Evaluation of uterine scar healing by transvaginal ultrasound in 607 nonpregnant women with a history of cesarean section

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Research article

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Abstract

Background: Caesarean scar defect (CSD) seriously affects female reproductive health. In this study, we aim to evaluate uterine scar healing by transvaginal ultrasound（TVS）in nonpregnant women with cesarean section（CS）history and to build a predictive model for cesarean section defects is very necessary.

Methods: A total of 607 nonpregnant women with previous CS who have transvaginal ultrasound measurements of the thickness of the lower uterine segment . The related clinical data were recorded and analyzed.

Results: All patients were divided into two groups according to their clinical symptoms: Group A (N=405) who had no cesarean scar symptoms, and Group B (N=141) who had cesarean scar symptoms. The difference in frequency of CS, uterine position, detection rate of CSD and the the residual muscular layer (TRM) of the CSD were statistically significant between groups; the TRM measurements of the two groups were (mm) 5.39±3.34 vs 3.22±2.33, P<0.05.All patients were divided into two groups according to whether they had CSDs: Group C (N=337) who had no CSDs , Group D (N=209) who had CSDs on ultrasound examination. The differences in frequency of CS, uterine position, TRM between groups were statistically significant (P<0.05). In the model predicting CSDs by TRM with TVS, the area under the ROC curve was 0.771, the cut-off value was 4.15 mm. The sensitivity and specificity were 87.8% and 71.3%,respectively.

Conclusions: Patients with no clinical symptoms had a mean TRM on transvaginal ultrasonography of 5.39 ± 3.34 mm, which could be used as a good reference to predict the recovery of patients with CSDs after repair surgery.

Background

With the increasing cesarean section (CS) rate, a growing number of studies suggest that the occurrences of long-term consequences of CS are related to the incomplete healing of the CS scar in the uterus, which leads to the development of cesarean scar defects (CSDs)[1−3]. In routine ultrasound examinations of the uteri of nonpregnant women with a history of at least one CS, the prevalence of CS scar defects ranges from 24–70%[4]. Some patients with CSDs are asymptomatic, but several investigators have reported an association between these defects and abnormal bleeding and postmenstrual spotting [5, 6]; CSDs can also cause chronic pelvic pain and even infertility[7]. Moreover, the development of CSDs seems to be on the rise, and CSDs can occur on a spectrum of disorders starting with cesarean scar (CS) ectopic pregnancy[8], to increased incidence of placenta previa and uterine rupture associated with major maternal morbidity, and even mortality[9]; this is a medical problem that affects a large population of women. Therefore, the detection and diagnosis of uterine incision diverticulum is very important, especially in asymptomatic patients.

In particular, the thickness of the residual muscular layer (TRM) of the CSD directly affects the severity of the clinical symptoms and the risk of maternal complications, such as uterine rupture in subsequent pregnancy. Therefore, it is very important to evaluate uterine scar healing in nonpregnant women with previous cesarean section. Transvaginal ultrasound is the most convenient and noninvasive means of examination. However, most of the studies about uterine incision healing included measurements of the lower uterine segment (LUS) thickness in pregnant women with a previous caesarean delivery[10, 11]. There is a lack of transvaginal ultrasound evaluations and multisampling statistical analyses for LUS measurements in nonpregnant women. There is no clinical reference standard to evaluate the efficacy of surgical repair in CSD patients. Therefore, this study investigated the ability of transvaginal ultrasound to detect cesarean scars and the prevalence of scar defects in nonpregnant subjects. By measuring the thickness of the scar in the lower segment of the uterus, diameters of the CSDs, uterine position and other imaging data, the range of TRM values in nonpregnant women with a CS history could be determined. The purpose of this study was to determine the value of LUS thickness that predicts good healing of the uterine incision after cesarean section and to reveal the clinical indicators that predict CSD and could be used clinically in patient management.

