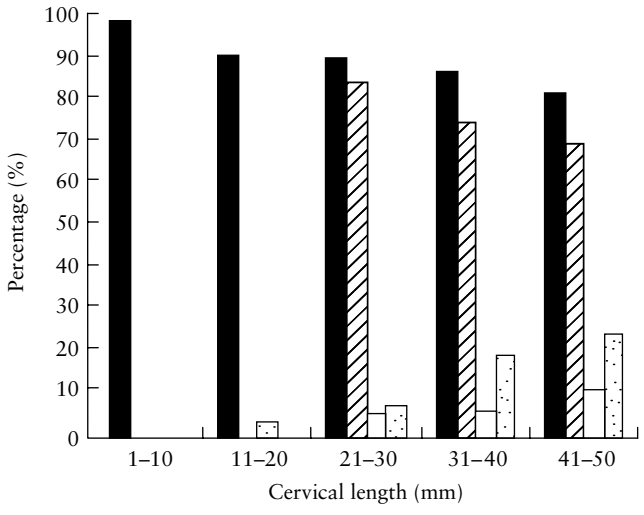

Figure 5 Percentages of spontaneous onset of labor and induction of labor for postdates, and likelihood of vaginal delivery and Cesarean section for failure to progress, according to sonographically measured cervical length at 37 weeks. ■, spontaneous labor: vaginal delivery; ▨, induced labor: vaginal delivery; □, spontaneous labor: Cesarean section for failure to progress; ⁘, induced labor: Cesarean section for failure to progress.

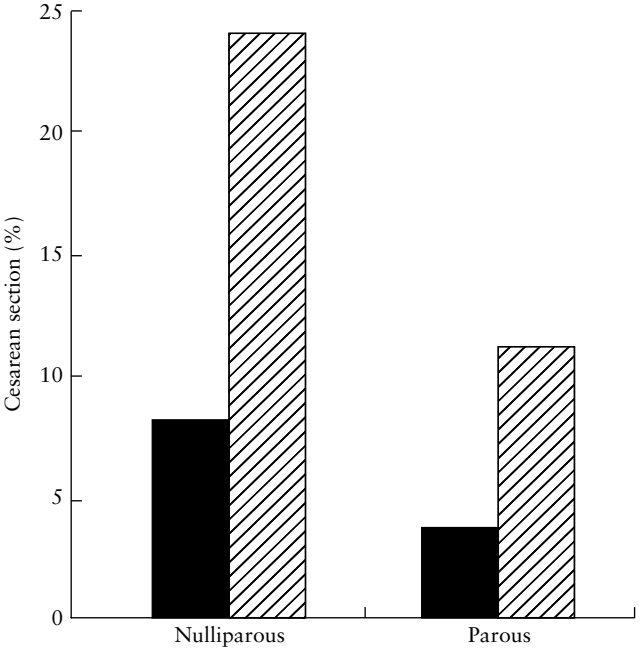

Figure 6 Percentages of women requiring Cesarean section for failure to progress, according to labor onset (spontaneous, ■; induced, ▨) and parity.

DISCUSSION

This study has demonstrated that cervical length at 37 weeks is (1) associated with the gestation at spontaneous onset of labor, (2) identifies the women at high risk of prolonged pregnancy and (3) can define the risk of Cesarean section for failed induction or failure to progress in labor.

Several previous studies have demonstrated an association between pre-induction cervical length and the induction-to-delivery interval[4,5]. One previous study in 128 singleton vertex pregnancies at 39–40 weeks has

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reported an association between sonographically measured cervical length and the likelihood of spontaneous onset of labor in the subsequent 7 days[10].

There are two potential applications of our findings in clinical practice. First, individualization of the timing of elective Cesarean section, rather than routine performance of this operation at 38 weeks. Second, routine measurement of cervical length at 37 weeks could identify a group at very high risk for prolonged pregnancy and subsequent emergency Cesarean section. Such women may choose to have elective Cesarean section at term.

