

# Diagnostic Accuracy of Three-dimensional Ultrasonography in Detection of Endometrial Lesions compared with Hysteroscopy in Infertile Women

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## ABSTRACT

**Introduction:** Two of the most frequent procedures performed on infertile women are two-dimensional ultrasound (2DUS) and three-dimensional ultrasound (3DUS). Hysteroscopy is considered as the gold standard for evaluation of acquired endometrial lesions in infertile women; however, 3DUS is used as a noninvasive, less expensive, and reliable assessment method for evaluation of the intrauterine lesions in infertile women. We aimed to compare the diagnostic efficiency between 3DUS and hysteroscopy in the detection of lesions (polyps, submucous leiomyoma, and synechiae) in infertile women.

**Materials and methods:** In this prospective observational study, infertile women (n = 155) with indication of hysteroscopy were scheduled to undergo 3DUS prior to hysteroscopy from September 2010 to 2011. Women with suspected congenital uterine anomalies were excluded. The sensitivity and specificity values of 3DUS were compared with those of hysteroscopy. Hysteroscopy was used as the gold standard for diagnosis of intrauterine lesions in infertile women.

**Results:** Of the 155 women, 50 were found to have an intracavitary abnormality, 36 had polyps, 12 had myomas, and 7 had synechiae on hysteroscopic findings. Examination with 3DUS in the diagnosis of intrauterine lesions reached an accuracy of 94%, and 92.15 and 96.9% of sensitivity and specificity respectively. Positive predictive value (PPV) was 83.9%, and a negative predictive value (NPV) was 91.3% (LR+ = 10.75, LR- = 0.065).

**Conclusion:** According to our results, 3DUS has a reliable diagnostic accuracy for intrauterine lesions, and it may limit unnecessary hysteroscopy in patients with normal results.

**Keywords:** Hysteroscopy, Three-dimensional sonography, Uterine cavity.

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## INTRODUCTION

Two-dimensional ultrasound (2DUS) and three-dimensional ultrasound (3DUS) are routinely used as a core part in infertility evaluation. Prior to assisted reproductive technology (ART) cycles, suspected uterine cavity abnormalities can be detected by hysteroscopy.<sup>1</sup> Hysteroscopy is also marked as the gold standard for the assessment of infertile women.<sup>2-4</sup> However, 2DUS and later 3DUS are being applied increasingly to determine preoperatively the presence and extent of the surgical pathology. Also, 3DUS is initially regarded as an experimental investigation tool, which soon developed into a useful complement to 2DUS for evaluation of uterine pathology. In addition, 3DUS may offer a better ground for therapy or verification of results by providing more precise anatomical sections to explore the endometrial cavity, the relations of submucosal myomata and possible encroachment on the cavity, the endometrial polyp, as well as the extent of cavity involvement in intrauterine adhesions. Therefore, it may help to reserve the hysteroscopy for uterine lesions that could benefit from this treatment.

In this study, we aimed to emphasize the diagnostic capabilities of 3DUS with regard to intralisions detection (polyps, submucous leiomyoma, and synechiae) as compared with a gold standard (hysteroscopy).

## MATERIALS AND METHODS

This prospective observational study included a group of infertile women (n = 155) with indication of hysteroscopy

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**Table 1:** Characteristic of all patients in the study

Characteristic	Values (n = 153)
Mean age	34/4 SD
Type of infertility	
Primary infertility	116
Secondary infertility	37
Duration of infertility (years)	7.3 SD
Indication of hysteroscopy	
Suspected intrauterine lesions	72
Unexplained infertility	11
Repeated spontaneous abortion	98
Failure following <i>in vitro</i> fertilization	42

SD: Standard deviation

(Table 1) who were scheduled to undergo 3DUS prior to hysteroscopy at Royan Institute from September 2010 to 2011. Exclusion criteria were suspected congenital uterine anomalies. Both hysteroscopy and 3DUS examinations were performed on the same day (with no time interval), 7 to 10 days from the start of menstruation.

Hysteroscopy has been used as the gold standard because its value was previously confirmed in studies.<sup>2-4</sup> In this study, 3DUS images were interpreted only by an experienced radiologist with a special training in gynecology [7 years' experience with three-dimensional extended imaging (3DXI)], whereas hysteroscopy was performed by an experienced gynecologist. Our surgeon was also blind to ultrasound findings. We used 3DXI (ACCUVIX XQ, Medison, South Korea) ultrasound with a 6.5-MHz transvaginal probe.

