Research article

Evaluation of cervical length by transabdominal and transvaginal scans during early pregnancy

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Abstract

Objective: To compare the measurements and the client-preferences of transabdominal scan (TAS) and transvaginal scan (TVS) in assessing cervical length.

Method: A validation study with a cross sectional component on patient-preferences was conducted among 568 pregnant women with a period-of-amenorrhoea between 11+0 to 22+6 weeks. Pre- and post-void TAS and a post-void TVS measurements were taken. Receiver Operating Characteristics (ROC) curves were generated to assess the detection of short cervix using pre and post void TAS at different lengths of the cervix.

Results: The mean (SD) age of the participants was 28.4 (5.7) years with a mean gestation age of 14+1 weeks. The mean (SD) cervical lengths detected by the pre-void TAS, post-void TAS and TVS were 32.2 (5.8) mm, 28.9 (5.8) mm and 34.4 (5.3) mm respectively. Factors with significant association with a higher TVS cervical length were; increasing age ($p<0.001$), higher gravidity ($p<0.001$), higher parity ($p<0.001$) and higher number of vaginal deliveries ($p<0.001$). The TAS and TVS measurements significantly correlated with each other ($p<0.001$).

Post-void TAS could not obtain measurement in 49.47% of attempts. The shortest cervical length can be detected by pre-void TAS was 26mm with a ideal cut-off of 33 mm. For post-void TAS the shortest length was 28 mm with an ideal cut-off of 28.16mm. Majority preferred TAS over TVS.

Conclusion: Pre-void TAS can predict a cervical length of 26mm or less with 87.5% sensitivity whereas the shortest length predicted by post-void is relatively longer. Nearly in half, a valid post-void TAS could not be recorded. Client preference was more favourable for TAS.

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Introduction

The average global preterm birth rate in the year 2010 was 11.1% which amounted to nearly 15 million births[1]. Approximately one million neonatal deaths occurred due to complications of preterm births [2].

Cervical incompetence is a recognized, but treatable cause of preterm birth. Recognised treatment modalities are cervical cerclage and vaginal progesterone administration. A randomized multi-center double blind placebo control trial conducted by Hassan et al (201) concluded that vaginal progesterone administration in pregnant women with a sonographically short cervix (10-20 mm) significantly reduces risk of preterm births [3].

National Institute of Health and care excellence, UK recommend cervical cerclage or progesterone for women with history of mid-trimester loss or ultrasonically confirmed short cervix[4]. A randomized trial of cerclage for preterm birth prevention in high-risk women with shortened mid-trimester cervical length done in the United States concluded that cervical cerclage in this population is beneficial[5].

Though short cervix in pregnancy is of low prevalence, some cost effective analysis studies have concluded in favour of universal cervical screening [6]. Sri Lanka, being a lower-middle income country with limited resources compared to the developed world, cannot accommodate such a program. But currently in Sri Lanka ultra sound dating scans are offered freely at specialists-led government hospital units. In most occasions transabdominal method (TAS) is used for this purpose. Thereby, using TAS as a screening tool, the sonographer can carry out cervical length assessment in conjunction with dating scan rather than offering a separate TVS on a routine basis. This would encourage health care providers to offer cervical length assessment as routine part of their antenatal care bundle.

TAS seems to be far less intrusive to the privacy of the client and culturally acceptable, especially in an Asian multi-ethnic country like Sri Lanka. Patient preparation needed for TVS is more cumbersome to the patient and it is technically more demanding compared to TAS.

Though single use barriers are used during a TVS, there is a risk of transmitting pathogens from patient to patient as well as to the operator. A prospective study done in France in 2012 revealed that despite use of single use barrier and low level disinfection TV probes had significant contamination with human papilloma virus, *C. trachomatis*, Mycoplasma and other gram positive and negative bacteria[7]. There is also room for lower genital tract organisms to be transferred to cervix.

These negative effects can be minimized if TAS can be used as a reliable screening tool in cervical surveillance.

Material and method

Five hundred sixty eight consecutive pregnant women with POA between 11+0 weeks to 22+6 weeks were assessed at Colombo South Teaching Hospital over 9 months. Ethical clearance was granted by the Ethics Review Committee, University of Kelaniya. Written informed consent was obtained from all participants.

Women with multiple gestations, currently being treated for cervical incompetency, cone biopsy, 2 LLETZ, spontaneous preterm birth or mid-trimester loss, foetus with anomalies and intra uterine deaths were excluded.

