Biometric analysis of uterine cervix during pregnancy using transvaginal ultrasonography and magnetic resonance imaging*

Avaliação biométrica do colo uterino durante a gestação por meio da ultra-sonografia transvaginal e ressonância magnética

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Abstract **OBJECTIVE: To evaluate the uterine cervix length with magnetic resonance imaging in comparison with findings at transvaginal ultrasonography. MATERIALS AND METHODS: Twenty pregnant women between the 19th and 30th gestational weeks underwent magnetic resonance imaging and transvaginal ultrasonography for evaluation of their uterine cervix. Measurements by means of magnetic resonance imaging were performed by two specialists in imaging diagnosis for calculating the interobserver variability of the method. RESULTS: Calculation of the Pearson's correlation coefficient between measurements of the cervical length demonstrated a significant correlation between the results of both methods ($r = 0.628$; $p < 0.01$). The paired *t* test demonstrated no statistically significant difference between measurements obtained by transvaginal ultrasonography and magnetic resonance imaging ($p = 0.068$). Interobserver agreement in cervical measurements by magnetic resonance imaging was high ($\alpha = 0.96$), demonstrating the reliability of the method. CONCLUSION: The comparison between both imaging methods in the evaluation of cervical biometry showed no statistically significant difference thus reinforcing the utilization of ultrasonography. However, in some cases where transvaginal ultrasonography is contraindicated, magnetic resonance imaging can be alternatively utilized for measurement of the cervical length.**

Keywords: Uterine cervix; Pregnancy; Magnetic resonance imaging.

Resumo **OBJETIVO: Avaliar o comprimento do colo uterino por meio da ressonância magnética e comparar aos achados da ultra-sonografia transvaginal. MATERIAIS E MÉTODOS: Foram realizados exames ultra-sonográficos e de ressonância magnética do colo uterino em 20 pacientes com idade gestacional entre 19 e 30 semanas. As medidas do colo obtidas pelo exame de ressonância magnética foram aferidas por dois especialistas em diagnóstico por imagem, para calcular a variabilidade interobservador do método. RESULTADOS: O cálculo do coeficiente de correlação de Pearson entre as medidas do comprimento cervical indicou correlação significante entre os métodos ($r = 0{,}628$; $p < 0{,}01$). A aplicação do teste *t* pareado não evidenciou diferença significativa entre as medidas aferidas pela ultra-sonografia transvaginal e ressonância magnética ($p = 0{,}068$). A análise da variabilidade interobservador das medidas do colo obtidas pela ressonância magnética demonstrou alta confiabilidade do método ($\alpha = 0{,}96$). CONCLUSÃO: A comparação entre os dois métodos de imagem na avaliação da biometria cervical não apresentou diferença estatística, o que reforça a aplicação do exame ultra-sonográfico. Entretanto, em situações nas quais a ultra-sonografia transvaginal apresenta contra-indicações, o exame de ressonância magnética poderá apresentar-se como segunda opção para a avaliação do comprimento cervical.**

Unitermos: Colo uterino; Gravidez; Imagem por ressonância magnética.

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INTRODUCTION

Since the decade of the 1970s, ultrasonography (US) has been utilized in the evaluation of the uterine cervix during gestation for identifying structural alterations indicative of risk for spontaneous preterm delivery[1–3]. So far, amongst the sonographic parameters considered in the as-

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sessment of the uterine cervix, the length is the most utilized and reproducible variable, with reduced intra- and interobserver variability (< 10%)[4].

Although a consensus is still to be reached in the literature about the ideal gestational age for sonographic assessment of the uterine cervix, as well as about the threshold value indicating high risk for preterm delivery, the majority of studies in the literature present a common conclusion: the shorter the uterine cervix length, the higher will be the risk for preterm delivery[5–11].

A small number of studies in the literature have focused on the evaluation of the uterine cervix during the gestational period by magnetic resonance imaging (MRI)[12–17]. The uterine cervix presents a singular appearance at MRI studies in pregnant or non-pregnant women, demonstrating morphological findings which could not be demonstrated by any other imaging method[12]. The clinical application of MRI in the assessment of the uterine cervix allows the identification of both biometrical and morphological alterations[13], besides the evaluation of the tissue hydration level by analyzing the signal intensity of the cervical stroma[14].