After a baseline transabdominal and transvaginal 2DUS, analysis of endometrial cavity was completed using multiplaner 3D and multislice view. Representative transverse and longitudinal images were then obtained, while 3DXI was employed as a new display modality. Furthermore, this study was approved by the Research Ethics Committee and the Institutional Review Board

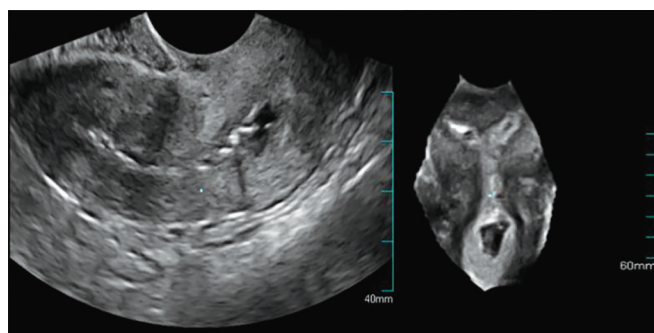
of Royan Institute, and informed written consent was obtained from the patients.

Diagnosis by 3DUS was recorded as follows: (1) Endometrial polyp (hyperechoic thickening of the endometrial mucosa) (Fig. 1), (2) intrauterine adhesions (irregularities of endometrium) (Fig. 2), and (3) submucous leiomyoma (a solid, whorled, and mixed echogenic tumor disrupting and affecting the endometrial interfaces) (Figs 3A and B). In this study, size and location of polyps and submucous leiomyoma were documented, indicating the display and the outline of the region-of-interest (ROI) in three perpendicular planes, simultaneously.

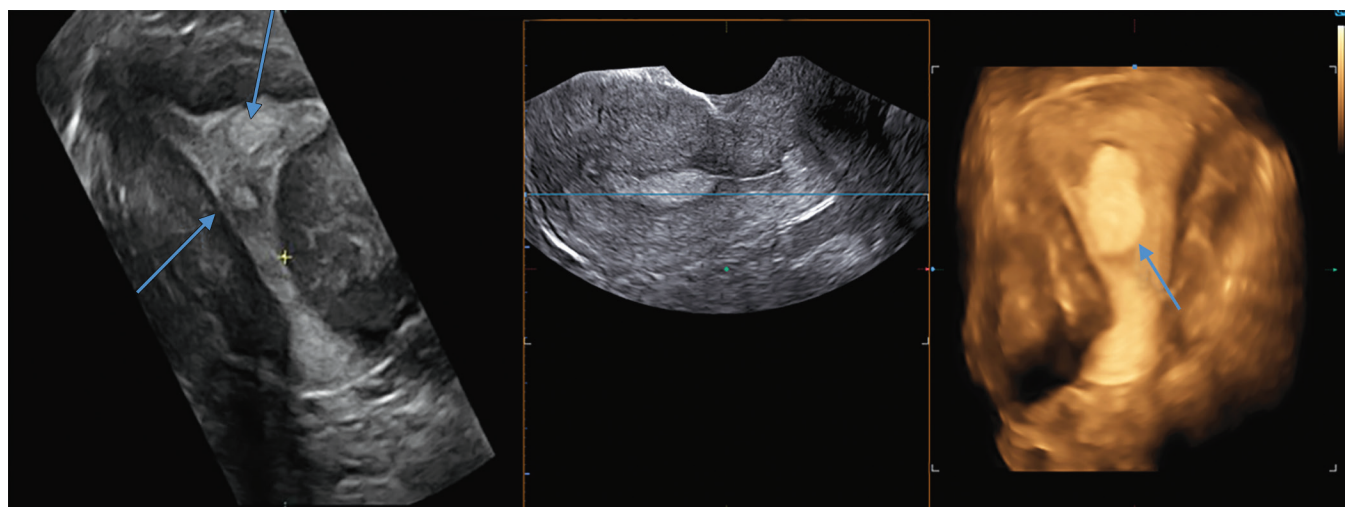
The hysteroscopy was performed under either general or regional anesthesia using a 4 mm hysteroscope system (Karl Storz-GmbH & Co., Tuttlingen, Germany) by an expert gynecologist.