Sonographic examination

A single GE health careVoluson E8 ultrasound machine was used and periodic calibration was carried out to ensure accuracy of measurements. Cervical length was measured from the internal to the external cervical os in mid-sagittal plane. Images were magnified so that the cervix was occupying approximately 50-75% of the image. Clear identification of the external and internal cervical os was required prior to measurement and the shortest linear cervical length was recorded.

Statistical analysis

Normality testing was done with the Q-Q plots and the Shapiro-Wilk test. Correlation between the TVS and TAS measurements were explored using the Spearman correlation coefficient. The factors associated with the inability to obtain a valid post-void TAS measurement were explored using the Mann Whitney U test (for the numerical variables) and chi square test (for categorical variables).

Receiver operating characteristics (ROC) curves were generated to assess the detection of short cervix using pre and post voidTAS at different lengths of the cervix. The validity assessments (sensitivity, specificity, negative predictive value and positive predictive value) for the TAS cut-offs (at 25mm, 30mm and 35mm) were done at the minimum length of the cervix for which the area-under the curve of the ROC curve was

statistically significant. The best possible cut-off for the TAS-pre void and post-void measurements were determined by considering the highest possible sensitivity and specificity values using the Youden index.

Results

Mean maternal age was 28 years (16-43) and mean POA was 14 weeks+1 day (11+0-21+2). 47.95% were primigravidae. Mean BMI was 24.07kg/m ^{2} (15.13-42.91) and 43 women had previous pelvic sur gery. Mean TAS pre-void, TAS posts-void and TVS cervical length measurements were 32.18 mm, 28.86 mm and 34.36 mm respectively. 3.5% of the women had cervical length <25 mm on TVS. Valid cervical length measurements were obtained in all pre-voidTAS scans while it could be obtained in only 49.47% of post-void TAS measurements and it was associated with higher maternal age and high BMI.

Pre-void TAS

The prediction ability of the pre-void TAS for the different cut-offs (from 25 mm to 30 mm) of the TVS measurements was calculated. The shortest cervical length for which a significant area-under-curve detected was "equal or less than 26 mm". The validity parameters (i.e. sensitivity, specificity, positive and negative predictive values) for three selected cut-offs of the pre-void TAS measurements are summarized in Table 1.

Post-void TAS

The prediction ability of the post-void TAS for the different cut off (from 25 mm to 30 mm) of the TVS measurements was assessed. The shortest cervical length for which a significant area-under-curve detected was "equal or less than 28 mm". The validity parameters for three selected cut-offs of the pre-void TAS measurements are summarized in Table 2.

The best possible cut-off for TAS measurements was determined by considering the highest possible sensitivity and specificity values using the Youden index. Cut-off values for pre-void and post-void TAS measurements was 33.0mm (sensitivity of 87.5% and specificity of 37.3%) and 28.165mm (sensitivity of 75% and specificity of 51.6%) respectively.

Majority 86% of the participants preferred TAS over TVS.

Table 1. Test characteristics of the pre-void TAS in detection of TVS equal or less than 26mm

	TAS≤25mm	TAS≤30mm	TAS≤35mm
Sensitivity	25.0%	50.0%	87.5%
Specificity	91.8%	60.4%	26.9%
Positive predictive value	15.4%	7.0%	6.7%
Negative predictive value	95.3%	95.3%	97.3%

Table 2. Test characteristics of post-void TAS in detection of TVS≤28mm

	TAS≤25mm	TAS≤30mm	TAS≤35mm
Sensitivity	37.5%	75.0%	87.5%
Specificity	71.0%	37.1%	19.4%
Positive predictive value	14.3%	13.3%	12.3%
Negative predictive value	89.8%	92.0%	92.3%

Discussion

The present study highlighted the potential application of the TAS in predicting the TVS measured cervical length as a screening tool. It revealed that pre-void TAS can be used to detect a relatively shorter cervical length compared to post-void TAS. Furthermore this study is an eye-opener for the development of a predictive tools for short cervix in which cervical length would be one parameter.

Goal of every pregnancy is to achieve a positive and healthy outcome. Preterm labour is associated with significant neonatal morbidity and mortality as well as psychological impact on the mother[2]. Burden on health services due to necessity for prolonged neonatal care, treatment of prematurity associated complications and long term sequela makes prevention of preterm delivery an important aspect of modern obstetric care. Detection of a short cervix leads to worthy interventions in minimizing pre-term births.