The present study was aimed at evaluating the uterine cervix length by means of MRI, in a way hitherto unprecedented in the medical literature, comparing with the findings of transvaginal ultrasonography (TVUS), with the objective of improving the accuracy of the study of the uterine cervix during the gestational period.

MATERIALS AND METHODS

Patients

The present study was approved by the Committee for Ethics in Research of Universidade Federal de São Paulo/Escola Paulista de Medicina, São Paulo, SP, Brazil, and the examinations were performed at Centro de Diagnóstico por Imagem (CDI), Vitória, ES, Brazil.

The patients were selected by the medical researcher and informed about the present study at the moment of their first-trimester obstetric US evaluation. The women who were interested in participating in the study were instructed to return at the second half of their gestation, and examinations were performed after the signature of a term of informed consent.

The sample of the present study included 22 pregnant women between their 19th and 30th gestational weeks. Cases of dead fetus, early amniorrhexis, vaginal bleeding, placenta previa, previous history of uterine cervix surgery, uterine malformation, multiple gestation and fetal malformation were excluded from the present study.

Examination

The measurement of the uterine cervix length was performed by means of post-voiding TVUS, in a Logic 5 equipment (GE Medical Systems; Wisconsin, USA) with a multifrequency 5.0–9.0 MHz vaginal transducer. All the measurements were performed by the medical researcher.

After the insertion of the vaginal transducer and identification of internal and external orifices, without applying any compression to the cervix, the endocervical canal was defined as a hypoechoic line between the orifices. The measurement of the uterine cervix length was performed on the sagittal view after the image magnification, covering on average 75% of the monitor screen, by drawing a straight line between the external and the internal cervix orifices (Figure 1). Minimum examination time was five minutes, three measurements were performed, and the lowest value found along the observational period was selected.

Immediately after the TVUS, and with no previous knowledge of the sonographic findings, MRI studies were performed in a high-field 1.5 tesla Achieva equipment (Philips Medical Systems; Best, The Netherlands), with a 4-channel sense coil.

Sagittal images were acquired with the patients in dorsal decubitus, utilizing turbo spin echo (TSE) and echo planar, T2-weighted sequences, 3 mm-thick slices, matrix 256 × 512 and field-of-view (FOV) 25 cm. The images were stored in the monitor of the MRI equipment.

The uterine cervix length was measured by drawing a continuous straight line between the external and internal orifices of the cervix, a technique similar to the one adopted in the TVUS (Figure 2). The evaluation of uterine cervix length by MRI was performed by two diagnostic imaging specialists. Following double-blind measurements, the values for uterine cervix length at TVUS were compared with those obtained at sagittal MRI.

Statistical analysis

The paired *t*-test was utilized to estimate the differences and comparing values for uterine cervix lengths obtained by TVUS and sagittal MRI. Intermethod agreement was evaluated by the Pearson's correlation coefficient, and interobserver variability in MRI studies was evaluated by the Cronbach's alpha test.

RESULTS

Among the 22 patients initially included in the present study, two were excluded for the presence of placenta previa and fetal malformation. Therefore, 20 patients in the age range between 16 and 39 years (mean,

