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Accuracy of Three Dimensional Saline Infusion Sonohysterography Compared to Magnetic Resonance Imaging in the Differential Diagnosis of Septate, Bicornuate and Arcuate Uteri

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ABSTRACT

Objective: *To establish the accuracy of three dimensional sonohysterography (3D-TVUS) compared with magnetic resonance imaging (MRI) in the differentiation between septate, bicornuate, and arcuate uterus.*

Patients and Methods: *Fourty women suspected to have septate, bicornuate uterus by examination by hysterosalpingography and/or two dimensioned ultrasound the patients were evaluated with 3D-Sonohysterography and MRI followed by combined hysteroscopy and laparoscopy. Sensitivity and specificily, positive predictive values, and negative predictive values were calculated using the endoscopy as the gold standard method of diagnosis.*

Results: *Three-dimensional sonohysterography in differentiation of septate from bicornuate and arcuate uterus, has a sensitivity of 90%, specificity 94%, PPV 91%, NPV 95%, with overall accuracy 93% while magnetic resonance imaging, had a sensitivity of 95%, specificity 100%, PPV 94%, NPV 96%, with overall accuracy 97%.*

Conclusion: *Despite MRI is superior over 3D-Sonohysterography in differentiation between septate from bicornuate uterus, Three-dimensional SIS has higher accuracy in the differentiation between septate and bicornuate uterus, so it is recommended as the first step in evaluation of the uterine cavity in work up of infertility and recurrent miscarriage.*

Keywords

Three-dimensional ultrasound, Magnetic uterus imaging, Septate uterus, Bicornuate uterus, Recurrent miscarriage.

Introduction

Congenital uterine anomalies, which can arise from malformations at any step of the mullerian developmental process, are present on 5.5% of the unselected Population, in 8% of infertile women and in 13.3% of women with histories of miscarriages [1,2]. Of the 7 classes of innate uterine anomalies, according to ESHRE-ESGE Classification system, Cases of septate uteri class II (U2); bicornuate uteri Class III (U3) are the most common and account for up to the 85% of anomalies [3].

Anatomic differences and their potential impact on fertility determine the distinct therapeutic approach with regard to particular anomaly. Only in cases of septate uterus, which is associated with some of the poorest reproductive outcomes, is surgical correction performed. Hysteroscopic resection of the septum in women with recurrent spontaneous abortions decreases the risk of pregnancy loss from 45.6% to 5.9% with arcuate and bicornuate anomalies, which have a less adverse impact on pregnancy [4].

Because of the different therapeutic approaches for each of these uterine defects, it is necessary to establish a straight forward algorithm of differential diagnosis [5,6].

Unfortunately, conventionally used imaging techniques, Such as 2D ultrasound (2D-US) and hysterosalpingography have a tendency to misclassify uterine abnormalities. The use of

hysteroscopy alone is considered to be a sub optional method in the diagnosis of mullerian dust anomalies [7,8].

For these reasons, hysteroscopy performed in conjunction with laparoscopy has been adopted as the gold standard in the differential diagnosis of the above mentioned anomalies.

Magnetic resonance imaging (MRI) technique has been reported to have high accuracy in the evaluation of mullerian duct anomalies as it provides higher accuracy in the visualization of the external contour and the uterine cavity and in subsequent diagnosis of the entire anomaly. Access to MRI imaging is limited and cost consuming [9,10]. Three dimensional ultrasound (3D-US) is a non-invasive reproducible and low cost technique that has the added advantage of being able to capture the coronal plane that provides clear frontal view of the uterus and its anatomical details. Adding saline infusion inside the cavity and performing sonohysterogram enhances the diagnostic accuracy in differentiation between bicornuate, septate, and arcuate uteri. Accordingly, 3D-SIS could be a viable alternative to MRI [10,11].

Materials

Study setting

The study was conducted in El-Shatby Maternity Hospital, Alexandria, Egypt.

