SONOGRAPHY

EDUCATION ARTICLE

The maternal cervix: Why, when and how?

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Abstract

Introduction: The incidence of preterm birth has continued to rise in most countries in the world during the last decade. There are many clinical risk factors that increase the risk of preterm birth. It has been shown that a sonographically shortened cervical length is a strong indicator of subsequent preterm birth in pregnancy.
Background: It has been established that women at an increased risk of preterm birth should have the cervical length recorded using a transvaginal approach. The sensitivity of a shortened cervical length to predict preterm birth is higher in women with a previous preterm birth, with reduced sensitivity in low risk women. The maternal cervix may be assessed using transabdominal, transperineal and transvaginal ultrasound approaches. This article discusses the available research into the use of these differing techniques and current guidelines for measuring maternal cervical length.
Summary: Measuring the maternal cervical length has become an important part of the mid trimester morphology examination. The appropriate technique to screen the cervical length in women at low risk of preterm birth is still debatable throughout the wider obstetric and ultrasound communities.

Why?

Risk factors

Preterm birth rates have continued to rise worldwide in the last decade.[1,2]

In Australia in 2011 preterm birth (PTB) occurred in 7.5% of all gestations. A small proportion of mothers gave birth at 20 to 27 weeks gestation (0.9%), with 0.8% at 28–31 weeks, whilst 6.6% gave birth at 32–36 weeks.[1] The rate of mortality for 32–36 week infants was 4.7 per 1000 births. This is five times higher than for babies born at term. The mortality rate was 410 per 1000 for babies born before 28 weeks and 30 per 1000 for babies born from 28 to 31 weeks.[2,3] Preterm birth is now the leading cause of neonatal death, and in children up to 5 years of age, the second largest cause of death.[4]

There are many clinical risk factors that can contribute to an increased risk of PTB during pregnancy, although many women who deliver preterm do not have any known risk factors. The greatest risk factor for PTB is a PTB in a previous pregnancy.[5] Women with a uterine anomaly or history of previous cervical cone biopsy/large loop excision of the transformation zone, fibroidectomy and multiple cervical dilatations are also at an increased risk of PTB.[6,7] It has been shown that women with a prior PTB have a 2.5 fold increased risk of subsequent PTB. However, this fact is not helpful in nulliparous women, who make up nearly half of all patients experiencing PTB[5], whilst a previous full term birth has been shown to decrease the risk of PTB in subsequent pregnancies.[8]

Currently, using ultrasound, the length of the cervix is the feature that we can assess to indicate the strength of the cervix.[9] A shortened cervical length as seen on transvaginal ultrasound (TVU) is a strong indicator that a baby will be born preterm in singleton and multiple gestations.[10] The shorter the cervical length, the greater the risk of spontaneous PTB.[10] Even so, it is important to note that 75% of women with a shortened cervix do not deliver preterm.[6] It has been shown that a shortened

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cervical length on TVU has a sensitivity of over 50% for subsequent PTB in women presenting with a clinically increased risk of PTB. In women with no risk factors the sensitivity is reduced to 37%.[6,11]

In a high-risk population the risk of PTB at 20 weeks with a cervical length of 25 mm is 26%.[12–14] This increases to 32% at 20 mm with an increase to 56 and 64% at 5 and 0 mm respectively.[12–14] Ultrasound can also recognise intra-amniotic sludge and choriodecidual separation. Intra-amniotic sludge in isolation has no increased risk of PTB, but in conjunction with a shortened cervical length as seen in Figure 1, results in a higher risk of PTB than a short cervix alone.[15] Detachment of fetal membranes from the decidua at the level of the internal os as seen in Figure 2 is also associated with an increased risk for PTB.[15]

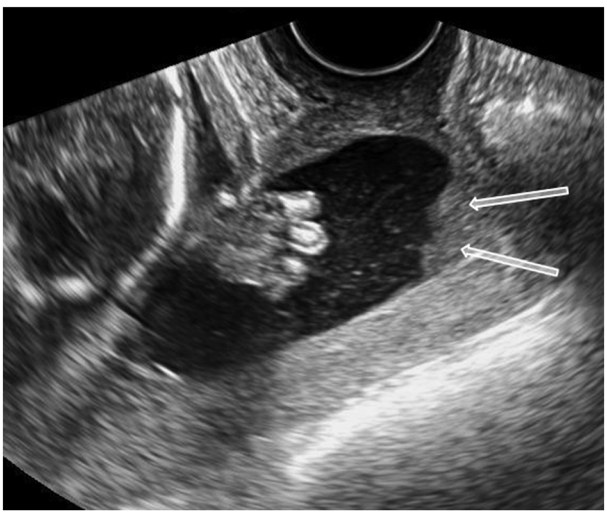

Figure 1 Transvaginal ultrasound of a shortened cervix with arrows pointing to intra-amniotic sludge.