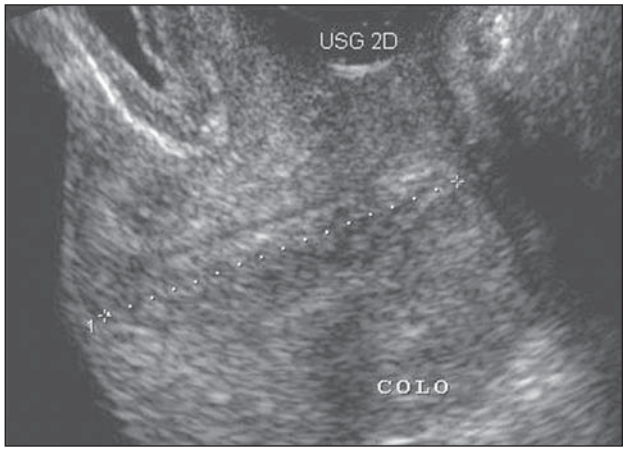
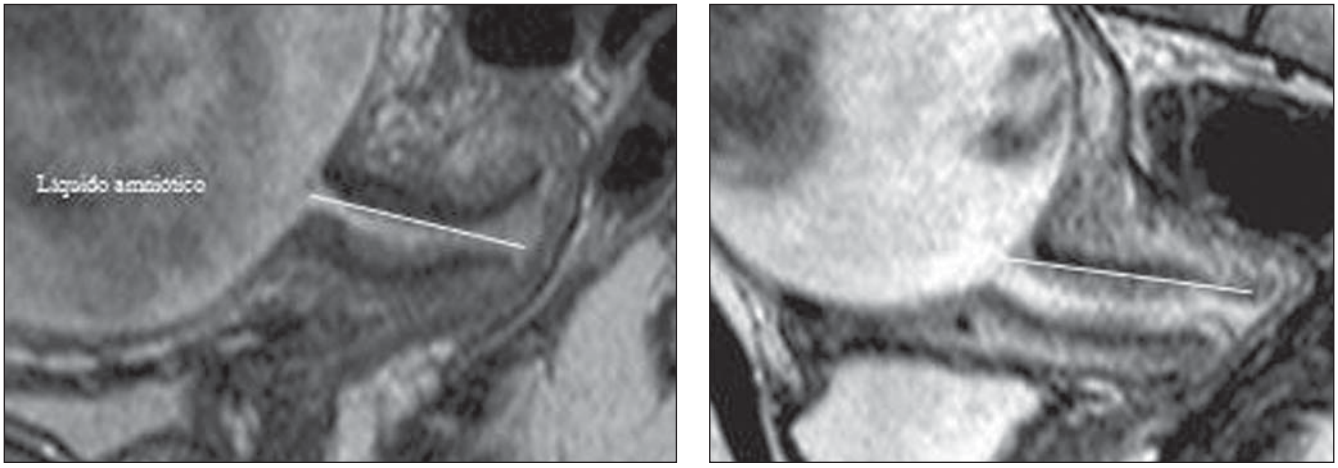


Figure 1. Sonographic image of uterine cervix demonstrating the mode of measurement of the cervix length.



A B

Figure 2. MRI of uterine cervix demonstrating measurement of the cervix length.

27.2 years) were evaluated. As regards race, 60% were white, and 40% of mixed races.

As regards previous obstetric history, 55% of the women were nulliparous, and 45% were multiparous. Most of them were married (85%), and the educational level was distributed as follows: 20% primary education, 45% secondary education, and 35% higher education level.

Mean gestational age at the moment of the study was 24.6 ± 3.3 weeks (minimum 19.6 weeks, and maximum 30.5 weeks).

The Pearson's correlation coefficient between uterine cervix lengths measures by TVUS and MRI indicates a significant intermethod correlation, demonstrating a linear association between measurements ($r = 0.628$; $p < 0.01$) (Figure 3).

In the evaluation of differences between mean values for uterine cervix length (paired *t*-test) no statistically significant difference was found between measurements by TVUS and MRI (Table 1), evidencing the correlation between measurements.

The highest values (± standard deviation) for uterine cervix length were found by means of MRI (33.7 ± 5.91 mm). The box-plot graphic illustrates the data distribution (Figure 4).

The analysis of interobserver variability of measurements by MRI demonstrated the reliability of the method ($\alpha = 0.96$).

DISCUSSION

Scarce studies in the international literature report the utilization of MRI in the

Table 1 Comparison of mean values uterine cervix length measured by TVUS and MRI.

Comparison	*n*	Mean (mm)	Standard deviation	Paired *t* test	*p*-value
Sagittal uterine cervix length (TVUS)	20	31.35	6.63		
Sagittal uterine cervix length (MRI)	20	33.71	5.91	1.937	0.068

Paired *t* test, $p < 0.05$.