This study compared TVS cervical length measurement with TAS (pre and post void) measurement to assess diagnostic accuracy of TAS measurements in predicting short cervix. Those with risk factors for preterm birth were excluded (women with multiple gestations, currently being treated for cervical incompetency, cone biopsy or 2 LLETZ, women with past history of PPROM, mid trimester loss or spontaneous preterm delivery). This may have led to lower prevalence of short cervix observed compared to 6.2% [8], but similar to findings in Taiwanese study[9] observed a prevalence of 2.3% in similar low risk sample population.

In our study mean cervical length observed were 34.36 mm, 32.18 mm, 28.86 mm for TVS, TAS pre-void and TAS post-void respectively. In a similar study carried out in neighbouring India by Hebbar et al found a mean TVS cervical length of 40.5 mm at 20 weeks of gestation[10]. But the findings of that study is limited by their small sample size (n=50).

Taiwan study observed a mean TA cervical length of 36.0 ± 4.9 mm and the mean TV cervical length of 37.6 ± 5.4 mm [9]. To et al reported on cervical length measurement of 39,000 women in United Kingdom showed a TV mean length of 36 mm [11]. Mean TVS cervical length of 34.36 mm observed in our study was lower compared to above studies. But it was similar to findings observed by Hernandez et al in an American study population (mean TVS length

34.8 mm)[12]. These deviations may be due to ethnic and racial variations or that our study has excluded participants with several risk factors for having a short cervix.

Factors positively correlated with TVS measured cervical length were higher maternal age, gravidity parity and history of vaginal delivery. It paves the pathway to develop more robust predictive tools in future with further research. Anthropometric measurements such as weight, height or BMI did not show a significant correlation with TVS cervical length. In contrast to our findings, an Indian study showed association with gestation age and BMI but not with parity[10].

Our results showed that TVS measurement were consistently higher than TAS pre-void value while TAS post-void consistently lower that TAS pre-void value. Our findings were keeping in line with findings of other similar studies[8,11,13,14]. Spearman correlation coefficient demonstrated a positive association between all three measurements. In a larger study in Korea examining 255 women found mean cervical lengths of 3.93 ± 0.72 cm on TVS and 3.88 ± 0.73 cm on TAS[13].

In the present study the investigators were able to obtain 100% valid pre-void TAS measurements. But Friedman et al were only able to achieve a 94% success rate [8]. Lower rate observed may be due to the fact that their sample had higher BMI. Another important aspect is that they carried out TAS cervical length measurements during routine anatomy ultrasound studies without increasing the time allocated to each session. In the present study time was not restricted to each scan allowing reasonable time to be available to obtain a valid TAS pre-void measurement. Kagan et al describing technique of obtaining valid cervical length measurement emphasis that scan time should be between 3 to 5 minutes[15]. This is due to the fact that cervix is not a static structure hence its length can vary depending on patient position, fetal position or uterine contractions. So operator needs to appreciate these features and take at least three measurements during the course of examination. So implementing a time restriction would negatively affect success of obtaining a valid measurement.

In our study a valid TAS post-void was obtained only in 49.47% participants. Similarly To et al was also able to achieve an overall TAS success rate of 49%[16]. This failure rate was much higher compared to those observed in an Australian[14] (17.2%) and (17.9%) in an

American study[8]. Possible reasons for this may be that mean GA in the present study was 14 week+1 day while it was above 20 week for aforementioned two studies.

Factors associated with success in obtaining a valid post-void TAS were lower BMI and lower maternal age while gestational age did not show a significant association. A past history of caesarean delivery , laparoscopy or laparotomy was also significantly associated with inability in obtaining a valid post-void TAS measurement. Women with high BMI would have thicker anterior abdominal wall making it difficult to obtain TAS measurement specially when bladder is not sufficiently filled to provide an acoustic window These findings can be used in combination with further research findings in developing criterion to screen unsuitable clients for post-void TAS. In addition it strengthens the effectiveness of the practice of encouraging clients in having a full bladder prior to TAS.

Globally 25 mm TVS cervical length is used as the cut off as identified by international bodies in diagnosing short cervix[17,18]. Since the objective is to select women for TVS and not to miss many cases of short cervix, a relatively higher sensitivity is needed in both TAS pre and post void cut off values.