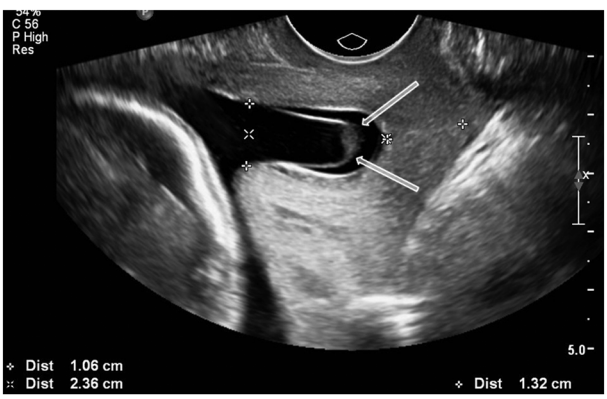

Figure 2 Transvaginal ultrasound of a shortened cervix with arrows pointing to detachment of fetal membranes.

There have been nomograms constructed which demonstrate expected cervical length throughout pregnancy.[16–18] At 20 weeks gestation the 50th percentile for cervical length in singleton pregnancies has been shown to be 42 mm.[19] Medical intervention is not usually considered until cervical length is less than 25 mm.[19–21] In women with a cervical length of $<$15 mm there are higher rates of intra-amniotic infection than those with a cervical length $>$15 mm. This may be because of an intra-amniotic infection resulting in contractions and a shortened cervix or a short cervix predisposing the patient to ascending infection.[22]

Interventions

There have been some trials testing the effectiveness of medical interventions in cases of shortened cervical length. Cervical cerclage has been widely used as a surgical method to prevent recurrent mid-trimester pregnancy loss in women at risk.[23] A suture or tape is placed around the cervix in an attempt to prevent dilatation resulting in subsequent PTB.[4] It has been found that cerclage can significantly reduce PTB rates in high-risk women (prior PTB) who present with a shortened TVU cervical length prior to 24 weeks gestation.[15] However, cerclage is associated with increased rates of vaginal bleeding, discharge and fever, and also a significant increase in caesarean section deliveries.[4] In cases of twin pregnancy, cerclage has been associated with a higher incidence of PTB and is contraindicated.[15]

A trial involving over 32 000 high and low risk asymptomatic women[24] and the use of vaginal progesterone on the maternal cervix resulted in a reduction of spontaneous preterm delivery before 34 weeks gestation. In these women, 733 were identified with a cervical length of between 10 and 20 mm. The participants were randomised into a placebo and progesterone group comprising 229 and 236 women respectively (268 women declined to participate). The PTB rate in the placebo group was 2.1%, with a reduction to 1.85% in the progesterone group.[24] Studies to date have shown progesterone treatment to be ineffective in preventing PTB in multiple gestations or women presenting in preterm labor.[4]

The cervical pessary is a silicone device traditionally used for treatment of genital prolapse that has been shown to have a significant reduction in spontaneous delivery before 34 weeks with no serious adverse effects. A small pilot study has found a significant reduction in PTB rates in multiple gestations.[15] Clinical protocols for this device are still in the development stage.[4]

Standard management paradigms recommend that low-risk women presenting with a cervical length of 20 to 25 mm undergo a repeat cervical length in 1–2 weeks' time.[7]

In women with a cervical length of 10–20 mm it is recommended that daily vaginal progesterone is administered until 36 or 37 weeks gestation[7,25], and women with a sonographic cervical length of <10 mm should receive cervical cerclage.[25] In high-risk women there have been recommendations of history indicated cerclage placement at 12–14 weeks gestation with removal at ≥36 weeks gestation, or cervical surveillance from 16 weeks gestation and vaginal progesterone between 16 and 36 or 37 weeks gestation.[7,25]

When?

