

Sonohysterography And 3d Transvaginal Ultrasonography Versus Diagnostic Hysteroscopy In Assessment Of Uterine Abnormalities In Female Infertility

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Abstract

Infertility may be caused by uterine lesions, such as fibroids, endometrial polyps, intrauterine adhesions, or all of these. Natural conception may also be delayed by congenital uterine abnormalities. One out of every six couples will experience infertility at some point in their lives. Hysterosalpingography (HSG) is the first line of defence in detecting uterine and Fallopian tube anomalies. One of the most often used diagnostic tools in gynaecology is two-dimensional transvaginal sonography (2D-TVS). 2D-SIS has been shown to be an excellent diagnostic tool for intrauterine abnormalities since it may delineate the uterine cavity, allowing any uterine lesion to be clearly depicted. A novel imaging technique, three-dimensional transvaginal sonography (3D-TVS), is already being used in clinical settings. Diagnosis of uterine cavity anomalies requires diagnostic hysteroscopy (DHS). SMFs, endometrial polyps, and IUAs may all be seen clearly in the uterine cavity because to its ability to provide a direct view of the uterine chamber. Three-dimensional transvaginal ultrasound, 2D-SIS, and DHS were compared in this research to see which had the best sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for aberrant uterine findings during HSG (DA). Until recently, diagnostic hysteroscopy (DHS) was the gold standard against which all other types of scanning were measured and evaluated. A cross-sectional study of 200 women attending the Outpatient Clinic of Benha University Hospital with suspected intrauterine abnormalities based on the history, clinical examination, and results of HSG was conducted from July 2018 to July 2021 to evaluate the diagnostic accuracy of 2D- (SIS) and 3D ultrasound in the evaluation of uterine cavity. We found 72 cases of congenital uterine anomalies (5 septum, 4 cervicofundal septum, 1 bicornuate, 4 bicornuate versus septate, 2 unicornus, 2 acute uterus) and 104 cases of intrauterine filling defects (44 polyps, 56 fibroids, and 4 irregular filling defects) in this study of HSG. We also found 24 cases of intrauterine adhesions (20 fine adhesions and 4 coarse adhesions). A total of 164 (82 percent) of the 200 patients examined had abnormalities detected by DHS (the gold standard), while only 36 cases (18 percent) were found to be free of pathological lesions or abnormalities. These findings included 60 cases of congenital uterine anomalies, 80 cases of intrauterine filling defects, and 6 cases of intrauterine adhesions. SMF, endometrial polyp, and both US and DHS are complimentary in the identification of individuals with congenital uterine abnormalities.

Key words: SONOHYSTEROGRAPHY - 3D Transvaginal Ultrasonography - Diagnostic Hysteroscopy - Uterine Abnormalities - Female Infertility

1.Introduction

The uterine cavity should be examined as part of a comprehensive infertility examination, which is generally agreed upon. Infertility may be caused by uterine abnormalities, whether they are inherited or acquired (1).

As many as 10% to 15% of couples who seek therapy for infertility have uterine cavity abnormalities as a contributing cause. These lesions may have a negative impact on both natural fertility and the success of assisted reproduction (2).

The uterine cavity is regularly examined in the first examination of infertile women due to the high occurrence of uterine anomalies. (3)

The most frequent way to find out whether a woman has a problem with her uterus is to do a hysterosalpingogram (HSG). Operative hysteroscopy (HS) under general anaesthesia has typically been used to further investigate and treat suspected disease discovered after an HSG, however there is disagreement between the two procedures in roughly 30% of patients ((4)).

Uterine diseases are routinely diagnosed with 2D transvaginal ultrasonography, which is a common and reliable method. However, even with this cutting-edge technology, 3D buildings can only be seen in two dimensions (5).

Randolph et al. proposed the concept of transvaginal SIS by injecting saline into the endomyometrial complex using an abdominal ultrasound transducer and then observing the intracavitary contours. A better overall sensitivity for detecting intrauterine anomalies may be achieved by distinguishing between localised and global processes.

