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A Prospective Study Comparing Three-Dimensional Ultrasonography versus Hysteroscopy in Evaluation of Uterine Cavity in Infertile Women

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ABSTRACT

Background: Hysteroscopy (HS) is a frequently utilized procedure for diagnosing and treating intracavitary pathologies in gynecological practice. It is a favored procedure for assessing of infertile women. While different types of ultrasounds scanning for infertility such as baseline or screening ultrasound, follicular monitoring ultrasounds, saline infusion sonograms (SIS) with or without three-dimensional transvaginal ultrasonography (3D-TVS) evaluation are utilized to evaluate uterine cavity. Abdominal ultrasound might be required with any of the above scanning modalities for better assessment of pelvic structures.

Objective: The current study aimed to evaluate the diagnostic accuracy of 3D ultrasonography versus hysteroscopy for assessment of uterine cavity in infertile females.

Patients and methods: The diagnostic study included 139 infertile patients. All cases were subjected to detailed history taking with special focus on age, parity, age of menarche, past history of obstetric problems or surgeries. All patients had pelvic 3D TVS assessment and then reassessed by hysteroscopy.

Results: The 3D TVS showed perfect performance characteristics for detection of uterine abnormalities in relation to hysteroscopy as a standard method, with sensitivity of 96.9%, specificity of 85.7%, positive predictive value (PPV) of 94%, negative predictive value (NPV) of 92.3%, and accuracy of 93.5%. The 3D TVS showed perfect performance characteristics regarding any Mullerian abnormality, septate uterus, subseptate uterus, bicornuate uterus, unicornuate and arcuate uterus.

Conclusion: 3D TVS is a cost-effective, non-invasive modality without complications in comparison with HS, must be considered as a first-line investigation in infertility.

Keywords: Hysterosalpingography, Three-dimensional TVS, Hysteroscopy.

INTRODUCTION

Infertility is failure to achieve a pregnancy after one year or more of regular unprotected intercourse [1]. Uterine cavity evaluation is mandatory in infertile females. Pathologies including fibroids, polyps as well as Müllerian anomalies can cause infertility, recurrent miscarriages and poor outcome of gestation. Thereby, their diagnosis and treatment are significant to achieve pregnancy in natural and ART cycles [2].

Hysteroscopy (HS) has now become a gold-standard method to assess uterine cavity in infertile females [3]. Apart from direct endometrial visualizing by the naked eye, any pathology missed by other methods can be detected and treated [3,4]. Unfortunately, HS can have complications e.g. perforations, cervical lacerations, hemorrhage, inadequate access in cases of cervical stenosis and considered as an invasive method [5].Two-dimensional transvaginal ultrasonography (2D-TVS) and three-dimensional TVS (3D-TVS) are non-invasive procedures used to evaluate uterine cavity. The 3D-TVS is better than 2D-TVS in diagnosing uterine cavity abnormalities as it obtains a view of 3 uterine planes [6].

Reports vary concerning the diagnostic accuracy of 3D-TVS which was found to have 41.3-81.5% sensitivity and 94.6-98.7% specificity [7,8]. Thus, 3D-TVS is considered a non-invasive and safe tool for assessment of uterine cavity abnormalities however its sensitivity, specificity and accuracy remain a matter of debate.

This study aimed at assessing the diagnostic accuracy of 3D-TVS versus HS for assessment of uterine cavity abnormalities among females with infertility.

PATIENTS AND METHODS

Study Design:

This study was a prospective diagnostic study, and was carried out from November 2018 to November 2021 at Obstetrics and Gynecology Department in Mansoura University Hospitals. This study included infertile women (primary or secondary) with age ranging between 18- 40 years old. Female patients less than 18 years or more than 40 years old, females with pelvic inflammatory diseases, or females with active uterine bleeding were excluded.

Methods:

A full history was obtained from each participant. Thorough clinical examination (including general, abdominal examination and local examination) was performed. Basic infertility workup including a semen analysis, assessment of ovulation, a hysterosalpingogram was revised. All patients were subjected during the proliferative phase to two diagnostic techniques for evaluating the uterine cavity.