Screening of the cervical length has been shown to be ineffective when performed before 14 weeks.[20] At this stage the endocervical canal is continuous with the lower uterine segment, which is falsely included in the cervical length.[20] In the first trimester the lower segment of the uterus is undeveloped because of the smooth muscle in the isthmic portion of the uterus undergoing marked hypertrophy in early pregnancy. The gestational sac is also usually located fundally and therefore exerts very little pressure on the lower uterine segment.[9] It has been shown that because of these factors cervical insufficiency does not generally develop until the second trimester and nearly all women, including those at high risk of PTB will have a normal cervical length prior to 14 weeks gestation.[6,15,20]

For the prediction of likelihood of PTB because of shortened cervical length, it has been shown that the optimal time to register the cervical length is between 16 and 24 weeks gestation.[25,26] Measurements later in pregnancy have a decreasing predictive value for PTB, and it has been recommended that measurements should not be performed after 28 weeks gestation.[25] The Australasian Society for Ultrasound in Medicine (ASUM) guidelines state that cervical length can be registered until 35 weeks gestation,[26] and the 3 Centres Collaboration in Victoria defines a short cervix as a cervical length of less than 20 mm at 18–22 weeks gestation.[7]

It has also been shown that cervical length measurements in late pregnancy may be useful not to screen for PTB, but to aid in the prediction of successful induction of labour.[28] It is also important to note that the earlier in pregnancy that a cervix is found to be short, the greater the risk is of PTB.[7,25]

How?

Cervical length

The length of the cervix is measured as the distance between the junction of the endocervical mucosa and the lower uterine segment (internal os) and the junction of the ectocervix and endocervical mucosa (external os). The closed length of the cervical mucosa is measured. This usually has a hyperechoic appearance and is surrounded by hypoechoic glandular tissue in many patients. The Fetal Medicine Foundation[29] recommends a straight line measurement be utilised. The straight line measurement has been shown to have better reproducibility between operators.[29,30] Some authors suggest a two straight line approach or a tracing of the canal in curved cervices.[31] Research by To *et al*. recommend being mindful of the effect of a highly curved cervical canal on patient management if a straight line technique is utilised, whilst concluding that a curved cervix is considered to be normal and a short cervix will become straight.

It has been established that high-risk patients should be offered TVU cervical length. The TVU approach is considered to be the gold standard for accurate measurement of cervical length.[11]

There is continuing debate as to the best way to measure the cervical length in women who are considered to be at a low risk of PTB.[33]

The American Congress of Obstetricians and Gynaecologists in conjunction with the American College of Radiology and the American Institute of Ultrasound in Medicine recommend that 'the cervix be examined sonographically when feasible'. They recommend that 'TVU or transperineal ultrasound may be considered if the cervix appears shortened or cannot be adequately visualised during the transabdominal examination'.[34]

The Royal Australian and New Zealand College of Obstetricians and Gynaecologists guidelines on measurement of cervical length for prediction of PTB state that 'accurately measured ultrasound cervical length has an inverse relationship with the risk of PTB'. It also states that 'cervical length is most accurately measured by TVU' and 'there is a growing body of evidence suggesting that interventions, such as progesterone and/or cervical cerclage may be of benefit for women otherwise considered low risk of PTB found to have a short cervix in the mid-trimester'.[35]

The Society of Obstetricians and Gynaecologists of Canada recommends that 'because of poor positive predictive values and sensitivities and lack of proven interventions, routine TVU cervical length is not recommended in women at low risk of PTB'.[26] The International Society of Ultrasound in Obstetrics and Gynaecology guidelines for the second trimester obstetric examination conclude that 'Currently there is insufficient evidence to recommend routine cervical length measurements at the mid trimester ultrasound in an unselected population'.[36] ASUM guidelines for the second trimester examination state that the 'cervix should be examined'.[27]

Each ultrasound approach that can be utilised has technical considerations. It is important that the correct landmarks be acquired for the appropriate ultrasound approach that is utilised in your department.

Ultrasound approaches

Transabdominal approach

There have been numerous studies comparing the transabdominal (TA) cervical length using a full maternal bladder to the transvaginal (TV) approach. These studies found that the cervical length was measureable in 100% of cases. Hernandez-Andrade *et al*., Marren *et al*. and O'Hara *et al*. found that a cervical length obtained with a full bladder overestimated the TV cervical length by 8, 6.1 and 14 mm respectively. The TA full bladder cervical length can also be problematic in that the cervical canal may be compressed by the bladder and 'mask' the appearance of funnelling of the cervical canal because of premature rupture of membranes.[39]

Some authors have compared TA cervical length to TV cervical length with an empty maternal bladder. Saul *et al*. were able to measure the TA empty bladder cervical length in 100% of cases. Studies by Marren *et al*., Friedman *et al*.,[41] To *et al*. and O'Hara *et al.* were able to register measurements for TA empty bladder cervical length in 82.8, 82.1, 50 and 98% of patients respectively.