Methods

Each subject underwent a transvaginal ultrasound of the cervix, uterus, and adnexa, which was performed by one experienced sonographer blinded to the woman’s history. Ultrasound examinations were performed using a color ultrasonic diagnostic apparatus, Philips iU22, Philips HD15, GE E8. Both ultrasound devices were equipped with a 4–9 MHz transvaginal probe. Cesarean scar defects were recorded as either present or absent. If a CSD was present, the defect was measured in two dimensions in the sagittal plane (anterior–posterior and cephalad–caudal) and transversely in the coronal plane. Three different values of length, width, and depth as well as TRM were taken, and the mean value of these parameters was considered the actual data. The frequency of scar identification, as well as the presence of fluid within the scar (“scar defect”), was recorded and later compared with the self-reported obstetric history. Photo documentation was recorded with the presence or absence of a cesarean scar defect and the presence or absence of fluid within the scar (Fig. 1). Additional images of the endometrial stripe thickness, presence or absence of polyps or myomas, and ovarian volumes were also recorded. Each subject was assigned a study number on entry. Data obtained from the questionnaires (including age, contact information, number of cesarean sections, time of last cesarean section, menstruation and so on) and from the ultrasound were entered separately.

Statistical analysis

Measurement data, such as length, width and depth as well as the TRM of the bottom of the CSD were expressed as the mean ± SD. Continuous variables were compared using paired t-tests. The results of the measurements were used to obtain receiver operating characteristic (ROC) curves to predict CSDs. With the use of these curves, the threshold values of each variable were set. Variables that achieved statistical significance in the univariate analysis were subsequently included in the multivariate analysis. A P value < 0.05 (two-tailed) was considered statistically significant. SPSS version 24.0 was used for all statistical calculations.

Results

Patient characteristics

A total of 607 consenting women with a history of at least one cesarean section were enrolled in the study over the period from October 2016 to October 2018; 17 subjects who did not undergo transvaginal ultrasound and 43 patients who underwent transvaginal ultrasound but did not have TRM measurements were excluded. A total of 546 women completed the study. All patients were divided into two groups according to their clinical symptoms: Group A (N = 405) included women who had no cesarean scar symptoms, and Group B (N = 141) included women who had cesarean scar symptoms, such as postmenstrual spotting, prolonged menstruation, and continuous brown discharge. The women were also divided into two groups according to their CSD status: Group C (N = 337) included women who had no CSDs on the ultrasound examination, and Group D (N = 209) included women who had CSDs on the ultrasound examination. The baseline characteristics of the 546 patients are presented in Table 1.

Table 1
Patient characteristics

Group	noCSD	CSD	Total
asymptomatic	310	95	405
symptomatic	27	114	141
Total	337	209	546

Clinical characteristics of the Patients in Group A and Group B

Group A (N = 405) included women who had no clinical symptoms. Group B (N = 141) included women who had cesarean scar symptoms, such as postmenstrual spotting, prolonged menstruation, and continuous brown discharge. The clinical data and uterine incision healing data were compared between the two groups. The results showed that the average age of the two groups of patients was 35.09 ± 5.32 vs 34.00 ± 4.83 years old, and the median age of the two groups was 34 years old. The number of women who only had one previous CS in Group A was 356 (87.9%) vs the 102 (72.3%) in Group B. The uterine positions of two groups of patients on ultrasound examination were compared, anterior position: 242 (59.8%) vs. 65 (46.1%); meso-position: 20 (4.9%) vs. 6 (4.3%); and retroposition: 143 (35.3%) vs. 70 (49.6%), P < 0.05. The detection rates of CSD in the two groups were dramatically different, 23.5% vs. 80.9%, P < 0.05. The length, depth, width and TRM of the CSD were all significantly different between the two groups (Table 2).

Table 2
Characteristics of clinical data between symptomatic group(Group A) and asymptomatic group(Group B)

		Group A(N = 405)	**Group B(N = 141)**	***P***
age(y)		35.09 ± 5.32	34.00 ± 4.83	$P = 0.148$
Number of C-section deliveries	one	356(87.9%)	102(72.3%)	$P < 0.05$
	two	46(11.4%)	36(25.5%)	
	More than two	3(0.7%)	3(2.1%)	
Uterus position	Anteflexion	242(59.8%)	65(46.1%)	$P < 0.05$
	Meso-position	20(4.9%)	6(4.3%)	
	Retroflexion	143(35.3%)	70(49.6%)	
hysteromyoma		71(17.5%)	15(10.6%)	$P = 0.053$
CSD(N)		95(23.5%)	114(80.9%)	$P < 0.05$
CSD parameters	length(mm)	5.09 ± 2.31	5.96 ± 2.64	$P < 0.05$
	depth(mm)	6.62 ± 3.05	8.39 ± 3.72	$P < 0.05$
	width(mm)	8.89 ± 4.15	11.44 ± 4.98	$P < 0.05$
	D▯W	1.85 ± 1.55	3.84 ± 3.08	$P < 0.05$
	TRM(mm)	5.39 ± 3.34	3.22 ± 2.33	$P < 0.05$