1. **The 3D-TVS:**

The uterine cavity was evaluated by obtaining a mid-coronal render image. Evaluation of mullerian

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anomalies was performed in accordance with the latest rules of the ESHRE/ESGE Thessaloniki consensus as follows [9]:

- Step 1: Uterine cavity imaging in a midcoronal plane, a rendered 3D image of a coronal section of uterus.
- Step 2: Drawing a line extending between both tubal ostia, in case of external indentation, another line was drawn connecting the external profile of both hemi-uteri.
- Step 3: In patient with normal external uterine surface, a distance between the line that connects tubal ostia to the external uterine contour is defined as the uterine wall thickness (reference value), in patient with an existing external serosal indentation, the distance between the previously mentioned 2 lines is defined as the uterine wall thickness (reference value).
- Step 4: Estimation of the length of any present internal indentation was performed through measurement of the indentation's edge at uterine cavity and distance between the interostial line, uterine septum is diagnosed if the indentation exceeds 50% of the total fundal uterine wall thickness formerly measured. Estimation of the lateral wall thickness was performed through measurement of an angle of 90 to the lining of the endometrial myometrial border.

2. Hysteroscopy:

HS was be done by a 3.6 mm diagnostic single-flow hysteroscopy sheath based with a 2.8 mm optic lens 30^o, karlstorz telescope. Uterus was dissented by continuous saline infusion. HS was considered adequate only when the whole cavity and the 2 tubal Ostia were visualized.

Primary Outcome: Diagnostic accuracy of 3D TVS versus HS for uterine cavity abnormalities.

Ethical Consideration:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Mansoura University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

All data were collected in a prepared sheet that was entered into an electronic spreadsheet (Excel sheet). The collected data were introduced and statistically analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 20 for windows (SPSS Inc., Chicago, IL, US). Qualitative data were defined as numbers and percentages. Chi-Square test and McNemar's test were used for comparison between categorical variables as appropriate. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as means and SD, and independent sample t-test was used for comparison between groups. Sensitivity, specificity, diagn ostic accuracy, PPV and NPV, and positive and negative likelihood ratios of 3D-TVS were calculated compared with HS. 95% confidence intervals were calculated. A P-value $\leq$0.05 was considered to be significant

RESULTS

The present study was conducted on 139 infertility cases with mean age of 27.9 (SD 4.4) years. The mean duration was 4.5 (SD 1.1) years. Number of cases with primary infertility was 74 (53.2%), and cases with secondary infertility were 65 (46.8%).

The incidence of uterine cavity abnormalities by hysteroscopy showed that cases who had normal cavity were 97 (69.8%), cases had any Mullerian abnormalities were 16 (11.5%), cases with septate uterus were 4 cases (2.9%), cases had subseptate uterus were 8 (5.8%), cases who had bicornuate uterus were 3 (2.2%), 1 case (0.7%) had uni-cornuate uterus and 1 case had arcuate uterus (0.7%). Cases with any intracavitary lesion were 27 (19.4%), cases with polyps were 9 (6.5%), cases with adhesions were 4 (2.9%), cases with thick endometrium were 4 (2.9%), cases with endometritis were 6 (4.3%), and cases with submucous myoma were 6 (4.3%).

While, the incidence of uterine cavity abnormalities according to 3D TVS showed that cases who had normal cavity were 100 (71.9%), cases who had any Mullerian abnormalities were 16 (11.5%), cases with septate uterus were 4 cases (2.9%), cases who had subseptate uterus were 8 (5.8%), cases who had bicornuate uterus were 3 (2.2%), 1 case (0.7%) had uni-cornuate uterus and 1 case had arcuate uterus (0.7%). Cases with any intracavitary lesion were 24 (17.3%), cases with polyps were 6 (4.3%), cases with adhesions were 2 (1.4%), cases with thick endometrium were 8 (5.8%), and cases with submucous myoma were 8 (5.8%).

None had endometritis by 3D TVS. It is noticed that 1 case had septate and bicornate uterus by both methods, 2 cases had endometritis and polyps by hysteroscope, 1 case had accurate uterus and polyp by hysteroscope, 1 case had accurate uterus, polyp and endometritis by 3D TVS (**Table 1**).