The studies by To *et al*. and Friedman *et al*.[41] also found that the mean TA empty bladder cervical length was shorter than TV cervical length by −2.5 and −2.6 mm's respectively. The recent studies by Marren *et al*. and O'Hara *et al*. found a mean difference of 0.6 and −0.6 mm between TA empty bladder and TV cervical length respectively.

It has also been proposed that there is a need to establish a TA cervical length over which we can be confident that the TV cervical length will be greater than 25 mm. Freidman *et al*.[42] concluded that a TA cervical length of 35 mm or greater would need to be obtained to be confident that the TV cervical length would be greater than 25 mm. This study included TA cervical length measurements acquired with a full bladder. Marren *et al*. concluded that a policy of routinely assessing the cervix by TA, empty bladder measurement and proceeding to TV if the TA empty bladder cervical length is less than 25 mm would miss 67% of cases with a shortened cervical length. Saul *et al*. found that a TA empty bladder cervical length cut off of 30 mm or less showed 100% sensitivity for identifying cervices with lengths of 25 mm or less on TVU, whilst O'Hara *et al.* and Stone *et al*. found that all TA empty bladder cervical lengths greater than 30 mm registered a TV cervical length greater than 25 mm.

Transabdominal cervical length measurement technique

The maternal bladder should be empty to only partially full because of overestimation of cervical length with a full maternal bladder. It has been recommended that the bladder should not exceed a one vertical height measurement of 5 cm.[40,44] The TA empty bladder approach utilises the amniotic fluid as the acoustic window. The transducer placement is slightly cephalid with a caudal tilt to visualise the cervical mucosa. The transducer is manipulated with oblique and parasagittal movements to delineate the full length of the cervical mucosa and internal and external os. The image should be magnified to aid visualisation of the cervix. The internal os should have a flattened T-shape appearance. Amnion may be visible especially in cases of a prominent mucus plug. The external os often appears as a very slight indentation. The posterior wall of the cervix should also be used as a guide when placing the caliper delineating the external os.[39,40,44] An advantage of the TA empty bladder cervical length is that the cervix may be interrogated multiple times throughout the fetal morphology scan.

Figure 3 is an example of the full maternal bladder causing elongation of the cervical canal because of compression of the lower uterine segment. The same cervix imaged post void can be seen at Figure 4 with Figure 5 the TV cervical length.

Figure 6 is a further image of TA cervical length post void.

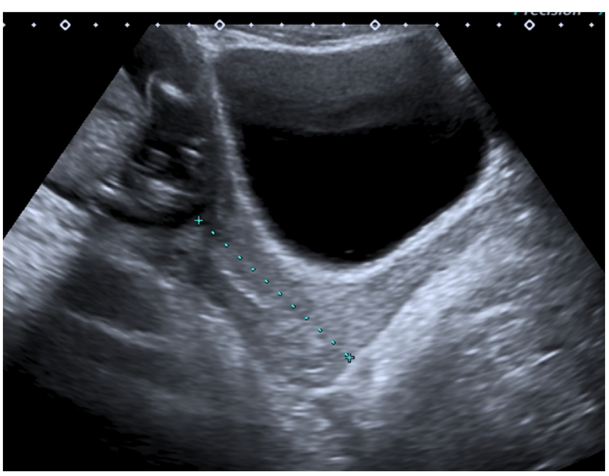

Figure 3 Transabdominal ultrasound full bladder cervical length of 57.8 mm.

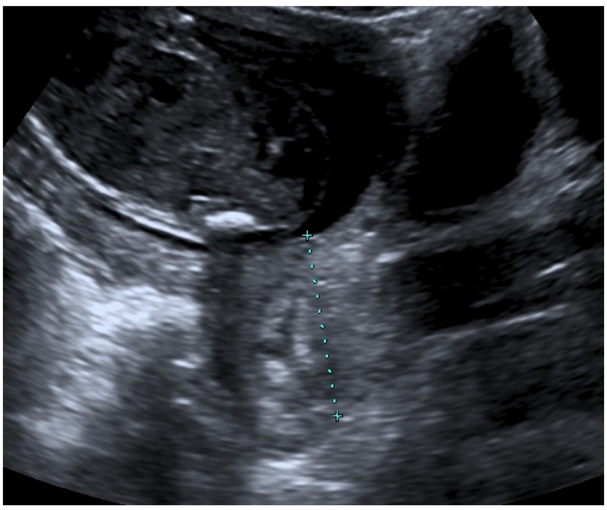

Figure 4 Transabdominal cervical length measurement of 34.7 mm with an empty bladder.