Ultrasound in three dimensions (3D-US) has only lately made its way into clinical settings. Anatomical restrictions on the number and orientation of scanning planes on 2D-TVS are no longer an issue with this method. Anatomical pictures may be readily comprehended and processed without the need for special experience in US diagnosis, resulting in a high degree of accuracy in the identification and categorization of intrauterine anomalies (8).

The use of three-dimensional sonography in therapeutic settings has grown in recent years. To use this technique, a large amount of data must be collected, and pictures in the transverse, sagittal, and coronal planes must be rapidly reconstructed. For obstetric and gynaecological illness, three-dimensional sonography has been employed. (5)

Retrospective examination of both the uterine shape and the fluid-filled endometrial cavity may be performed using 3D technology in conjunction with standard 2D SIS (9). Congenital uterine abnormalities such as a septate or bicornuate uterus may be accurately

diagnosed using a combination of 2D SIS and 3D sonographic technologies (10).

Endometrial cancer and other premalignant lesions, as well as intrauterine polyps and sub mucous fibroids, may all be detected by hysteroscopy. Besides locating missing intrauterine devices, it may also be used to evaluate the shape and size of the endometrial cavity during an infertility work-up and to observe intrauterine septa and adhesions. (11).

It is now possible to conduct diagnostic hysteroscopy (DHS) with little pain and a considerable reduction of the associated risks and costs. Using this technique, anomalies in the uterus may be detected quickly, effectively, and with a great deal more precision, allowing doctors to better plan any upcoming surgical treatment (12).

An endometrial biopsy may be taken directly from the lesions using hysteroscopies because of its capacity to see directly into uterine tissue. Intra uterine adhesions (IUAs), which are difficult to detect using other techniques, were classified by the method and have certain therapeutic effects; for example, the removal of submucous fibroids (SMF) and the lysis of IUA. Among the drawbacks of hysteroscopy include the requirement for expensive equipment, a skilled hysteroscopist, and a pricey operation. Fluid overload is also a major concern for women who undergo hysteroscopy (13).

2-D SIS and 3-D transvaginal ultrasound were compared to hysteroscopy in the identification of intrauterine pathologies in infertile women with suspected uterine diseases, either by 2D ultrasound or hysterosalpingiography, in this study's primary objective.

2. Patients and Methods

This is a comparative, observational, cross-sectional study which was conducted on 200 women attending Outpatient Clinic of Benha University Hospital with suspected intrauterine abnormalities according to the history, clinical examination and results of HSG to evaluate the diagnostic accuracy of 2D- (SIS), 3D ultrasound compared to hysteroscopy in the evaluation of uterine cavity from July 2018 to July 2021.

I-Inclusion criteria:

- Women age ranged from 20-40 years old.
- History of infertility whether primary or secondary.
- With suspected intrauterine abnormalities either by 2D ultrasound or hysterosalpingiography.

II-Exclusion criteria:

- History suggestive of pelvic inflammatory disease .
- Any cause of bleeding including (bleeding disorders or any coagulation defects, liver cell failure, Drugs as anticoagulant therapy).
- Vaginal, vulval or cervical causes of bleeding or infection.
- Recent uterine perforation.

The two hundred (200) studied patients, were categorized into 3 groups according to their abnormal uterine finding at HSG as:

- **Group I:** included 72 patients with HSG suggestive of congenital uterine anomalies.
- **Group II:** included 104 patients with intrauterine filling defects irregular uterine contour.
- **Group III:** included 26 patients with intrauterine adhesions (fine and coarse).

III- Method Protocol:

All the studied cases (200 cases) in the 3 groups were subjected to the following:

- 1-Taking their verbal consent about all the steps of the procedure.
- 2-History: Detailed history taking from each patient regarding age, parity, with special reference to present, past, menstrual history and obstetric history.
- 3-General, abdominal, and pelvic examination (Including; bimanual assessment of the uterine size, position, mobility and adnexal evaluation, any cervical or vaginal abnormalities).
- 4- **Hysterosalpingography:**
- 5- **Laboratory investigations:** were done for every patient as pre-operative investigations for diagnostic hysteroscopy. They included:
 - Serum pregnancy test.
 - Fasting and 2 hour postprandial blood glucose.
 - C.B.C.
 - Serum creatinine and blood urea.
 - SGPT and SGOT.
 - E.C.G.