Table 1: Incidence of uterine cavity abnormalities in the studied females according to office hysteroscopy and 3D TVS.

Variable		Cases (N= 139)			
		Hystroscopy		3D TVS	
		N	%	N	%
Total No	**Normal cavity**	97	69.8%	100	71.9%
	Abnormal cavity	42	30.2%	39	28.1%
Mullerian anomalies	**Total No**	16	11.5%	16	11.5%
	Septate uterus	4	2.9%	4	2.9%
	Subseptate uterus	8	5.8%	8	5.8%
	Bicornuate	3	2.2%	3	2.2%
	Unicornuate uterus	1	0.7%	1	0.7%
	Arcuate uterus	1	0.7%	1	0.7%
Intracavitary lesions	**Total no**	27	19.4%	24	17.3%
	Polyp	9	6.5%	6	4.3%
	Adhesions	4	2.9%	2	1.4%
	Thick endometrium	4	2.9%	8	5.8%
	Endometritis	6	4.3%	0	0%
	Submucous myoma	6	4.3%	8	5.8%
1 case had bicornual septate uterus by both methods 2 cases had double lesions endometritis and polyps by hysteroscope. 1 case had arcuate uterus and polyp by hysteroscpe 1 case had arcuate uterus, polyp and endometritis by 3D TVS.					

Total number of cases were 139 cases, 130 cases had concordant results and 9 cases with disconcordant results. Among cases with concordant results, 94 cases were positive by the 2 methods and 36 cases were negative by both methods. While among cases with disconcordant results, 6 cases were positive by 3DTVS method only and 3 cases were positive by hysteroscopy method only (**Figure 1**). The 3D TVS showed perfect performance characteristics for diagnosing uterine abnormalities in relation to HS, with sensitivity of 96.9%, specificity of 85.7%, PPV of 94%, NPV of 92.3%, and accuracy of 93.5% (**Table 2**). Validity of 3D TVS was compared to hysteroscopy for detection of Mullerian abnormalities. The 3D TVS showed perfect performance characteristics regarding any Mullerian abnormality, septate uterus, subseptate uterus, bicornuate uterus, unicornuate and arcuate uterus (**Table 3**).