Clinical characteristics of the patients in Group C and Group D

Group C (N = 337) included women who had no CSDs on transvaginal ultrasound, Group D (N = 209) included women who had detected CSDs on transvaginal ultrasound. The average age of two groups patients was 35.04 ± 5.41 (Group C) vs 34.44 ± 4.88 (Group D) years old, and the median age of two groups was 34 years old. The number of patients who only had one previous CS in Group C was 297 (88.1%) vs the 161 (77%) in Group D, P < 0.05. The uterine position of two groups on transvaginal ultrasound were compared, anterior position: 215 (63.8%) vs 92 (44%), meso position: 11 (3.3%) vs 15 (7.2%), and retroposition: 111 (32.9%) vs 108%, P < 0.05. The mean TRM measurements in the two groups were 6.54 ± 2.13 vs 4.21 ± 3.03, P < 0.05. The TRM in the non-CSD group was significantly thicker than that in the CSD group (Table 3).

Table 3
Characteristics of clinical data in non-CSD group and CSD group

		Group C(N = 337)	Group D(N = 209)	*P*
age(y)		35.04 ± 5.41	34.44 ± 4.88	$P = 0.355$
symptomatic		27(8.0%)	114(54.5%)	$P < 0.05$
Number of C-section deliveries	one	297(88.1%)	161(77%)	
	two	38(11.3%)	44(21.1%)	$P < 0.05$
	More than twice	2(0.6%)	4(1.9%)	
Uterus position	Anteflexion	215(63.8%)	92(44%)	$P < 0.05$
	Meso-position	11(3.3%)	15(7.2%)	
	Retroflexion	111(32.9%)	102(48.8%)	
hysteromyoma		61(18.1%)	25(12%)	$P = 0.056$
TRM(mm)		6.54 ± 2.13	4.21 ± 3.03	$P < 0.05$

Receiver Operating Characteristic Curves And Logistic Analysis

The clinical symptoms, uterine position, and TRM in the women with CSDs were significantly different from those in the women without CSDs. The results of logistic multivariate regression analysis are shown in Table 4. The ROC curves of the CSD and non-CSD groups were drawn with these three values (Fig. 2). The curves obtained from the three values together to predict CSD indicated a cutoff value of 0.346 with a sensitivity of 84.6% and a specificity of 55.9% (95% CI 0.76–0.85). In terms of individual indicators to predict CSDs, the TRM with TVS had a high predictive value. The ROC curve indicated that at the cutoff value of 4.15 mm, the TRM variable had a sensitivity of 87.8% and a specificity of 71.3% for predicting CSDs (95% CI 0.723–0.819), and the area under the ROC curve was 0.779 (Table 5).

Table 4
Logistic regression analysis results

	B	S.E.	*Wald*	df	P	Exp(B)	95%CI
symptom	2.95	0.26	*70.31*	1	0.00	8.98	5.38–14.99
Uterus position	0.29	0.11	*6.68*	1	0.10	1.33	1.07–1.66
TRM	0.25	0.04	*31.05*	1	0.00	0.78	0.72–0.85

Table 5
Receiver operating characteristic curves

Indicator	Cut-off	AUC	*P*	sensitivity	specificity	Youden's index	95%CI
Symptom	0.522	0.733	$P < 0.05$	0.545	0.92	0.465	0.686–0.779
Number of C-section deliveries	0.444	0.556	$P < 0.05$	0.23	0.881	0.111	0.506–0.606
Uterus position	0.389	0.603	$P < 0.05$	0.56	0.638	0.198	0.554–0.652
TRM	4.15	0.771	$P < 0.05$	0.878	0.713	0.591	0.723–0.819
Three indicators	0.346	0.805	$P < 0.05$	0.713	0.846	0.559	0.761–0.848

Discussion

In China, the proportion of caesarean sections (CSs) performed in 2010 was 35–58%, which has attracted significant concern regarding the development of CSDs [12]. With the increasing CS rate and the implemented two-child policy in China, the complications of CSDs, such as prolonged menstrual bleeding, secondary infertility, and even uterine rupture during a subsequent pregnancy, have emerged as important clinical problems[13]. Therefore, it is necessary to evaluate cesarean section scarring before the next pregnancy.