Then, every patient in the 3 groups were subjected to the following procedures: 2D-TVS, 2D-SIS, 3D-TVS and DHS in this sequence.

6- 2 D Transvaginal sonohysterography.

7-3D Ultrasonography.

8- Hysteroscopy.

Hysterosalpingography:

Hysterosalpingography was performed in the 1st 5 postmenstrual days in regular menstruating patients and in those with irregular cycles a pregnancy test was performed before carrying out the procedure. Findings charted from the films noting the abnormalities of the uterine shape including filling defects, synechia, and uterine anomalies.

2D Sonohysterography:

Sonohysterography was performed for all patients in the postmenstrual period using two dimension vaginal probe of Voluson 730 Pro (GE ® Medical System, USA) US machine, equipped with a transvaginal probe RIC5-9H 5-9MHz (fig.1).

Patients preparation for the examination was minimal, neither prophylactic antibiotics nor analgesic were given before the procedure.

Patients were examined in the lithotomy position with an empty bladder under aseptic conditions. Then, the probe frequency was setted at 9 MHz.



Fig.(1): Voluson 730"General Electric" (The ultra sound machine used in the study at Benha University Hospital). After performing transvaginal ultrasound, A sterile speculum was inserted into the vagina. The external cervical os was localized and cleansed with povidone iodine solution. Insertion of pediatric foley's catheter (size 8 FR, 30cm length, 2.7mm diameter, Ultramed, Egypt) into the cervix (fig. 2).



Fig. (2): A sterile Latex 8 FR ballooned Folly's catheter.Quoted from **Healthmad.com**.

After insertion of the catheter into the cervix, its balloon tip was then inflated with 1–2mL of saline. The speculum was then removed carefully to avoid dislodging of the catheter ⁽¹⁴⁾. Twenty milliliter syringe which was prefilled with the distending media (saline) was fitted to the catheter (fig. 50). The vaginal probe of the 2D-US was introduced in the posterior vaginal fornix. The uterus was then visualized in the longitudinal plane to demonstrate the endometrial cavity. Once this is possible, sterile saline was slowly injected through the catheter into the uterine cavity up to ten milliliter of saline is usually enough for the procedure.

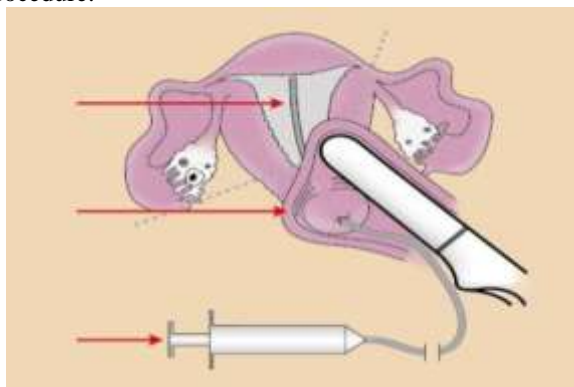


Fig.(3): The technique of 2D-SIS. From above, the 1st arrow denotes to the Folly's catheter placed intrauterine, the 2nd arrow denotes the posterior vaginal fornix and the 3rd arrow denotes the syringe which was used. Quoted from **Parson** ⁽¹⁵⁾.

Three Dimensional Transvaginal Ultrasound:

Three dimensional vaginal ultrasound was done for all the patients with Voluson 730 Pro (GE ® Medical System, USA) US machine, equipped with a transvaginal probe RIC5-9H 5-9MHz.

The patient was asked to evacuate the bladder before examination. Then, examination was performed in lithotomy position. The probe was introduced into the vagina covered with a condom filled and covered with echo gel.