Study Design

Cross Sectional Study.

Study Subjects

This study included forty patients with a suspected diagnosis of septate or bicornuate uterus based on two dimensional (2D) ultrasonography or hysterosalpingography (HSG), on workup for recurrent miscarriage and infertility.

Sample size calculation

Using pass software version 12 for size calculation. The minimum sample size required to 40 patients to detect 2% Prevalence rate of Müllerian duct anomalies (MDA) with 5% error, at 80% power and 5% level of significance.

Sampling technique

Forty patients are randomly selected from out patient's clinic in Shatby Maternity University Hospital.

Methods

Every Female in the study sample was subjected to the followings

- Three dimensional saline infusion sonohysterography (Transvaginal 3D-SIS).
- Non Contrast Pelvic magnetic resonance imaging.
- Combined hysteroscopy and laparoscopy to confirm diagnosis and managing the underlying anomaly.

The data obtained was analyzed retrospectively according to ESHRE-ESGE consensus for classification of MDAs. Written consent was taken from all patients, with full explanation of the procedures. Patients with uterine myomas or other masses and patients with previous uterine surgery were excluded from the study.

Three-dimensional saline infusion Sonohysterography

All ultrasound examinations were performed using ultrasound machine, equipped with a variable frequency (2.9-10 MHz) transvaginal probe.

The settings used during the examination were constant for all patients: Power 100%; gain7. The volume data were observed in three orthogonal planes in addition to the reconstruction. 3D-SIS scan is best done as the menstrual flow finishes, the day 5-9 of menstrual cycle. The patients asked to empty urinary bladder, speculum is placed in to the vagina and soft plastic catheter is introduced inside the uterus through cervical canal. A small amount of normal saline inserted into the uterus thus allowing the endometrium to be clearly visualized.

The ultrasound diagnosis of uterine anomalies was based on ESHRE-ESGE consensus for classification of MDAs.

For the diagnosis of bicornuate uterus, the process as follows

Class U3 or bicorporeal uterus incorporates all cases of fusion defects. As bicorporeal is defined the uterus with an abnormal fundal outline; it is characterized by the presence of an external indentation at the fundal midline exceeding 50% of the uterine wall thickness. This indentation could divide partly or completely the uterine corpus including in some cases the cervix and/or vagina.

For the diagnosis of septate uterus, the process is as follows

Class U2 or septate uterus incorporates all cases with normal fusion and abnormal absorption of the midline septum. Septate is defined as the uterus with normal outline and an internal indentation at the fundal midline exceeding 50% of the uterine wall thickness. This indentation is characterized as septum and it could divide partly or completely the uterine cavity including in some cases cervix and/or vagina [3].

ESHRE/ESGE classification
Female genital tract anomalies

Uterine anomaly			Cervical/vaginal anomaly	
Main class		*Sub-class*	*Co-existent class*	
U0	Normal uterus		C0	*Normal cervix*
U1	Dysmorphic uterus	**a.** T-shaped **b.** Infantilis **c.** Others	C1	*Septate cervix*
U2	Septate uterus	**a.** Partial **b.** Complete	C2	*Double 'normal' cervix*
U3	Bicorporeal uterus	**a.** Partial **b.** Complete **c.** Bicorporeal septate	C3	*Unilateral cervical aplasia*
U4	Hemi-uterus	**a.** With rudimentary cavity (communicating or not horn) **b.** Without rudimentary cavity (horn without cavity/no horn)	C4	*Cervical aplasia*
U5	Aplastic	**a.** With rudimentary cavity (bi- or unilateral horn) **b.** Without rudimentary cavity (bi- or unilateral uterine remnants/aplasia)	V0	*Normal vagina*
U6	Unclassified malformations		V1	*Longitudinal non-obstructing vaginal septum*
			V2	*Longitudinal obstructing vaginal septum*
			V3	*Transverse vaginal septum and/or imperforate hymen*
			V4	*Vaginal aplasia*

Figure 1: Scheme for the classification of female genital tract anomalies according to the new ESHRE/ESGE classification system [3].