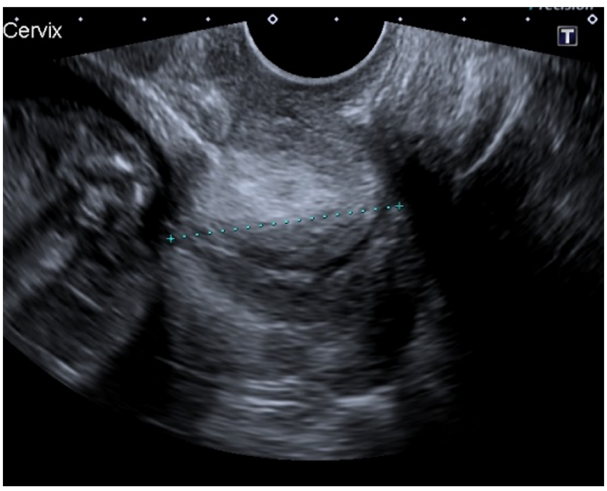

Figure 5 Transvaginal ultrasound cervical length of 34.2 mm.

Transvaginal cervical length

In 2006 Kagan *et al*. concluded that the best approach for measurement of cervical length is by TVU. TVU is highly reproducible, and in 95% of occasions, the difference between two measurements by the same observer and by two observers is 3.5 mm or less and 4.2 mm or less respectively.[30] On TVU the most important technical pitfall is elongation of the endocervical canal caused by distortion of the cervix by the transducer.[45] This approach can utilise a high-frequency endovaginal transducer to allow greater detail of the sonographic landmarks of the cervical canal.[21] In all previously mentioned studies comparing other ultrasound approaches to the TV approach, the TV cervical length was registered in 100% of cases.

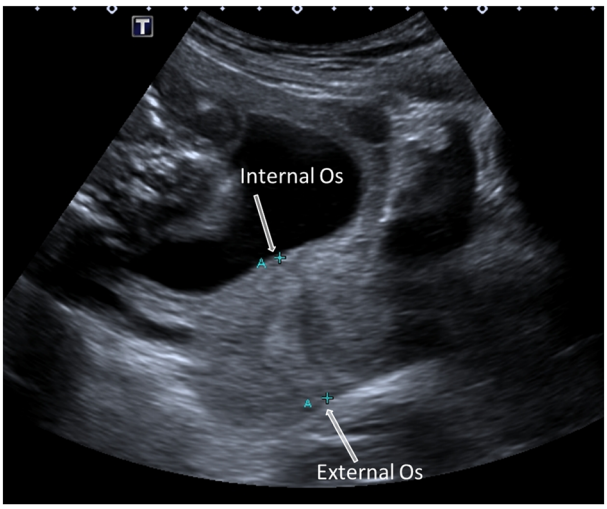

Figure 6 Transabdominal ultrasound cervical length with an empty bladder.

In patients with a premature rupture of membranes with amniotic fluid loss or bleeding in cases of placenta praevia, the TV approach will be contraindicated.[46]

Consent can also be problematic with the TV approach. Recently authors researching the implementation of a TV cervical length screening programme for low-risk and high-risk women in the American population found that 18 and 21% of women respectively declined to undergo the TV approach. Further problems were encountered with women not able to have the TV approach because of language barriers.[47,48]

Transvaginal cervical length measurement technique

The patient should be in an elevated lithotomy position. The transducer should be advanced into the vagina until the cervical mucosa and internal and external os are identified. The transducer is then withdrawn until the image is just out of focus (loss of detail of the required landmarks) and then readvanced just enough to again identify the landmarks for the cervix. This is to overcome artifactual lengthening of the cervical canal which can occur with too much probe pressure on the anterior fornix of the cervix.[29,31,39] The cervical canal should be equidistant from the anterior and posterior cervical walls as seen in Figure 7, with unequal distances being a sign of too much probe pressure as seen in Figure 8.