Hysteroscopy:

Diagnostic Hysteroscopy:

The procedure of diagnostic hysteroscopy was performed with the use of 4 mm telescope with an angle of 30 degree (Karl Storz, Germany). The diagnostic shaft of the hysteroscope is 5 mm in diameter.

Statistical Analysis

In all studied cases, the results of 3D-TVS, 2D-SIS, and DHS were compared to each other regarding their sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy (DA). Diagnostic hysteroscopy (DHS) was regarded as the gold standard with which other methods of scanning were compared. The results were estimated through the test performance parameters.

3.Results

The following table (1) shows abnormal uterine findings in the HSG that necessitated further study of the patients:

Group I: Congenital uterine anomalies.	72 cases
Group II: Filling defect (uterine fibroid and polypi).	104 cases
Group III: Multiple irregular filling defects (intrauterine adhesions).	24 cases

The following table (2) shows the final diagnosis after diagnostic hysteroscopy (DHS) was performed, which was regarded as the gold standard with which other methods of scanning were compared:

	Abnormal cases	Normal cases
Group I: Congenital uterine anomalies.	60	12
Group II: Uterine fibroid and polypi.	80	24
Group III: Intrauterine adhesions.	24	0
Total	164	36
Percentage	82%	18%

In Group I: (N=72 cases), HSG showed congenital uterine anomalies. No. of detection of positive and negative cases by other methods of scanning is shown in the following table (3):

		2D-SIS	3D-TVS	DHS
Group I : (N=72 cases) by HSG.	+ve	52	64	60
	-ve	20	8	12

Taking diagnostic hysteroscopy (DHS) as the gold standard in the diagnosis of congenital uterine anomalies in Group II (N=18 cases), the following table shows the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of other methods of scanning used:

Table (4): Validity of 3D U/S in prediction of Congenital anomalies.

Hysteroscopy	Abnormal		Normal		Statistical test	P value
	No (60)	%	No (12)	%		
3D U/S						
Abnormal	60	100	4	33.3	FET= 38.5	<0.001**
Normal	0	0.0	8	66.7		
AUC	0.933 (0.877-0.989)					
Sensitivity	100					
Specificity	66.7					
PPV	93.8					
NPV	100					
Accuracy	94.4					

So, in congenital uterine anomalies (Group I): 3D-TVS was the best method of diagnosis as it was an excellent test followed by 2DSIS which was a good test as shown in the ROC table.

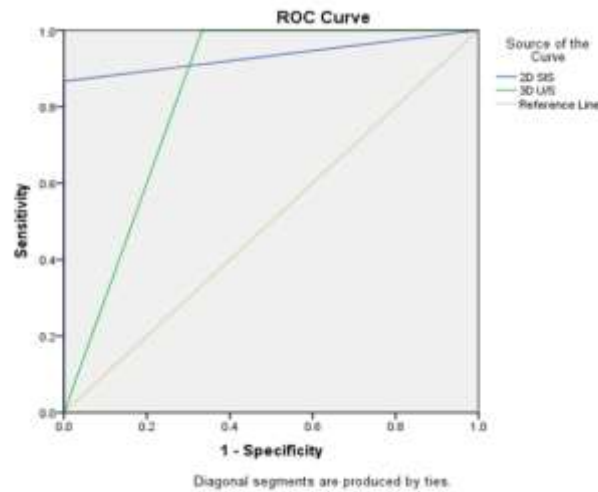


Fig.(4): ROC curve of Validity of 2D SIS and 3D U/S in prediction of congenital anomalies.

In Group II: (N=104 cases) HSG showed a filling defect (fibroid and polypi). No. of detection of positive and negative cases by other methods of scanning is shown in the following table (5):

Group II: (N=104cases) by HSG.		2D-SIS	3D-TVS	DHS
		+ve	84	88
	-ve	20	16	24

Taking diagnostic hysteroscopy (DHS) as the gold standard in the diagnosis of uterine fibroid and polypi in Group I (N=26 cases), the following table shows the sensitivity, specificity, positive predictive value

(PPV), negative predictive value (NPV) and diagnostic accuracy of other methods of scanning used:

Table (6): Validity of 2D SIS in prediction of filling defects.