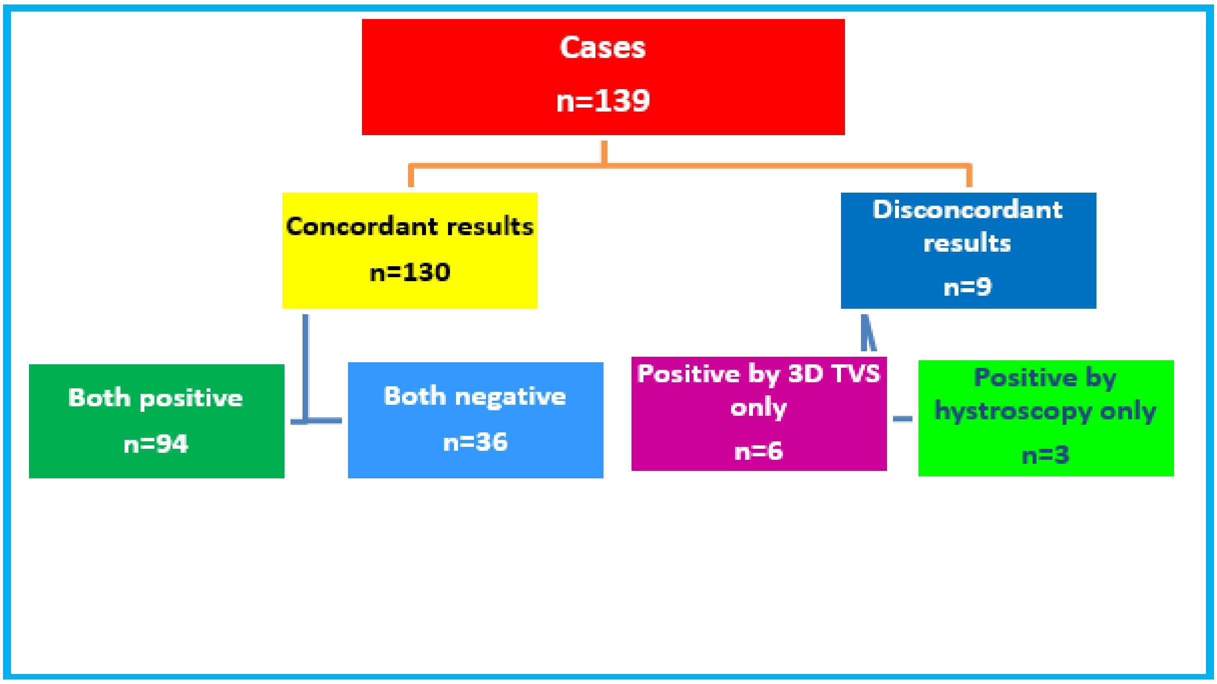

Figure 1: Concordance of results between 3D TVS and hysteroscopy for detection of normal cavity.

Table 2: Validity of 3D TVS in relation to hysteroscopy.

Variable	Normal cavity
Sensitivity (%)	96.9
Specificity (%)	85.7
PPV (%)	94.0
NPV (%)	92.3
Accuracy (%)	93.5

Table 3: Validity of 3D TVS in relation to hysteroscopy for detection of Mullerian abnormalities.

Variable	Any Mullerian abnormality	Septate uterus	Subseptate uterus	Bicornuate uterus	Unicornuate	Arcuate uterus
Sensitivity (%)	100	100	100	100	100	100
Specificity (%)	100	100	100	100	100	100
PPV (%)	100	100	100	100	100	100
NPV (%)	100	100	100	100	100	100
Accuracy (%)	100	100	100	100	100	100

Comparing 3D TVS and hysteroscopy results for detection of any Mullerian abnormalities revealed that 16 cases were positive by both methods (11.5%), 123 cases were negative by both methods (88.5%), none had disconcordant results, with perfect agreement (K=1).

Comparing 3D TVS and hysteroscopy results for detection of septate uterus revealed that 4 cases were positive by both methods (2.9%), 135 cases were negative by both methods (97.1%), none had dis-concordant results, with perfect agreement (K=1). Comparing 3D TVS and hysteroscopy results for detection of subseptate uterus revealed that 8 cases were positive by both methods (5.8%), 131 cases were negative by both methods, none had dis-concordant results (94.2%), with perfect agreement (K=1). Comparing 3D TVS and hysteroscopy results for detection of bicornuate uterus revealed that 3 cases were positive by both methods (2.2%), 136 cases were negative by both methods, none had dis-concordant results (97.8%), with perfect agreement (K=1). Comparing 3D TVS and hysteroscopy results for detection of unicornuate uterus revealed that 1 case was positive by both methods (0.7%), 138 cases were negative by both methods, none had dis-concordant results (99.3%), with perfect agreement (K=1). Comparing 3D TVS and hysteroscopy results for detection of arcuate uterus revealed that 1 case was positive by both methods (0.7%), 138 cases were negative by both methods, none had dis-concordant results (99.3%), with perfect agreement (K=1) (**Table 4**).

Table 4: Agreement between 3D TVS and hysteroscopy for detection of any Mullerian abnormalities, septate uterus, subseptate uterus, bicornuate uterus, unicornuate uterus, and accurate uterus