The shortest cervical length which can be significantly predicted by the pre-void TAS in the study sample was 26mm. For this value the cutoff with maximum sensitivity and specificity was 33 mm in pre-void TAS. This means that when women are to be screened for short cervix, 87.5% women with a cervical length of 26 mm or less could be detected by the pre-void TAS. It further means that only 12.5% women with an actual short cervix (of 26 mm or less) will be falsely classified as not having a short cervix. Equivalently , high TAS cut-off values have been determined in previous studies in order to maintain high sensitivity[8,12].

Even among these women, some may be directed for further evaluation for short cervix considering the factors associated with the cervical length. When more powerful predictive models are developed with further research evidence, women who are filtered with TAS could be directed for TVS, significantly reducing the workload of prenatal ultrasound units. The value of this is further proven with the clients responses on the self-rated embarrassment, pain and preference of future US modality. Most are preferring TAS over TVS.

Shortest cervical length which can be significantly predicted by the post-void TAS in the study sample was 28 mm. For this value the cutoff with maximum sensitivity and specificity was 28.165 mm in post-void TAS. This means that when women are to be screened for short cervix, only 75% women with a cervical length of 28 mm or less could be detected by the post-void TAS. It further means that 25% women with an actual short cervix (of 28 mm or less) will be falsely classified as not having a short cervix.

While a valid post-void TAS was obtained only during 50.53% of scans, post-void cut off of <28.165 mm for detecting TVS measured cervical length of <28 mm with a sensitivity of 75% and specificity of 51.6%. The relatively lower validity parameters and the longer cervical length which could be detected, point towards the better effectiveness of performing pre-void TAS than the post-void counterpart.

Saul et al [19] found 30 mm to be a sensitive TAS cut value for detecting TV measured short cervix, whereas Hernandez-Andrade et al and Friedman et al found TA measurements less than 25 mm and 30 mm to be poorly sensitive[8,12]. Present study findings are similar to the findings of latter authors indicating that higher TAS cut off values are required to obtain a high sensitivity. Disagreement between some previous studies may be due to study designs that mainly focused on describing the correlation between TAS and TVS measurements and were underpowered to determine test characteristics for prediction of TVS measured short cervical length of less than 25 mm [8,12,19].

Though we were able to predict TVS cervical length equal or less than 26 mm (pre-void TAS) and 28 mm (post-void TAS), neither of the TAS methods were successful at reliably detecting a TVS <25 mm. This may be owing to the fact that the prevalence of such short cervical lengths were rare among the study sample.

Currently evidence is conflicting regarding clinical usefulness of TAS measured cervical length. Furthermore many society guidelines recommend use of TVS measured cervical length during between 16+0 and 24+0 weeks of gestation [17,20]. Prior to 16 weeks of gestation, some studies have shown that the lower uterine segment is underdeveloped, making it challenging to distinguish this area from the endocervical

canal[21]. This may be a reason why it was failed in the present study in obtaining valid post-void TAS in significant number of patients.

Implementing such screening program is logistically feasible in countries where there is an already established practice of routine anomaly scan performed from 18 to 21 week of gestation. Cervical length screening can also be carried out during the same session avoiding repeated hospital visit to patient and without over burdening health care system. Sri Lankan public health system at the moment does not have such routine anomaly scan but provide early dating scans to all pregnant women. So in our setting incorporating a cervical length screening program to already existing dating scans is a feasible strategy . Transabdominal ultrasound is routinely used during dating scans and by using pre and post void cervical length cut offs determined in our study , health care providers can reliably screen for women with short cervix.

Limitations

Screening of cervical length is recommended from 16+0 to 24+0 weeks of gestation. But our study included pregnant women from 1 1+0 to 22+6 weeks (mean 14+1 week).

Women with risk factors for preterm birth were excluded from the study. This may have led to lower incidence of women with short cervix in our study . This in turn would have led to lower sensitivity of TAS cut off values and inability to reliably detect TVS <25mm.

Conclusion and recommendations

- Advanced age, higher gravidity , higher parity and higher number of vaginal deliveries were significantly associated with a higher TVS cervical length.

- Pre-void transabdominal ultrasound could identify 87.5% of women with cervix equal or less than 26 mm at a cut-off of 33 mm.

- Post-void transabdominal ultrasound could identify 75% of women with cervix equal or less than 28 mm at a cut-off of 28.16 mm.

- Post-void transabdominal ultrasound was unable to obtain valid cervical length measurement in nearly half of attempts. This was associated with higher BMI, maternal age and having undergone major gynaecological surgery or caesarean section.

- Pregnant women felt significantly more embarrassment and discomfort with TVS. Majority preferred transabdominal scan in their next pregnancy.

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