Hysteroscopy	Abnormal		Normal		Statistical test	P value
	No (80)	%	No (24)	%		
2D SIS					FET= 77.26	<0.001**
Abnormal	80	100	4	16.7		
Normal	0	0.0	20	83.3		
AUC (95%CI)	0.917 (0.828-1.0)					
Sensitivity	100					
Specificity	83.3					
PPV	95.2					
NPV	100					
Accuracy	96.2					

Table (7): Validity of 3D U/S in prediction of filling defects.

Hysteroscopy	Abnormal		Normal		Statistical test	P value
	No (80)	%	No (24)	%		
3D U/S					FET= 58.01	<0.001**
Abnormal	80	100	8	33.3		
Normal	0	0.0	16	66.7		
AUC (95% CI)	0.833 (0.716-0.951)					
Sensitivity	100					
Specificity	66.7					
PPV	90.9					
NPV	100					
Accuracy	92.3					

So, in uterine fibroid and polypi (Group II): 2D-SIS was the best method of diagnosis as it was an excellent test followed by 3D-TVS which was also an excellent test in the diagnosis as shown in the ROC table.

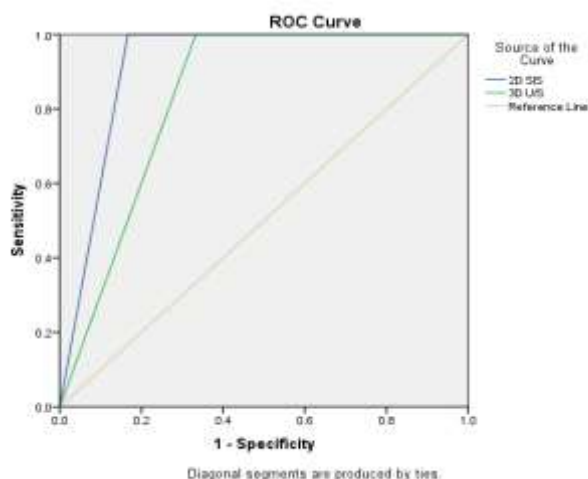


Fig.(5): ROC curve of Validity of 2D SIS and 3D U/S in prediction of filling defect.

In Group III (N=24 cases): HSG showed intrauterine adhesions. No. of detection of positive and negative cases by other methods of scanning is shown in the following table:

Table (8): Distribution of cases with adhesions according to 2D SIS, 3D U/S and hysteroscopy findings.

Adhesions	No (24)	%
2D SIS		
Abnormal	16	66.7
Normal	8	33.3
3D U/S		
Abnormal	12	50.0
Normal	12	50.0
Hysteroscopy		
Abnormal	24	100
Normal	0	0.0

4. Discussion

According to our findings, HSG demonstrated the following characteristics: For 72 women, abnormalities in the placenta were discovered at birth (5 cases involved the septum, 4 cases involved the cervicofundal septum and 1 case involved the bicornus), for 104 women, irregularities in the intrauterine filling were discovered (44 polyps, 56 fibroids and 4 irregular filling defects) and for 24 women it was discovered that there were internal adhesions (20 fine adhesions and 4 coarse adhesions).

DHS (the gold standard) was used to diagnose 200 patients in the study, and the findings were as follows: Eighty-two percent of the patients had pathological lesions, whereas only eighteen percent of the cases had abnormalities. Congenital uterine malformations were found in 60 instances; intrauterine filling deficits were found in 80; and adhesions were seen in six.

A total of 152 instances (76 percent) were found to be abnormal, whereas 48 cases (24 percent) were found to be normal using 2D sonohysterography. 3D US, on the other hand, yielded the following results: 164 instances of abnormality (82 percent) and 36 cases of normality (18 percent).