The cervix should be magnified to fill 75% of the image. The internal os may appear as a typical V-shaped notch or as a flattened T-shape appearance, and the external os is seen with a triangular notch as seen in Figure 7. The amnion may be seen at the internal os; Figure 9 is an example of cervical measurement in a case of a

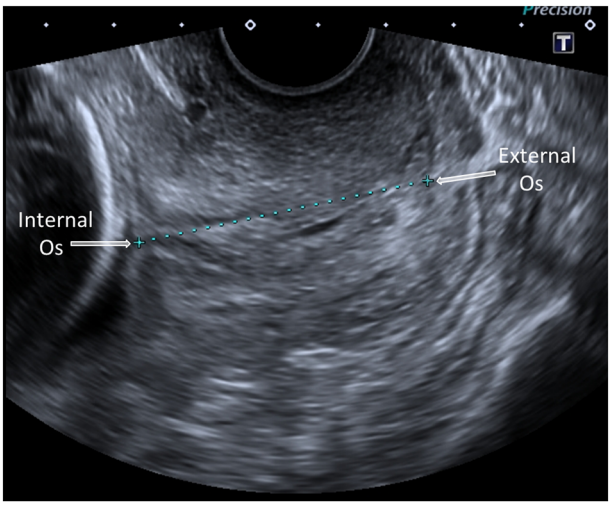

Figure 7 Transvaginal ultrasound cervical length of 45 mm with good technique.

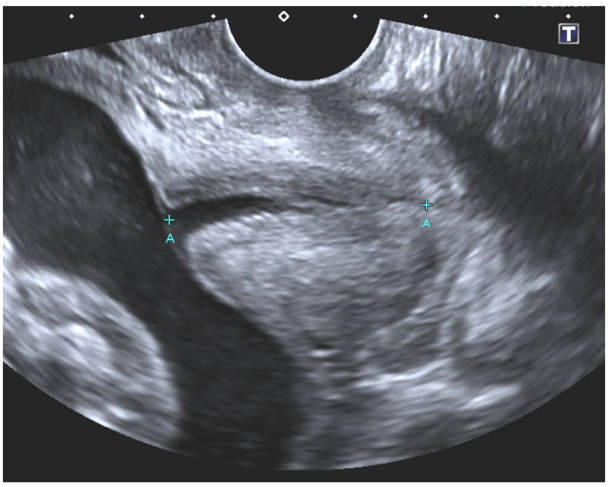

Figure 9 Transvaginal ultrasound cervical length with prominent mucus plug – caliper for internal os placed at amnion.

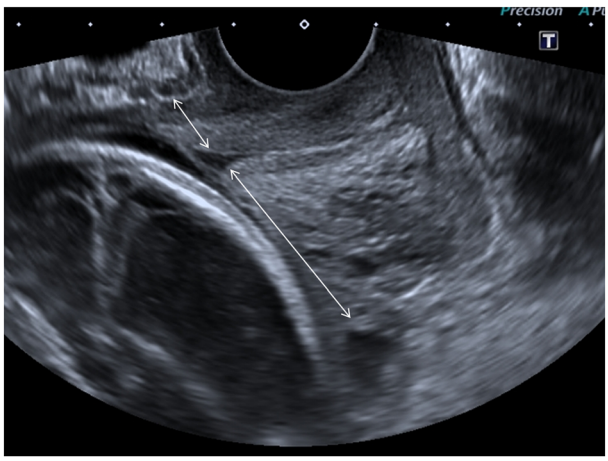

Figure 8 Transvaginal cervical length artifactually lengthened because of too much probe pressure, with arrows highlighting the unequal distance of the anterior and posterior walls of the cervix to the cervical canal.

prominent mucous plug with caliper placement for the internal os at the amnion. Three measurements should be taken over a 3–5-min period. Dynamic changes should be noted during this time. The shortest accurate length obtained is registered as the cervical length.[29,31,39]

Transperineal cervical length

There have been some authors who have compared the transperineal (TP) approach to the TV. A study by Cicero *et al*. looked at the cervix using the TP approach in the mid trimester (22–24 weeks). They showed a mean difference in cervical length of 0.2 mm between TV and TP cervical length, though were only successful in 80% of patients. Yaziki *et al*. showed a mean cervical length difference of 1 mm between TP and TV approaches and were successful in measuring the TP cervical length in 89% of patients. O'Hara *et al*. showed a mean difference of −0.16 mm between TP and TV cervical length and were successful in 90% of cases. The main technical issues with the TP approach are rectal gas overlying the external os[50] and the lower transducer frequency required to image the cervix.