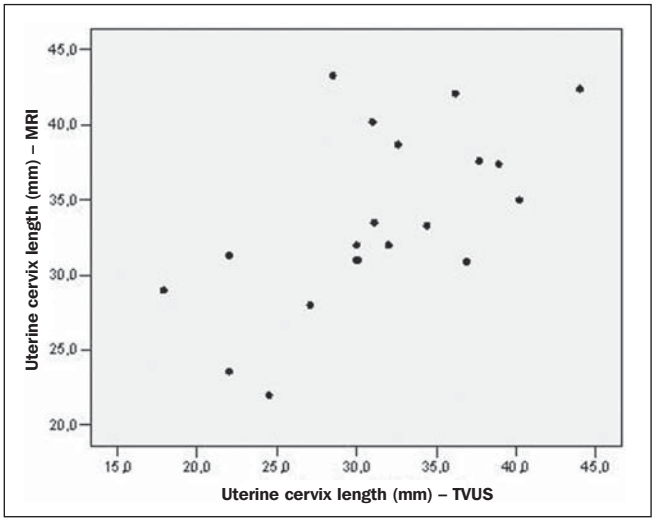


Figure 3. Graphic demonstrating the correlation between uterine cervix lengths measured by TVUS and MRI.

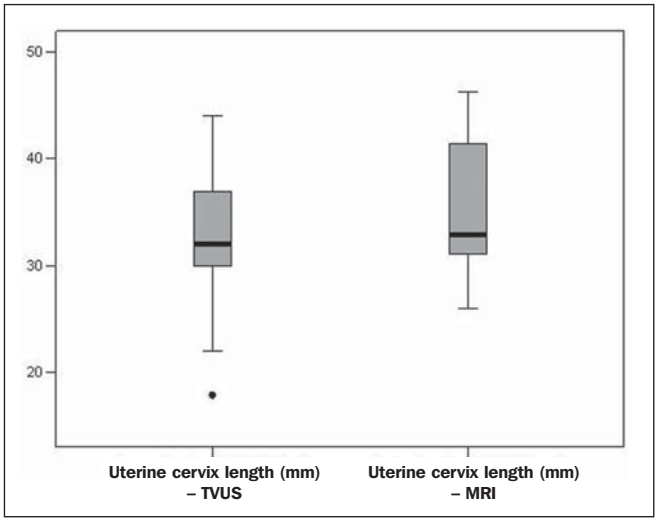


Figure 4. Graphic demonstrating values for uterine cervix lengths measured by TVUS and MRI.

uterine cervix evaluation during the gestation[12–17]. So far, no study was found in the literature comparing TVUS and MRI in the evaluation of the uterine cervix during gestation.

TVUS was introduced late in the eighties as a method for evaluating risk markers in the prediction of spontaneous preterm delivery, the transvaginal approach being superior to transabdominal US and digital vaginal examination[4,5,18]. Some researchers consider TVUS as an objective, non-invasive and reliable method for evaluating the uterine cervix and segment, particularly in the second gestational trimester, improving the screening for preterm delivery[5,19–22].

Some of them have mentioned the MRI superiority as compared with US in the evaluation of soft tissues, demonstrating the high resolution and tissue contrast capabilities of the method[17,23]. MRI enables the visualization of biometric and functional alterations of the uterine cervix[24], and is the only method that can provide information on the physiological status of the cervical stroma[16].

Anatomical MRI findings in the uterine cervix were first described by Hricak et al.[25] in 1990, and afterwards by other authors who reported similar data[26,27]. Different areas of the cervix can be visualized at MRI: the cervical stroma extending from the internal to the external orifice, demonstrated as low-intensity strip on the internal portion and moderately intense on the peripheral zone, similarly to the myometrium; and the central region of the cervix including the endocervical glands and mucus, presenting medium and high intensity signal (Figure 5).