Uterine malformations present at birth (Group I) are classified as follows: Diagnostically, 3D-TVS was the most accurate (DA=94.4), followed closely by 2DSIS (DA=88.9), which was superior to intrauterine filling abnormalities (Group II): The best diagnostic test

was 2D-SIS (DA=96.2), followed by 3D-TVS (DA=92.3), which was also an outstanding diagnostic test. And in Group III (intrauterine adhesions), 2D-SIS was an excellent test (66.7%), but 3D-TVS was a bad test (50%) compared to hysteroscopy in diagnosing the condition (100 percent)

Studies comparing HSG, 2D-TVS and DHS in the diagnosis of congenital uterine abnormalities have been undertaken several times. We found that the results of Alborzi et al. (16) were in line with our findings, as they concluded that HSG is a good predictor in the diagnosis of congenital uterine anomalies, but it cannot reliably differentiate between bicornuate and septate uterus. Furthermore, the findings of Traina et al. (17) were in agreement with our own findings.

When evaluating the diagnostic accuracy (DA) of HSG and DHS in the diagnosis of these anomalies in 106 patients with a history of recurrent abortion after considering DHS/laparoscopy as the gold standard method for diagnosis, Raziq et al. (18) found that HSG has a low accuracy with a high false +ve rate in the diagnosis of congenital uterine anomalies. Another person who came to the same conclusion was Naila (19).

Pellerito et al. (20) found that 2D-TVS has a high accuracy and low false positive rate in the diagnosis of congenital uterine anomalies in a study comparing the diagnostic accuracy (DA) of HSG, 2D-TVS, and MRI in the classification of these anomalies among 26 infertile

patients, with a reference to DHS/laparoscopy as the gold standard method for the diagnosis.

Instead, Nicolini et al. (21) found that 2D-TVS had a low accuracy in the diagnosis of congenital uterine anomalies when they conducted a study to estimate the prevalence of these anomalies in 98 patients without knowledge of the patients' history or the results of previous ultrasonographic or radiologic investigations after considering DHS/laparoscopy as the gold standard method for diagnosis.

Similar results were obtained for 2D-SIS by Guimaraes Filho et al. A similar finding was reached by Ludwin A et al. (23), who went on to say 2D-SIS provides a greater diagnostic accuracy (DA) than DHS alone in the distinguishing between arcuate, bicornuate, and septate uterus.

When Momtaz et al. (24) conducted a study to evaluate the use of 3D-TVS in the assessment of these anomalies and other uterine cavity lesions in 38 patients who were detected from 132, they met our results because they concluded that this method is valuable, non-invasive, and more useful than HSG and 2D-TVS not only in the diagnosis of congenital uterine anomalies but also in the differentiation between bicornuate and septate uterus. Many researchers, including Ghi et al. (25), Miseljc N et al. (26), and Ahmadi et al. (27), obtained the same finding (10).

SMF diagnosis HSG findings showed no false positives. Transvaginal sonography in two dimensions, three dimensional, and two dimensional SIS all agreed completely with the gold standard in diagnosing all patients. 3D-TVS, on the other hand, could only replace this gold standard in the diagnosis because the reconstructed image produced by the 3D frontal view of the uterus allowed accurate assessment of the site, size, and shape of SMF, and was more informative about the relation to myometrium (the intramural part of fibroid) especially for the decision of management either myomectomy through open surgery or hysteroscopic myomectomy.

This lesion was found in 14 of the individuals tested who had HSG that suggested endometrial polypi, however it was non-specific for its diagnosis and could not distinguish between SMF polyps and other endometrial polps.

More than one study has compared uterine cavity lesions such as SMF and endometrial polyps diagnosed using HSG, 2D-TVS, 2D-SIS, 3-dimensional tomography (HDTV), and DHS to these methods. When Fayez et al. (27) evaluated the diagnostic accuracy (DA) of HSG in comparison to DHS in the evaluation of 400 infertile patients, they found that this method was useful in the evaluation of uterine cavity lesions such as endometrial polypi and SMF, and that even DHS added only a small amount of information over HSG in diagnosis, especially when HSG results were negative.