Variable		Mullerian abnormalities by Hystroscpy	
		Negative	Positive
Mullerian abnormalities by 3D TVS	Negative	123	0
	Positive	0	16
	P	<0.001	
	K	1	
	Agreement	Perfect	
Variable		Septate uterus by hystroscope	
		Negative	Positive
Septate uterus by 3D TVS	Negative	135	0
	Positive	0	4
	P	<0.001	
	K	1	
	Agreement	Perfect	
Variable		Subseptate uterus by hysteroscopy	
		Negative	Positive
Subseptate uterus by 3D TVS	Negative	131	0
	Positive	0	8
	P	<0.001	
	K	1	
	Agreement	Perfect	
Variable		Bicornuate uterus by hysteroscopy	
		Negative	Positive
Bicornuate uterus by 3D TVS	Negative	136	0
	Positive	0	3
	P	<0.001	
	K	1	
	Agreement	Perfect	
Variable		Unicornuate uterus by hysteroscopy	
		Negative	Positive
Unicornuate uterus by 3D TVS	Negative	138	0
	Positive	0	1
	P	<0.001	
	K	1	
	Agreement	Perfect	
Variable		Arcuate uterus by hysteroscopy	
		Negative	Positive
Arcuate uterus by 3D TVS	Negative	138	0
	Positive	0	1
	P	<0.001	
	K	1	
	Agreement	Perfect	

Validity of 3D TVS was compared to hysteroscopy for detection of intracavitary lesions. The 3DTVS had sensitivity of 77.8% for detection the intracavitary lesions, with specificity of 97.3%, PPV of 87.5% and NPV of 94.8% with high accuracy of 93.5%. The 3D TVS had sensitivity of 55.6% for detection polyps with specificity of 99.2%, PPV of 83.3% and NPV of 97% with high accuracy of 96.4%. The 3D TVS had sensitivity of 100% for detection submucous myoma with specificity of 98.5%, PPV of 75% and NPV of 100% with high accuracy of 98.6%. The 3D TVS had sensitivity of 50% for detection adhesions with specificity of 100%, PPV of 100% and NPV of 98.5% with high accuracy of 98.6%. The 3D TVS had sensitivity of 0% for detection endometritis with specificity of 100%, NPV of 95.7% with high accuracy of 95.7%. The 3D TVS had sensitivity of 100% for detection thick endometrium with specificity of 96.3%, PPV of 44.4% and NPV of 100% with high accuracy of 96.4%. The 3D TVS had good performance characteristics for detection of submucous myoma, adhesions, endometritis and thick endometrium (**Table 5**).

Table 5: Validity of 3D TVS in relation to hysteroscopy for detection of intracavitary lesions.

Variable	Intracavitary lesions	Polyp	Submucous myoma	Adhesions	Endometritis	Thick endometrium
Sensitivity (%)	77.8	55.6	100	50	0	100
Specificity (%)	97.3	99.2	98.5	100	100	96.3
PPV (%)	87.5	83.3	75	100	-	44.4
NPV (%)	94.8	97	100	98.5	95.7	100
Accuracy (%)	93.5	96.4	98.6	98.6	95.7	96.4

Comparing 3D TVS and hysteroscopy results for determination of intracavitary lesions revealed that 21 cases were positive by both methods (15.1%), 109 cases were negative by both methods (78.4%), 6 cases was positive by hysteroscopy only (4.3%) and 3 cases were positive by 3D TVS only (2.2%), with substantial agreement (K= 0.784). Comparing 3D TVS and hysteroscopy results for detection of polyps revealed that 5 cases were positive by both methods (3.6%), 129 cases were negative by both methods (92.8%), 4 cases were positive by hysteroscopy only (2.9%), and 1 case was positive by 3D TVS only (0.7%), with substantial agreement (K= 0.648).

Comparing 3D TVS and hysteroscopy results for detection of myoma revealed that 6 cases were positive by both methods (4.3%), 131 cases were negative by both methods (94.2%), 0 cases were positive by HS only and two cases were positive by 3D TVS only (1.4%), with excellent agreement (k=0.850). Comparing 3D 6).

TVS and hysteroscopy results for detection of adhesions revealed that 2 cases were positive by both methods (1.4%), 135 cases were negative by both methods (97.1%), 2 cases were positive by hysteroscopy only (1.4%), and 0 cases were positive by 3D TVS only with substantial agreement (K= 0.660).