Traditionally, elective Cesarean sections are performed at 38 weeks' gestation with the aim of avoiding emergency surgery because more than 90% of women have spontaneous onset of labor beyond this gestation. However, the need of mechanical ventilation to treat presumed surfactant deficiency in the neonate is 120 times more likely after elective delivery at 37–38 weeks than after delivery at 39–41 weeks[11], and the risk of respiratory morbidity is halved with each completed week of gestation between 37 and 41 weeks[12]. Our findings of a high association between cervical length at 37 weeks and gestation at spontaneous onset of labor may be utilized in individualizing the gestation for elective Cesarean section. Such a policy would avoid the increased risk of maternal mortality and morbidity from emergency as compared with elective surgery and also reduce neonatal respiratory morbidity. For example, we found that 94% of women with cervical length ≤ 20 mm at 37 weeks had spontaneous onset of labor before 40 weeks of gestation and therefore in such patients elective Cesarean section is best carried out at 37–38 weeks. By contrast, for women with cervical length > 30 mm elective Cesarean section could be delayed until 40 weeks because only 10% of these women will have spontaneous onset of labor before this gestation.

There is an association between cervical length at 37 weeks and the incidence of prolonged pregnancy and the need for emergency Cesarean section in such pregnancies. For example, we found that only 3.6% of parous and 8.1% of nulliparous women with cervical length ≤ 30 mm at 37 weeks had not delivered by 40 weeks and 10 days. By contrast, 9/12 nulliparous women with cervical length > 40 mm had prolonged pregnancy and eight of these nine women ended up having an emergency Cesarean section for fetal distress or failure to progress in labor. It could be argued that on the basis of such data many of these women would have chosen to have an elective Cesarean section at term. However, the subgroup of nulliparous women with cervical length > 40 mm constituted only 0.8% of our population and it is therefore unlikely that routine sonographic measurement of cervical length at 37 weeks for this indication will gain widespread application.

An alternative view is that in this century ultrasound examination should become an integral part of every antenatal visit and replace the traditional palpation and auscultation of the maternal abdomen as a method of monitoring fetal growth and well-being. For example, in this study we diagnosed breech presentation in 1.5% pregnancies that were clinically thought to be cephalic presentations. Since elective Cesarean section for breech presentation at term, compared to planned vaginal birth, is associated with a three-fold decrease in the incidence of perinatal mortality, neonatal mortality or serious neonatal morbidity[13], a routine 37-week scan may be desirable for this indication alone.

There is good evidence that an obstetric scan should include cervical assessment because measurement of cervical length provides useful information to the obstetrician and parents in deciding on the appropriate management of the pregnancy. Several previous studies have demonstrated that measurement of cervical length at 20–24 weeks provides sensitive prediction of the risk of early preterm delivery[2,3] whereas measurement of the cervix immediately before induction of labor for prolonged pregnancy helps define the likelihood of successful vaginal delivery within 24 h of induction[4,5]. Our finding of a high association between cervical length at 37 weeks and the gestation of labor onset may provide useful information to both the pregnant woman in preparing for delivery and the attending obstetrician in planning the subsequent management of the pregnancy. This may be of particular importance in the management of pregnancies that may have an element of maternal or fetal compromise that requires delivery in the near future. As induction of labor is associated with its own risks, knowing that there is a high chance of delivery in the subsequent week if the cervical length measurement is short may allow the clinician to decide to await spontaneous labor. Conversely, if the cervical length measurement is long, induction of labor may then be carried out.

This study has demonstrated that measurement of cervical length at 37 weeks can be used to determine the likelihood of prolonged pregnancy and the risk of emergency Cesarean section for failure to progress or failed induction of labor. As emergency Cesarean sections are the worst mode of delivery in terms of maternal morbidity, concentrating on better antenatal advice and management would surely be the cornerstone to more optimal care.

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