Golan et al. (28) found, on the other hand, that HSG was unable to accurately identify SMF and endometrial polyps. When they did a research to evaluate diagnostic accuracy (DA) between HSG and

DHS, they concluded that DHS was the gold standard technique for diagnosing infertility in 406 infertile individuals, hence HSG should be fully replaced as the first line of infertility inquiry.

This study shows that HSG did not produce any false positives. Two-dimensional transvaginal sonography (2D-TVS) had a limited role in the diagnosis as it diagnosed just 1 patient whereas 3D-TVS and 2D-SIS enhanced the outcomes of 2D-TVS by additional diagnosis of 1 and 2 patients respectively. As a result, we concluded that DHS was the best method for diagnosing IUAs because it was the only method that correctly diagnosed the patient with thick IUAs who had been misdiagnosed by 2D-TVS, 3D-TVS, and 2D-SIS as a patient with two endometrial polyps and the patient with marginal IUAs, respectively. There are just a few studies comparing HSG, 2D-TVS, 2D-SIS, 3D-TVS, and DHS in the diagnosis of IUAs, therefore it is difficult to draw any firm conclusions on the accuracy with which these adhesions may be classified by DHS. According to Fayez et al. (27), who conducted a research on HSG and determined that it is as accurate as DHS in diagnosing IUAs, our findings were supported by their findings (27).

On the other hand, Raziel et al. (18) found in a previous investigation that HSG was not reliable in the diagnosis of IUAs, reporting that more than one-third (38.3%) of HSG had erroneous (+ve) results. Soares et al. (29) came to the same result, as did the researchers.

Numerous writers, such as Soares et al. (29) and Momtaz et al. (40), concurred with our findings on the limited diagnostic accuracy of 2D-TVS in the diagnosis of IUAs (24).

In a study evaluating the diagnostic accuracy (DA) of 2D-SIS in the detection of uterine cavity lesions including IUAs in 65 infertile patients, comparing its results with those of HSG and 2D-TVS with a reference to DHS as the gold standard, Soares et al. (29) met our results by concluding that this method has a higher accuracy than 2D-TVS but a lower accuracy than that obtained by HSG in the diagnosis of IUA

According to Salle et al. (30), 2D-SIS should be performed in all patients suspected of having IUAs who undergo HSG, 2D-TVS, and 2D-SIS before undergoing hysteroscopy (the gold standard procedure) under laparoscopic or US guidance, based on their study of 90 patients who had been diagnosed with IUAs based on their clinical histories. When it comes to diagnosing IUAs, Momtaz et al. (31) found that 2D-SIS was more accurate than 3D-TVS.

The findings of Sylvestre et al. (32), who conducted a study to evaluate the diagnostic accuracy (DA) of 3D-TVS in the detection of uterine cavity lesions among 209 patients suspected of having an intra-uterine lesion at HSG or 2D-TVS, with a reference to DHS as the gold standard method for the diagnosis, were in line with our findings. But they found that 3D-TVS was more accurate than 2D-TVS in making

diagnoses. In addition, the findings of Momtaz et al. (24) and Momtaz et al. (31) were in agreement.

To the contrary, in a study of 54 infertile patients with HSG suggesting IUAs and after considering DHS as the gold standard method for diagnosis, Cohen and Copperman (33) found that 3D-TVS provides a more accurate diagnosis of IUAs and determines the extent of cavity damage than HSG. This is especially true when distinguishing between severe IUAs and a lower uterine segment outflow obstruction. Furthermore, they argued that HSG-based grading systems for IUA severity should be updated to include 3D-US results..

Every research that looked at DHS considered it to be the gold standard for treating IUA adhesions since it offered a diagnostic, categorization, and therapy all at the same time.

5. Conclusion

SMF, endometrial polyps and congenital uterine defects may all be detected with ultrasound and digital high-resolution sonography (DHS).

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