CSDs can be detected by transvaginal ultrasound (TVU) [3, 14], hysterography, sonohysterography (SHG), magnetic resonance imaging (MRI), and hysteroscopy (HSC) 15–18. Among these methods, transvaginal sonography is a simple, low-cost, and noninvasive examination that should be considered as the first choice for screening[19]; nevertheless, unskilled gynecologists or the use of a low-resolution ultrasound machine can miss defects during routine ultrasound scans, especially if the operator does not suspect a CSD and there does not look for a defect.

N. Singhl et al[20] evaluated scar thickness in pregnant patients with previous caesarean section by TVS and magnetic resonance imaging (MRI) to determine the precision of radiologically measured scar thickness with the actual measured scar thickness. These measurements were correlated with each other and with the scar thickness measured during elective repeat caesarean section using a caliper. The study showed that the thickness measured with TVS had a better correlation coefficient with the actual scar thickness than the thickness measured with MRI ($R = 0.72$ vs. $R = 0.59$). Marasinghe's research had similar conclusions[21]. These authors all relieved that TVS could be considered the preferred modality for antenatal scar thickness measurements.

Therefore, our study established a CSD risk assessment model by applying TVS to evaluate the uterine scar healing of 607 women with a history of cesarean section. The results showed that the TRM measured with TVS effectively predicted CSDs when TRM was less than 4.15 mm, and uterine incision diverticulum was more easily detected below this thickness threshold. In other words, if the detected TRM was less than 4.15 mm by ultrasonography, but a CSD was not found, it was suggested that the scar condition should be re-evaluated by other imaging examinations. This method could avoid missed diagnoses of poor uterine scar healing.

A study by Hayakawa et al., in turn, enrolled a total of 137 women and demonstrated that double-layer interrupted sutures reduced the prevalence of myometrial defects after CS 30–38 days after surgery[22]. Another randomized study that enrolled 78 women with scar thicknesses evaluated by TVS 40–42 days after surgery found that suturing all the myometrial layers, including the endometrium, reduced the risk for inadequate healing and incomplete regeneration[23, 24]. Finally, a retrospective study by Sevket at al., which applied the longest follow-up period of 6 months, showed that the use of a double layer locked/unlocked suture after CS promoted complete healing[25]. This finding is consistent with the follow-up results of our previous study about the transvaginal repair of CSDs, which showed that the wound healing was stable six months after surgery. In this study, women were followed up for more than 6 months after cesarean section.

The clinical guidelines for the treatment of CSDs remain unclear. Several successful surgical treatments for CSDs have been reported in recent years, including hysteroscopic resection, laparoscopic surgery, laparoscopic and hysteroscopic repair, and vaginal repair. In our previous studies, at 6 months after surgery, 80.3% of patients (94 of 117) reached ≤ 10 days of menstruation, 48 patients (63.2%) had no CSDs, and 11 patients (14.5%) had a > 70% reduction in CSD volume; additionally, CSDs still existed in approximately 40% of patients after vaginal repair [26]. As long as the TRM increased and their menstrual symptoms improved, the repair surgery could still be considered effective in increasing the safety of the second pregnancy. However, no clinical guidelines have been issued for the management of CSDs with intermenstrual bleeding and/or thickness of the remaining muscular layer (TRM) or for the residual muscle thickness that is considered the ideal result of a repair. Therefore, we need to evaluate uterine scar healing in women after cesarean section to obtain the average level of scar recovery.