Qualitative variations in the cervical signal intensity are correlated with the different histological aspects of the cervical tissue components [25,26]. The uterine cervix is a fibromuscular structure, and 10%–15% of the stroma corresponds to a smooth musculature located in the periphery of the cervix. Collagenous connective tissue predominates in the inner stroma; and cylindrical glandular epithelium and mucus, in the central portion of the cervix [25,26].

A group of researchers of the University of Hong Kong has developed an observational study with 91 pregnant women at their 35–40th gestational weeks. These authors have utilized MRI to evaluate the uterine cervix, correlating the findings with the gestational age and delivery time interval. Among other variables, uterine cervix length, signal intensity of the cervical stroma and respective quantitative analysis (relaxation index) have been researched[14]. In their results, the authors have demonstrated (*t*-Student test) a significant correlation between the signal intensity of the cervical stroma and relaxation index (p = 0.035 and 0.031, respectively) and gestational age, i.e., the relaxation index increases as the gestational age progresses[14]. According to these authors, pregnant women with increased tissue signal intensity presented a shorter delivery time interval ($p = 0.019$)[14]. The mean cervical length was 34.3 mm (standard deviation = 0.92), similarly to the results of the present study (33.7 ± 5.91 mm). However, in contrast to the present study, the interobserver variability coefficient has demonstrated a poor correlation ($r = 0.52$) in the analysis of the cervical length measurement by MRI as compared with the results of the present study ($\alpha = 0.96$).

In 2005, House et al.[17] evaluated the biometrical alterations and cervical transformations demonstrated by MRI, associated with gestational age progress and previous vaginal delivery. In 53 patients evaluated in the period between the 17th and 36th weeks, these authors observed an increase in the area of the endocervical canal (31%), cervical stroma (10%) and higher signal intensity in the cervix tissue (10%) with the progress of the gestational age. The mean uterine cervix length was 35.8 ± 8.6 mm and the greatest part of the MRI studies was performed before the 24th week and in the period between the 30th and 35th gestational weeks[17].

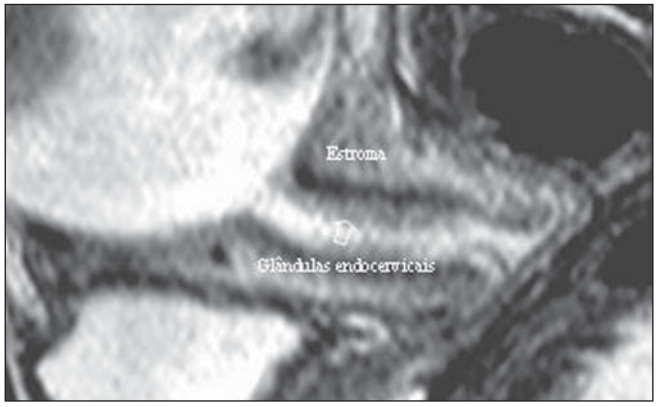


Figure 5. Uterine cervix anatomical MRI findings.

MRI provides uterine cervix images with high tissue contrast, besides allowing the analysis of the cervical anatomy. Currently it is considered as a relevant tool in the evaluation of biophysical transformations of the uterine cervix[15]. The phenomenon of cervical dilatation is preceded by cervical effacement characterized by shortening and alteration of the cervical stroma intensity signal. These transformations originate in the alteration in the amount of water and collagenous tissue which change the signal intensity of the cervical stroma and can be detected by MRI[15].

CONCLUSION

In this study, no statistically significant difference was found in the comparison between the two imaging methods in the biometric analysis of the uterine cervix. This finding reinforces the applicability of TVUS, considering the low cost and higher availability of the method. However, in cases where TVUS is contraindicated such as in the early amniorrhexis or patient's refusal of transvaginal approach, MRI can be alternatively utilized for evaluating the uterine cervix length with reduced interobserver variability. The anatomical detailing of uterine cervical tissues allows the recognition of MRI as a promising method for evaluating the structural alteration of the uterine cervix involved in the gestation and spontaneous preterm delivery. Further studies should confirm this assumption.

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