Transperineal cervical length measurement technique

The patient should be in the elevated lithotomy position. The elevated position has been shown to help alleviate rectal gas over the external os.[50]

A low-frequency curved abdominal transducer is needed to enable adequate penetration to the internal os. The transducer is placed on the labia majora or perineum. Oblique or parasagittal movements are used to delineate the full length of the cervical canal. The caliper placement for the internal os should be adjacent to the cervical mucosa at the point where the opposing sides of the cervix come together and form a flattened T-shape appearance. The caliper placement for the external os should be adjacent to the cervical mucosa at the point where the cervix meets the vagina. A small hypoechoic 'notch' may be seen on some patients. The posterior wall of the cervix should also be used as a guide when placing the caliper delineating the external os.[31,39,49,51] Figure 10 is an example of transperineal cervical length measurement.

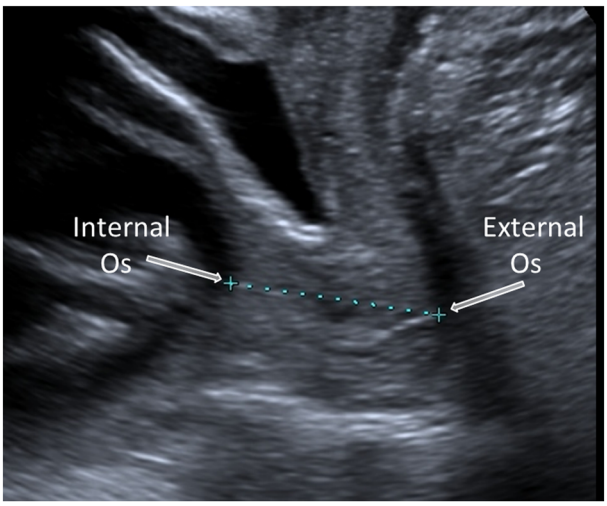

Figure 10 Transperineal ultrasound cervical length.

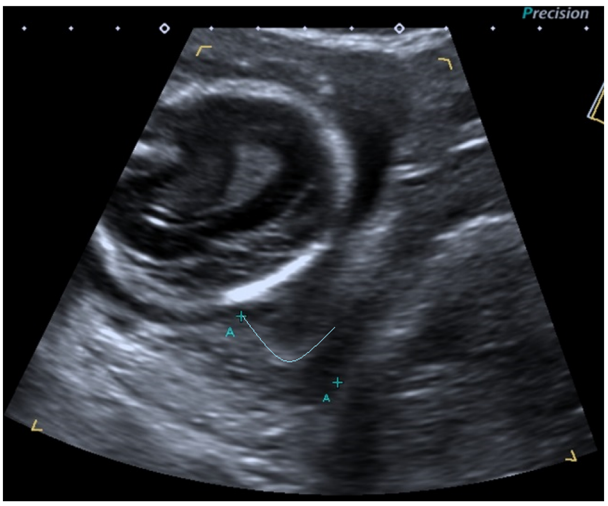

Figure 11 Transabdominal empty bladder cervical length with an undeveloped lower uterine segment exhibiting incorrect caliper placement for the external os (cervical canal is highlighted in the image).

Further examples of cervical length imaging

Undeveloped lower uterine segment

In some patients the lower uterine segment remains undeveloped or 'immature' into the early second trimester. The cervix can appear quite curved and have a 'horizontal' orientation in relation to the maternal vagina. All ultrasound approaches can be technically difficult. This appears to occur more frequently in patients in their first gestation. The external os is difficult to appreciate, and using the TVU approach the transducer needs to be withdrawn to delineate the appropriate landmarks. Often a lower frequency is also needed to be able to image the full length of the cervical mucosa to the internal os. Figures 11 and 12 are examples of cervical length measurement in cases of an undeveloped lower uterine segment.

Lower uterine contractions

In cases of lower uterine contractions the measurement of the true cervical canal can be technically difficult in all ultrasound approaches. Ideally, the cervix will be measured following relaxation of the contraction. The prominence of the cervical glandular tissue or cervical mucosa in the cervical canal is used to delineate the internal os from the lower uterine segment. Figure 13 is an example of TVU cervical length measurement with the presence of a lower uterine contraction.