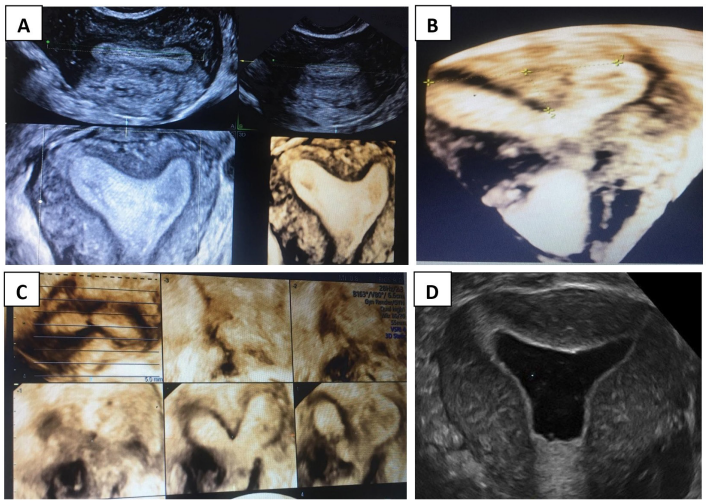

Figure 2: (A) 3D image of arcuate uterus. (B) 3D image of bicornuate uterus. (C) 3D image of incomplete uterine septum. (D) 3D image of normal uterus with saline infusion sonohysterography.

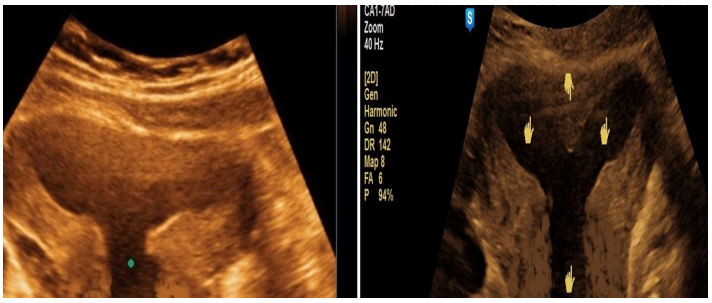

Figure 3: 3D-SIS coronal view of the uterus: normal (A) and arcuate (B).

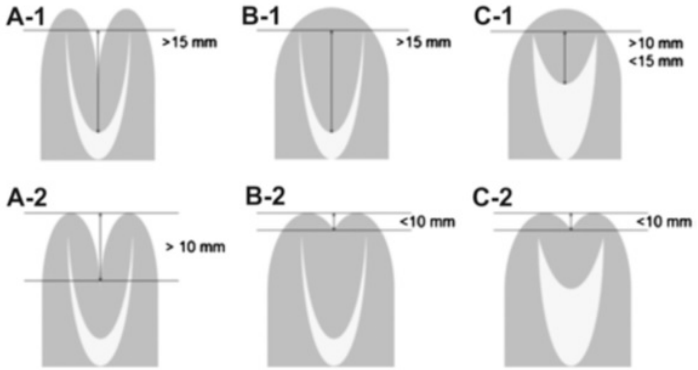

Figure 4: Diagnosis of bicornuate (A), septate (B), and arcuate (C) uteri by 3D-TVS and 3D-SIS on the coronal planes; (1) Distance between the interostial line and the uterine fundus; (2) Outer surface: distance between intercornual line and present cleft between the horns/the apex of fundal external contour (adopted from Ludwin et al. [12]).

Magnetic resonance imaging

The protocol for performing MRI in women with suspected uterine abnormalities included the following sequence: Axial T1 weighted fat spin echo (FSE), axial FSE T1 weighted with fat saturation, axial-T2 weighted FSE, sagittal T2 weighted FSE, oriented according to the uterine axis, and coronal T2 weighted FSE, oriented parallel to the major uterine axis. It generally took about 20 minutes to perform MRI for suspected uterine anomalies plus 15 minutes for pas processing.