Comparing 3D TVS and hysteroscopy results for detection of endometritis revealed that 0 cases were positive by both methods (0%), 133 cases were negative by both methods (95.7%), 6 cases were positive by hysteroscopy only (4.3%), and 0 cases were positive by 3D TVS only with slight agreement (K= 0.001). Comparing 3D TVS and hysteroscopy results for detection of thick endometrium revealed that 4 cases were positive by both methods (2.9%), 131 cases were negative by both methods (94.2%), 0 cases were positive by HS only and four women were positive by 3D TVS only (2.9%), with substantial agreement (K= 0.653) (Table

Table 6: Agreement between 3D TVS and hysteroscopy for detection of Intracavitary lesions, Polyp, Submucous myoma, Adhesions, Endometritis and Thick endometrium.

Variable		Intracavitary lesions by hysteroscopy	
		Negative	**Positive**
Intracavitary lesions by 3D TVS	**Negative**	109	6
	Positive	3	21
	P	<0.001	
	K	0.784	
	Agreement	Substantial	
Variable		**Polyp by hystroscpy**	
		Negative	**Positive**
Polyp by 3D TVS	**Negative**	129	4
	Positive	1	5
	P	<0.001	
	K	0.648	
	Agreement	Substantial	
Variable		**Submucous myoma by hysteroscopy**	
		Negative	**Positive**
Submucous myoma by 3D TVS	**Negative**	131	0
	Positive	2	6
	P	<0.001	
	K	0.850	
	Agreement	Excellent	
Variable		**Adhesions by hysteroscopy**	
		Negative	**Positive**
Adhesions by 3D TVS	**Negative**	135	2
	Positive	0	2
	P	<0.001	
	K	0.660	
	Agreement	Substantial	
Variable		**Endometritis by hysteroscopy**	
		Negative	**Positive**
Endometritis by 3D TVS	**Negative**	133	6
	Positive	0	0
	P	1	
	K	0.001	
	Agreement	Slight	
Variable		**Thick endometrium by hystroscope**	
		Negative	**Positive**
Thick endometrium by 3D TVS	**Negative**	131	0
	Positive	4	4
	P	<0.001	
	K	0.653	
	Agreement	Substantial	

This study showed no significant association of concordance of results between HS and 3D TVS regarding, age, duration, primary and secondary infertility of the cases. Age, duration and type of infertility could not predict disconcordant results between HS and 3D TVS (**Table 7**).

Table 7: Association of concordance of results between hysteroscope and 3D TVS with baseline features of all studied women.

Variable			Concordance		Disconcordance		P-value	OR (95%CI)
			N= 130		N= 9			
Age (years)		**Mean ± SD**	27.7	SD 4.4	29.8	SD 4.3	0.181	1.053 (0.976-1.136)
Duration (years)		**Mean ± SD**	4.4	SD 1.1	5.9	SD 1.43	0.188	1.065 (0.970-1.170)
Fertility	**Primary**	**N, %**	71	54.6%	3	33.3%	0.221	1.519 (0.778-2.963)
	Secondary	**N, %**	59	45.4%	6	66.7%		

OR: odds ratio. CI: Confidence interval.

DISCUSSION

Infertility is failure to achieve a pregnancy after one year or more of regular unprotected intercourse in women under 35 and 6 months in women older than 35. It affects approximately 15.5% of females [10]**.** The main causes of infertility are ovulatory dysfunction, tubal and peritoneal pathology, male factor, unexplained infertility and uterine pathologies and intrauterine pathologies are one of the reasons that can be treated surgically, negatively affects fertility by decreasing the receptivity and implantation success [11]**.** HS is a widely used method in the diagnosis and treatment of intracavitary pathologies in gynecology practice, HS is a preferred technical method in the evaluation of infertile patients in recent years because it is a minimally invasive procedure, has low complication rate, allows for diagnostic and therapeutic interventions, and has high sensitivity and specificity [12]**.** Different types of ultrasounds scanning for infertility including, Baseline or screening ultrasound, Follicular monitoring ultrasounds, SIS with or without 3D assessment are utilized for uterine cavity assessment. Abdominal ultrasound might be required with any of the above modalities for better assessment of pelvic structures [13]**.** The aim of our study was to assess the diagnostic accuracy of 3D TVS in comparison with hysteroscopy for evaluation of uterine cavity abnormalities in infertile women.