Conclusions

This study showed that for patients with no clinical symptoms, the mean thickness of the TRM with transvaginal ultrasonography is 5.39 ± 3.34 mm; for the patients who have clinical symptoms, the mean thickness of the TRM with transvaginal ultrasonography is 3.22 ± 2.33 mm. We believe that a residual muscle thickness of 5.39 ± 3.34 mm could be used as a good reference to predict the recovery of patients with CSDs after repair surgery.

Abbreviations

CS	caesarean section
CSD	caesarean scar diverticula (defect)
TRM	thickness of the remaining muscular layer
TVU	transvaginal ultrasound
GDM	gestational diabetes mellitus
LUS	lower uterine segment
ROC	receiver operating characteristic
MRI	magnetic resonance imaging

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Shanghai First Maternity and Infant Hospital (KS1512). This study was retrospective clinical study using medical record, written consent was obtained by the ethics committee.

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Author contributions

XZ: Manuscript writing,data analysis. HQ: Data collection. TZ: Data collection or management. YZ: Manuscript revision,data analysis. XW: Project

development, manuscript editing. All authors read and approved the fina manuscript .

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

All study procedures were approved by the Ethics Committee of Shanghai First Maternity and Infant Hospital, affiliated with Tongji University (KS1512). We conducted research using identifiable electronic medical record data. The research project did not involve personal privacy and commercial interests and was no longer accessible to participants. Therefore, the ethics committee approved the waiver of signed written informed consent and approved the procedure for verbal consent. At the same time, after obtaining ethical approval, we tried to contact the participants before using the data and notified them by phone. A patient who couldn't be reached by phone, whose data could be used directly. For participants with missing follow-up data, oral informed consent was obtained before the start of each telephone interview. All processes have been recorded and saved. Administrative permissions were required to access and use the medical records described in our study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