When differentiating bicornuate from septate uteri using MRI, all cases with an incision >1 cm deep in the fundus were considered to be bicornuate uterus.

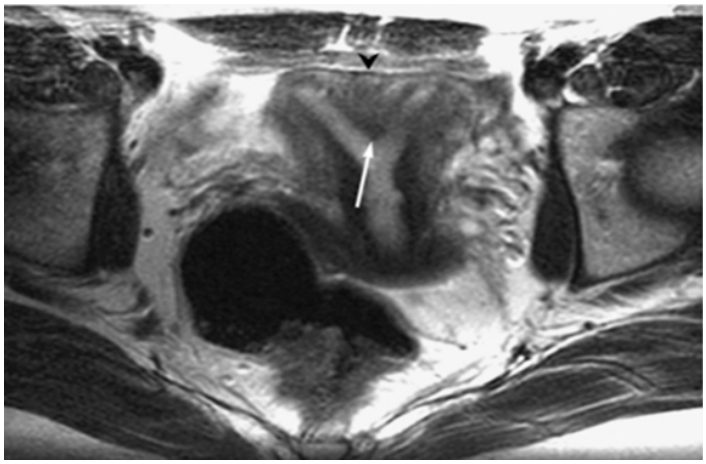

Figure 5: Septated uterus. Axial T2-weighted image demonstrates a partial septum dividing the endometrial cavity (arrow) and a nonclefted uterine fundus (arrowhead).

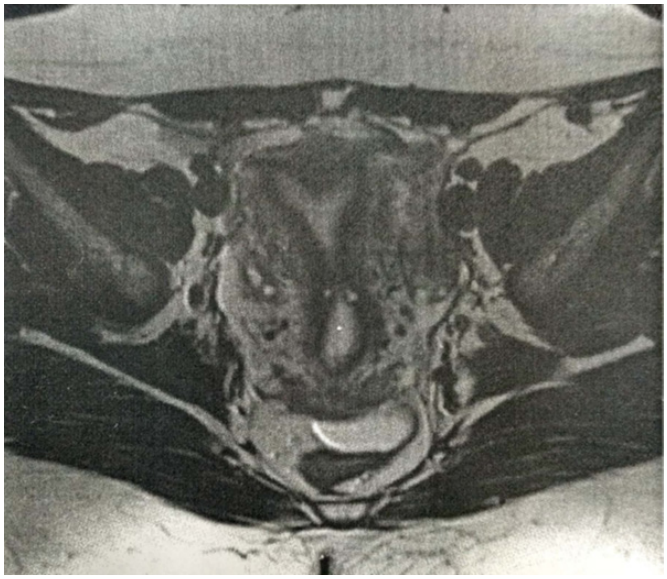

Figure 6: A case diagnosed as arcuate uterus. Axial oblique T1 MR Image showing broad saddle shaped indentation at the fundal portion of the uterine cavity with normal external fundal contour.

Figure 7: Bicornuate unicollis uterus. Axial T2-weighted image demonstrates a clefted fundus (white double-headed arrow) and single cervix (black arrow).

Combined hysteroscopy and laparoscopy

Both hysteroscopy and laparoscopy done in all the studied patients aiming at confirmation of the diagnosis and management of the abnormality present (hysteroscopic resection of uterine septum in cases of septate uterus) [14].

The data collected from 3D-SIS and MRI imaging, combined hysteroscopy and laparoscopy were evaluated retrospectively in accordance with ESHRE-ESGE consensus.