Regarding the incidence of uterine cavity abnormalities among the studied women in our study, according to HS were as follows, Cases who had normal cavity were the most common, were 69.8% of our cases, cases had any Mullerian abnormalities were 11.5%, cases with septate uterus were 2.9%, cases had subseptate uterus were 5 .8%, cases who had bicornuate uterus were 2.2%, 0.7% had uni-cornuate uterus and arcuate uterus. Cases with intracavitary lesion were 19.4%, cases with polyps were 6.5%, cases with adhesions were 2.9%, cases with thick endometrium were 2.9%, cases with endometritis were 4.3% and cases with submucous myoma were 4.3%.

Al-Zinaty *et al.* [14] found that HS showed 26 intracavitary lesions in 25% of cases. Intrauterine polyps were 13.6%, adhesions were 7.6%, septum was 13.6% of them, 4.5% were septate vs bicornuate, 7.6% were septate and 1.5% was arcuate. Submucous myoma was 3.0%, compression of the uterine cavity was 3.0%, and endometrial hyperplasia was 1.5%. Endometrium was normal in 7.7% of cases, thin in 63.5% of cases, and thick in 28.8% of cases.

Regarding The incidence of uterine cavity abnormalities among the studied women according to 3D TVS in our study were as follows, Cases who had normal cavity were 71.9%, cases who had any Mullerian abnormalities were 11.5%, cases with septate uterus were 2.9%, cases who had subseptate uterus were 5 .8%, cases who had bicornuate uterus were 2.2%, 0.7% had uni-cornuate uterus arcuate uterus. Cases with any intracavitary lesion were 17.3%, cases with polyps were 4.3%, cases with adhesions were 1.4%, cases with thick endometrium were 5.8%, cases with submucous myoma were 5.8% and none had endometritis. While a study by **Van den Bosch *et al.*** [6] evaluated diagnostic accuracy of 3D TVS in detection of uterine cavity lesion in women with abnormal uterine bleeding. They found endometrial polyp in 26%, submucous myoma in 7%, endometrial hyperplasia in 6%, and cancer in 1% of subjects**.**

The present study compared 3D TVS and HS results for detection normal uterine cavity revealed that 67.6% of cases were positive by both methods and 25.9% of cases were negative by both methods, 2.2% of cases had positive results by HS only and 4.3% of cases had positive results by 3D TVS only with excellent agreement between both methods, which agreed with **Naredi *et al.*** [15] of 154 females, they revealed normal uterine cavity on 3D TVS in 130 of them versus 128 normal cavities on HS meaning that 16.88% were found to have a uterine pathologies on HS and 15.58% on 3D TVS depicting a concordance in both modalities.

The present study revealed that the 3D TVS showed perfect performance characteristics regarding any Mullerian abnormality, septate uterus, subseptate uterus, bicornuate uterus, uni-cornuate and arcuate uterus. Our results disagreed with **Naredi *et al.*** [15] who found that 3D TVS detected six septate uteri, however, Hysteroscope detected septations in 10 females. The 4 bicornuate uterus documented by 3D TVS were not confirmed by HS.

The present study regarding the validity of 3D TVS versus HS for detection of intracavitary lesions, found that the 3D TVS had sensitivity of 77.8% for detection the intracavitary lesions, with specificity of 97.3%, PPV of 87.5% and NPV of 94.8% with high accuracy of 93.5%. The 3D TVS had sensitivity of 55.6% for detection polyps with specificity of 99.2%, PPV of 83.3% and NPV of 97% with high accuracy of 96.4%.

El Tagy *et al.* **[16]** found that 3D TVS showed 100% diagnostic accuracy. For diagnosing endometrial polyps, 80% sensitivity, 100% specificity, 100% PPV, and 83.33% NPV, 3D-TVS had 84.1% diagnostic accuracy for detecting uterine lesions in infertile females, 3D TVS had high specificity, however its sensitivity was limited, particularly for endometrial polyps. A high number of infertile females had evidence of uterine cavity pathologies. As such, hysteroscopy remains the gold standard for uterine cavity assessment.