**Statistical Method**

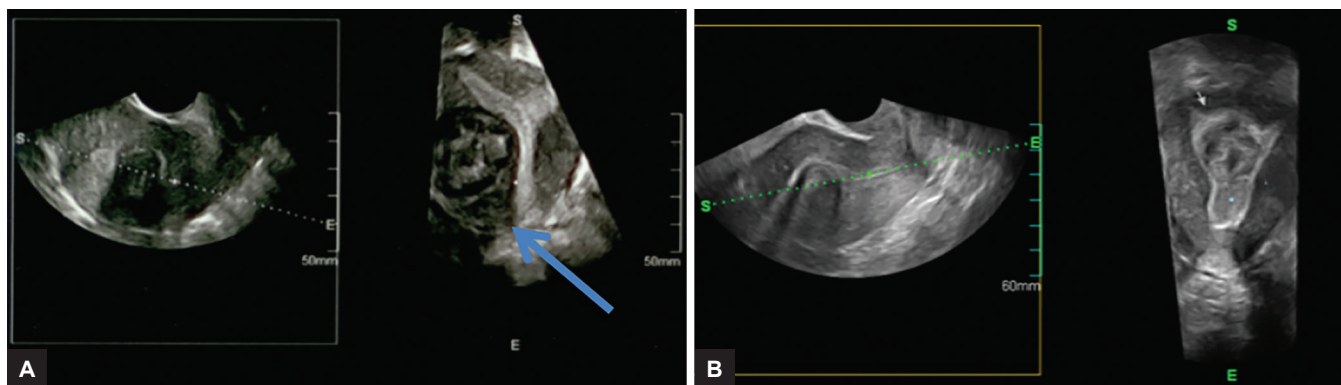
Accuracy was represented using the following values: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), positive and negative likelihood ratios, and overall accuracy. Precision of these terms was shown using confidence interval. A probability



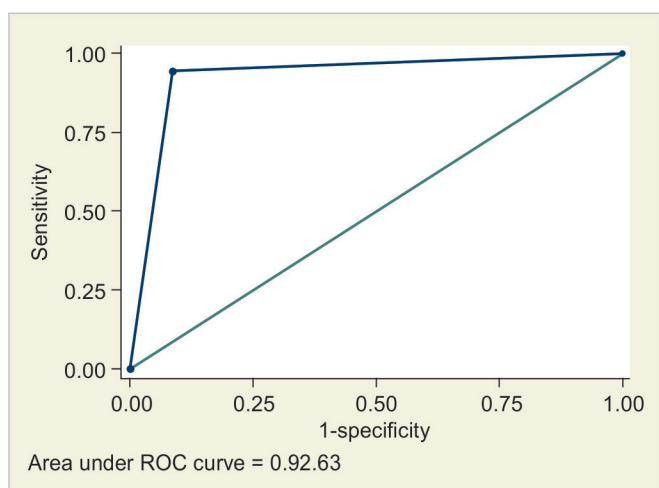
**Fig. 2:** Sagittal and coronal view: The exact location and the extent of uterine synechiae is more specified in coronal view



**Fig. 1:** Endometrial polyps (arrows) on 3DUS



**Figs 3A and B:** Sagittal and coronal view show submucosal leiomyoma (arrow) causes displacement and distortion of the uterine cavity



**Graph 1:** Accuracy of test according the area under the ROC curve

**Table 2:** Detection of intracavitary uterine lesions: Comparison of results of hysteroscopy to 3DUS

3DUS	Hysteroscopy		Total
	Abnormal	Normal	
Abnormal	47	9	56
Normal	3	94	97
Total	50	103	153

(at least one intrauterine lesion) and 97 (63%) had normal test results on 3DUS. Graph 1 shows ROC curve, including sensitivity *vs* one minus specificity. Normal and abnormal results of intrauterine lesions detected by hysteroscopy and 3DUS are illustrated in Table 2. As shown in Table 3, the 3DUS had 92.15% accuracy, 94% sensitivity, 91.3% specificity, 83.9% PPVs, and 96.9% NPVs for the diagnosis of intrauterine lesions as compared with the gold standard.