Results

This study was conducted on 40 patients suspected to have septate or bicornuate either uterus based on two – dimensional (2D). Ultrasonography and/or hysterosalpingography (HSG), on work up for recurrent miscarriage and infertility. All the patients included in the study were revaluated with three – dimensional saline infusion sonohysterography (transvaginal 3D – SIS) And Non Contrasts magnetic resonance imaging.

There after laparoscopy or hysteroscopy or combination of both were done aiming at verify the diagnosis and management of the under lying anomaly.

According to the three dimensional saline infusion sonohysterography

Three patients (7.5%) were class U0, normal uterus, three patients (7.5%) were class U1, dysmorphic, uterus 18 patients (45%) were class U2, septate uterus, and 16 patients (40.0%) were class U3, bicorporal uterus.

According to MRI findings

Two patients (5.0%) were class U0, normal uterus, four patients (10.0%) were class U1, dysmorphic uterus (arcuate uterus) 22 patients (55.0%) were class U2, septate uterus, and 12 patients (30.0%) were class U3, bicorporal uterus.

According to final diagnosis mad by endoscopic intervention

Two patients (5.0%) were class U0, normal uterus, four patients (10.0%) were class U1, dysmorphic uterus (arcuate uterus), 20 patients (50.0%) were class U2, septate uterus, 14 patients (35.0%) were class U3 bicorporal uterus.

Uterus	3D/sonohysterography		Endoscopy	
	No.	%	No.	%
U0 (normal uterus)	3	7.5	2	5
U1 (Dysmorphic uterus)	3	7.5	4	10
U2 (Septate uterus)	18	45	20	50
U3 (bicorporeal uterus)	16	40	14	35
Sensitivity	90			
Specificity	94			
Accuracy	93			
Positive Predictive Value	91			
Negative predictive value	95			

Table 1: Three dimensional sonohysterography accuracy in differential of septate and bicorporal uterus "n=40".

Uterus	MRI		Endoscopy	
	No.	%	No.	%
U0 (normal uterus)	2	5	2	5
U1 (Dysmorphic uterus)	4	10	4	10
U2 (Septate uterus)	22	55	20	50
U3 (bicorporeal uterus)	12	30	14	35
Sensitivity	95			
Specificity	100			
Accuracy	97			
Positive Predictive Value	94			
Negative predictive value	96			

Table 2: Shows MRI accuracy measures in differential of septate for bicorporal uterus. "n=40".

Discussion

Mullerian duct anomalies (MDAs) are congenital entities that result from non-development, defective vertical or lateral fusion, or resorpation failure of mullerian (Paramesonephric) ducts. The ESHRE-ESGE established a new classification system of congenital uterine malformation which is simple and correlates with patient's management. The congenital uterine anomalies may lead to different reproductive problems as primary amenorrhea, infertility, menstrual irregularities, or recurrent miscarriage. The diagnosis of MDAs can be achieved by ultrasound, hysterosalpingography and magnetic resonance imaging.

Hysterosalpingography (HSG) is a traditional method of identification of anomalies of the reproductive system [12].

This technique is known to be helpful in demonstrating tubal potency and intrauterine adhesions but it necessitates exposure to contrast material and ionizing radiation.

We tried to investigate whether the use of 3D-SIS in the diagnosis of these anomalies adds any benefits compared with other imaging techniques, such as 3D-US and MRI, for which good diagnostic accuracy has been reported.

It turned out that 3D-SIS was the only ultrasound method the findings of which were completely consistent with hysteroscopy/ laparoscopy. It was found that 3D-TVS SIS and MRI were characterized by slightly lower accuracy in the evaluation of the 3 above mentioned anomalies, which were 94 and 97%, respectively.

The 100% accuracy of 3D-SIS, which is a minimally invasive method and does not generate high costs, undermines the authenticity of using much more invasive hystroscopy laparoscopy (HL) in women with infertility or miscarriages only for a final differential diagnosis of the most frequent congenital uterine

anomalies, if these conditions are not accompanied by other medical indications.