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Figures

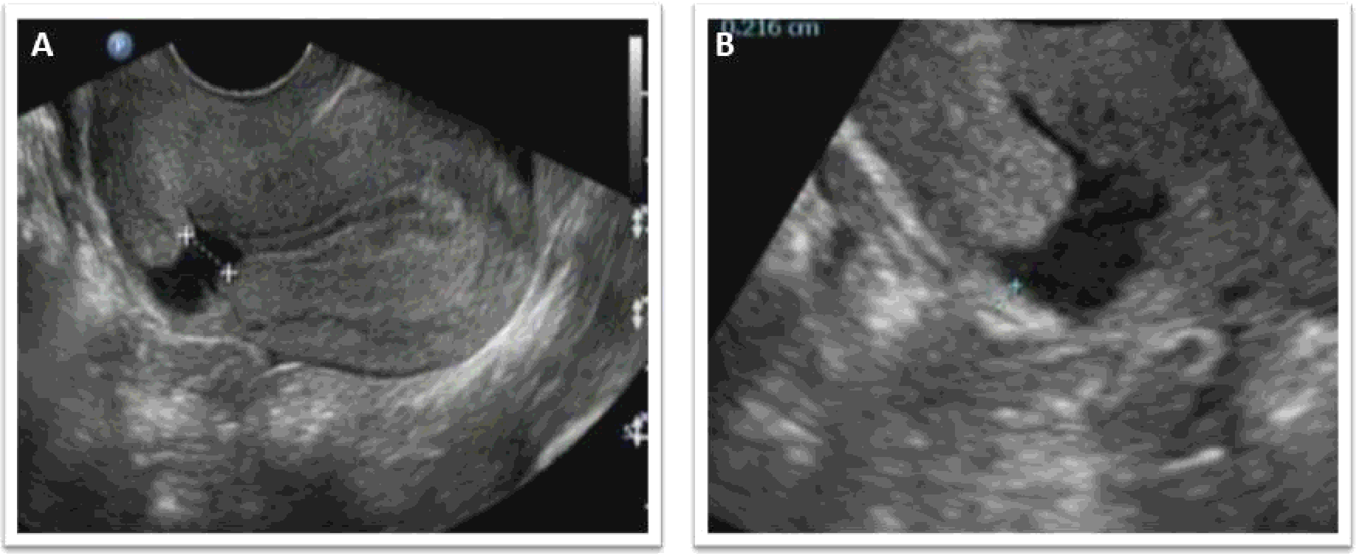

Figure 1

A: CSD under transvaginal ultrasound; B: TRM under transvaginal ultrasound

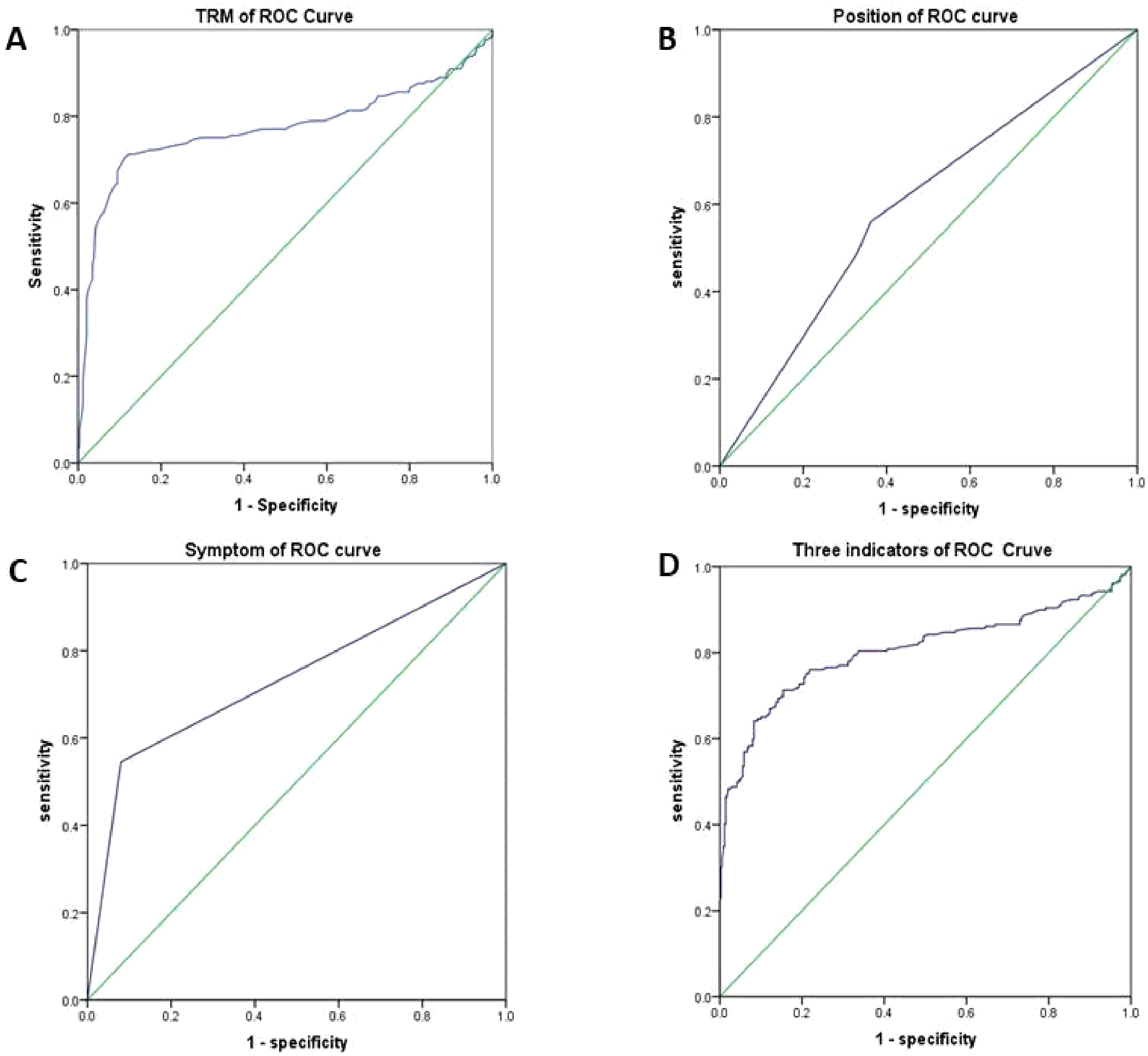

Figure 2

Receiver operating characteristic curves, A: ROC curve of TRM thickness; B: ROC curve of uterine position; C: ROC curve of symptoms; D: ROC curve of all three indicators