The present study revealed that, the 3D TVS had sensitivity of 100% for detection submucous myoma with specificity of 98.5%, PPV of 75% and NPV of 100% with high accuracy of 98.6%. The 3D TVS had good performance characteristics for detection of submucous myoma, adhesions, endometritis, and thick endometrium.

While **Al-Zinaty *et al.*** **[14]** revealed that sensitivity of 3D TVS was 70.59% and specificity 62.50%, which is significant, so can assume the null hypothesis or alternative hypothesis which tries to prove that the 3D TVS is equivalent to HS in diagnosing intrauterine abnormalities. If 3D TVS is equivalent to HS and has the same sensitivity and specificity, it can be used in the diagnosis instead of hysteroscopy as 3D TVS is not invasive tool. But hysteroscopy is superior and more accurate than 3D TVS so still considered, hysteroscopy as the gold standard for uterine cavity evaluation.

The same disagreement with **Arefi *et al.*** **[17]** and other studies which stated that the HS has a higher sensitivity and specificity compared to other diagnostic tools (saline infusion hysterosonography 'SIHS', TVS, and 3D USS) and stated that HS is the gold standard for direct uterine assessment for intrauterine abnormalities **[17-19]**.

The present study, for detection of myoma revealed that 4.3% of cases were positive by both methods 94.2% of cases were negative by both methods, 0 cases were positive by hysteroscopy only and 1.4% of cases were positive by 3D TVS only with excellent agreement. Our results revealed that, the 3D TVS had sensitivity of 0% for detection endometritis with specificity of 100%, NPV of 95.7% with high accuracy of 95.7%. The 3D TVS had sensitivity of 100% for detection thick endometrium with specificity of 96.3%, PPV of 44.4% and NPV of 100% with high accuracy of 96.4%.

This study agrees with other study by **Ahmed *et al.*** **[20]** in cases of adenomyosis: 3D U/S has a sensitivity, specificity, and accuracy higher than HS. In cases of fibroids: 3D U/S has sensitivity like HS, but specificity is higher for HS. In cases of thick endometrium: in comparison to HS, 3D U/S has lower sensitivity, specificity, and accuracy. In cases of polyps: 3D U/S has lower sensitivity, specificity, and accuracy than HS. In cases of all lesions: 3D U/S has sensitivity specificity and accuracy less than for hysteroscopy. Although 3D ultrasound is a sensitive approach for evaluating lesions in the endometrial cavity, HS directly visualizes the uterine cavity, allowing it to identify focal intrauterine lesions that 3D ultrasound or curettage may miss**.**

Our results by comparing 3D TVS and HS results for detection of adhesions revealed that 1.4% of cases were positive by both methods and 97.1% of cases were negative by both methods, 1.4% of women were positive by HS only and no women were positive by 3D TVS only with substantial agreement. The 3D TVS had sensitivity of 50% for detection adhesions with specificity of 100%, PPV of 100% and NPV of 98.5% with high accuracy of 98.6%. Which agreed with **Mohammad *et al.*** **[21]** who stated that for intrauterine adhesions the sensitivity, specificity, PPV, NPV, and accuracy for 3D TVS were 57.14%, 100%, 100%, 93.48% and 94%, respectively. For endometrial hyperplasia the sensitivity, specificity, PPV, NPV, and accuracy for 3D TVS were 100%. The sensitivity, specificity, PPV, NPV, and overall accuracy of 3D TVS for overall uterine abnormalities were 89.13%, 100%, 100%, 44.44% and 90%, respectively.

The present study found no significant association of concordance of results between HS and 3D TVS regarding, age, duration, primary and secondary infertility of the cases. Age, duration, and type of infertility could not predict dis-concordant results between HS and 3D TVS with same line with previous results by **Mohammad *et al.*** **[21].**

CONCLUSION

3D TVS is a cost-effective, non-invasive technique without complications in comparison with HS, must be considered as a first-line tool for infertility investigation and with larger studies further assessing its accuracy has a great potential to replace HS for females having IVF, it can be utilized to diagnose uterine lesions with results similar to HS.

Conflict of interest: None.
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