This illegitimacy particularly applies to the use of HL or independent hysteroscopy in cases of suspected bicornuate or arcuate uteri, if there is no evidence that surgical treatment would be beneficial.

It seems that the use of endoscopic methods can be limited to their therapeutic use during metroplasty of the uterine septum. The accuracy of ultrasound methods, particularly of MRI and 3D-SIS by an experienced clinician, might also justify the decision not to use laparoscopy during hysteroscopic metroplasty, when it would only serve the purpose of differentiating between septate and bicornuate uteri.

The results from our study show that 3D-SIS can also be regarded as an optimal test, which additionally can find application in doubtful cases as a reference method, instead of HL. There have not been many reports regarding the use of 3D-SIS in the differentiation of the uterine anomalies.

Despite the higher precision of 3D-SIS compared with 3D-TVS and 2D-SIS, the differences among these imaging techniques were not statistically significant. Three dimensional ultrasound (3D US) is a valuable method for the diagnosis of uterine anomalies owing to its capacity to demonstrate the coronal plane, with subsequent detection of the morphology of the uterine cavity and the external contour of the uterus and its relation to nearby structures. Moreover, 3DUS has good intra- and inter observer reproducibility in the diagnosis of uterine anomalies [15].

Magnetic resonance imaging is considered the gold standard imaging modality in the diagnosis of congenital uterine malformation. Behr reported that T1 and T2 weighted spin echo sequences required to detect congenital uterine malformations. The fast spin echo T2W images are required for optimum evaluation of the genital anatomy. The T1W images are essential to describe the anatomy and to help in diagnosis of the nature of any fluid collection or associated gynecological lesion. The coronal T1W sequence through the uterine fundus is best for evaluating the fundal contour [16].

Our study aimed at comparing the accuracy of 3D sonohysterography and that of MRI in the diagnosis of MDAS. The overall accuracy of both modalities was similar. However, the MRI found superior than 3D sonohysterography in the diagnosis of septate uterus (Class II) and hemi-uterus (Class IV).

Detuch et al, compared MRI 3DUS results with surgical results, finding that 3D US had a sensitivity of 100% in both diagnosis and categorization of the uterine anomalies [17]. Caliskan et al. [18], compared the diagnostic accuracy of 3DUS with that of laparoscopy and hysteroscopy, and also with MRI in both the first and second phases of the menstrual cycle recording a sensitivity of 94.7% for 3DUS in the follicular phase and 100% in the luteal phase and specificity of 75% in the follicular phase and 93.7% in the luteal phase.

Faivre et al, demonstrated accuracy of 100% for 3DUS in the differential diagnosis between septate and bicornuate uterus, compared with MRI [19].

Ludwin et al, encountered problems in the diagnosis of uterine congenital anomalies according to the ESHRE-ESGE compared with AFS classification. According to ludwin et al. [3], septate uterus is diagnosed in cases in which the uterus full fills previous morphometric criteria for accurate or in some cases normal uteri. On the other hand, Grimbizis et al, asserted that the new system gives a unique opportunity to achieve an objective estimation of the clinical Consequences related the various degree of uterine deformity [20].

Saravelos et al. [21] and Chan et al. [22] suggested that, with the exception of HL, 3D-US and 2D-SIS are the most accurate methods in the evaluation of uterine anomalies and can be used as the ‘‘optimal diagnostic tests’’ in the identification and differentiation of these anomalies.

Conclusion

In conclusion, 3D-SIS, similar to HL, is the most accurate method for the differentiation of bicornuate, septate, and arcuate uteri.

Transvaginal 3D – SIS is accurate for diagnosis and differentiation between septate uterus and bicornuate uterus. We recommend 3D – SIS transvaginal ultrasonography as the first and mandatory step in the assessment of the uterine cavity in patients with a suspected septate or bicornuate uterus, especially before planning surgery. MRI should be preserved for patients in whom 3D TVS not possible like virgins.

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