The hysteroscopy detected 50 cases of uterine abnormalities, while 3DUS was in complete agreement in 47 of 50 cases. The results also showed that 4 patients had more than one intrauterine lesion. The hysteroscopy findings revealed 36 polyps, 12 leiomyoma, and 7 synechia, while 3DUS findings were in complete agreement in 23/36 cases of polyps and 8/12 cases of submucosal leiomyoma.

value (p-value) less than 0.05 was considered significant. Also, receiver operating characteristic (ROC) curve was used to depict area under curve. The ROC curve graph included sensitivity *vs* one minus specificity (Graph 1). Data were analyzed using Stata version 11 (StataCorp LP, College Station, TX, USA).

**RESULTS**

This study involved 3DUS examination in 155 infertile women prior to undergoing hysteroscopy. Two patients were excluded due to cancellation of hysteroscopy. The mean age of study group was 34.4 ± 3.83 SD (20–48) years (Table 1).

The duration of couples’ infertility ranged from 1 to 30 (mean = 7.37) years. For the calculation of diagnostic accuracy, all patients (153) were examined by both the diagnostic test (3DUS) and the gold standard test (hysteroscopy). Of the 153 women, 56 (35.6%) had abnormal test results

**DISCUSSION**

The acquired uterine anomalies are important causes of female infertility, hence investigation of the uterine cavity plays an integral role in the infertility evaluation, particularly prior to ART cycles.<sup>5</sup> The noninvasive ultrasound imaging modalities, such as 2DUS, 3DUS, and three-dimensional hysterosonography (3DHS)<sup>6</sup> are useful tools to improve the effective treatment and management of infertility.

Recently, 3DXI has provided the ability to obtain simultaneous display of multiple sequential of acquired

**Table 3:** Diagnostic accuracy of three-dimensional ultrasound vs hysteroscopy in the diagnosis of intrauterine lesions

	Accuracy	Sensitivity	Specificity	PPV	NPV	LR <sup>+</sup> .LR <sup>-</sup>	AUC	kappa
3DUS	92.1%	94%	91.3%	83.9%	96.9%	LR <sup>+</sup> = 10.75.LR <sup>-</sup> = 0.065	91.6 (CI = 85.9 – 95.4)	82.7

volume scans in A, B, and C planes.<sup>7</sup> Although the simultaneous display of three planes in 3DUS provides visualization of the anatomy in planes, the procedure is unable to provide the direct scanning. The reconstructed planes are very useful in the evaluation of anomalies<sup>8-10</sup> and also of utmost importance for reliable investigation of intrauterine lesions by offering more precise analysis of spatial relationships among structures under study. Furthermore, 3DUS provides a more accurate visualization of the adhesions and extent of cavity destruction,<sup>11</sup> better determination of the degree of intramural involvement of leiomyoma, and the exact location and size of polyps.<sup>9</sup> This preoperative information reduces complication rates and duration of operation.

Magnetic resonance imaging is also an effective secondary imaging modality when more information is needed on the location and architecture of a fibroid, especially when they are large and multiple.

The benefit and even the superiority of 3DUS over commonly 2DUS are its ability to acquire coronal view of the uterus as well as offline assessment, which reduces the duration of examination and causes less discomfort for the patients.<sup>12</sup>

The efficiency of 3DUS has been confirmed by three individual studies conducted by Ali,<sup>13</sup> Bocca,<sup>14</sup> and Zvâncă.<sup>15</sup> Diagnostic accuracy of 3DUS was also investigated among infertile, premenopausal, and postmenopausal women with abnormal uterine bleeding (AUB) who mostly suffered from intrauterine lesions.<sup>13-15</sup> The number of studies comparing diagnostic accuracy between 3DUS and hysteroscopy are few. To consider the obtained data, these studies concluded that 3DUS is an accurate method in detection of endometrial cavity abnormalities with sensitivity and specificity values of more than 63 and 80% respectively.<sup>16,17</sup> In this study, the sensitivity and specificity values of 3DUS and the related values of hysteroscopy are within the expected range as compared with previous study demonstrating a sensitivity and specificity values of 93.75 and 81.25% respectively, in patients with AUB.<sup>17</sup>

In spite of many advantages, 3DUS may not provide qualitative image when the endometrium is thin. Additionally, this technique is not easily available and confined to specialized centers.

## CONCLUSION

According to our results, 3DUS has a reliable diagnostic accuracy for intrauterine lesions, and it may limit unnecessary hysteroscopy in patients with normal results.

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