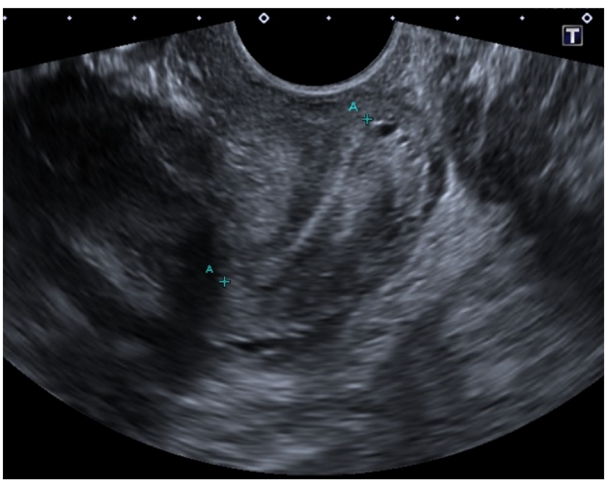

Figure 12 Transvaginal cervical length with an undeveloped lower uterine segment.

Cervical length measurement with cervical funnelling

Recent research has found that in cases of cervical funnelling or bulging membranes, measurement of the funnel length or width are unnecessary for prediction of PTB. The most important measurement to be registered is the length of the remaining cervical canal or functional length,[15] as demonstrated in Figure 14. The distance from the inferior edge of the placenta to the internal edge of the remaining canal should also be documented, and the width and length of the funnel should also be documented as in Figure 2 to aid in the planning of treatment.

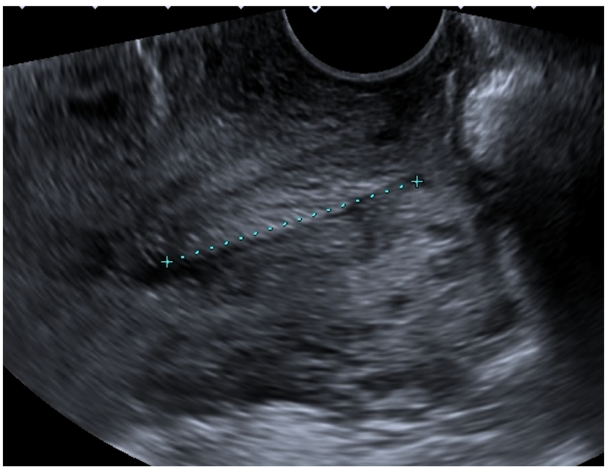

Figure 13 Transvaginal cervical length with a lower uterine contraction.

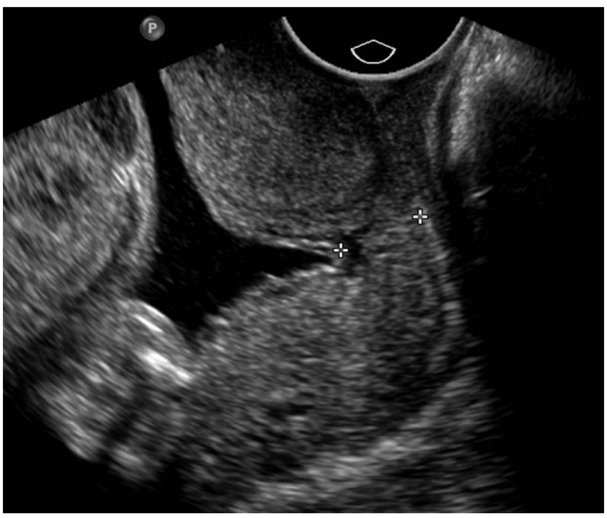

Figure 14 Transvaginal cervical length measurement of remaining functional cervical length registering 12mm.

Summary

Measuring the maternal cervical length has become an important part of the mid-trimester morphology examination because of its strong relationship with a subsequent PTB. In high risk women cervical length should be acquired using a TV approach because of the increased sensitivity of a shortened cervical length for PTB. As yet there is no formal consensus on the best method to register cervical length in low risk women. Cervical length should be ideally registered between 16 and 24 weeks gestation. It has been shown that cervical length measurements acquired using a transabdominal approach with an empty maternal bladder, have a close correlation to transvaginal measurements. A cervical length of less than 25 mm is considered clinically significant and it has been found by some authors that a TA cervical length of 30 mm or greater acquired with an empty maternal bladder has a 100% sensitivity for a TV cervical length of greater than 25 mm. Transabdominal cervical length acquired with an empty bladder will not be successful at registering the appropriate landmarks in some cases and a TV approach should then be used.

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